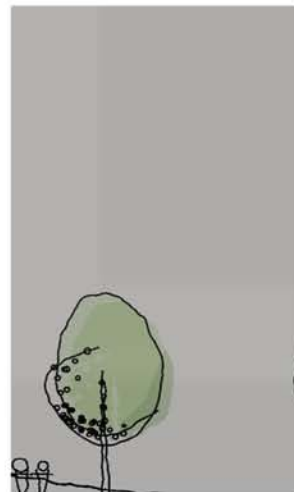
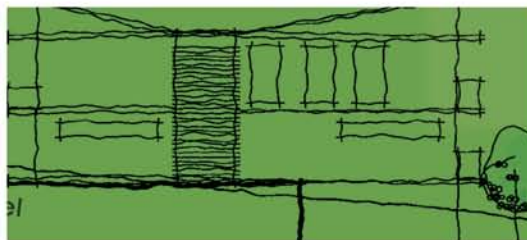




Terrestrial Flora and Fauna Assessment

Proposed WWTP Network – WWTP
Catherine Hill Bay

Prepared for Solo Water



Planit Consulting Pty Ltd
December 2013

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1.0 INTRODUCTION

Planit Consulting has been commissioned to undertake a Terrestrial Flora and Fauna Assessment for a proposed Waste Water Treatment Plant Network development at Catherine Hill Bay.

This report outlines the results of terrestrial flora and fauna surveys and describes vegetation types, habitat associations and ecological values of the Catherine Hill Bay area. It also qualifies the area of native vegetation and quantities of native trees to be impacted by the proposed works and provides recommendations regarding ecological impact mitigation.

In preparing the report, regard for the Threatened Species Conservation Act 1995 has been made throughout the assessment. The assessment has also had regard to the Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water

The proposal will see the construction of a purpose built Waste Water Treatment Plant and Network to service the approved residential estate south of the existing Catherine Hill Bay village. This development obtained Project Approval (MP 10/0204) by the NSW Planning Commission in respect of 550 residential lots, 1 retail lot, 9 reserves, bulk earthworks, infrastructures and two heritage lots. 72 hectares on the site of the former Moonee Colliery.

The Waste Water Treatment Plant and Network (WWTPN) comprises three core elements. These being;

1. the Waste Water Treatment Plant and recycled Water 'third pipe' Network – which is located within the existing approved development footprint;
2. Pump Station - to be built within the the Wyong City Council Reservoir site on Kanangra Drive; and
3. Pipe network – 2.1km of new pipe (0.6km located within the approved development site and 1.5 to be built within Kanangra Road Reserve and within the Water reservoir site) and 4.2km of existing pipeline located within the NPWS/RFS fire trails.

This report is specific to element 1 of the WWTPN, the Waste Water Treatment Plant (WWTP) and recycled water 'third pipe' network, which is located within the development footprint of the approved residential development. The WWTP occupies an area of approximately 1.45ha.

A separate report has been prepared for elements 2 and 3 as part of the pipeline occurs, within and / or adjoining State Conservation Areas (Lake Macquarie State Conservation Area, Cranagan Bay and Munmorah SCA). Office of Environment and Heritage approval under the

National Parks and Wildlife Act 1974 or National Parks and Wildlife Regulation 2009 and a Conservation Risk Assessment is required for these elements.

This report builds upon the lengthy and detailed investigations carried out over the development area which ultimately secured Project Approval. The report provides details of additional investigations over the proposed Waste Water Treatment Plant area and portion of pipeline contained within the project approval footprint area.

Significant to note is the occurrence of a severe bushfire event During October 2013 which modified vegetation and fauna distribution across the locality.

2.0 SITE DESCRIPTION & LOCATION

The proposed Waste Water Treatment Plant and Network (WWTPN) has a relatively small irregular footprint and linear elements typical of an infrastructure related development. Figures 1 – 3 provide the contextual location diagrams for the proposal. Figure 1 illustrating its location at a broad locality level.

Attachment 1 provides a copy of figure 1

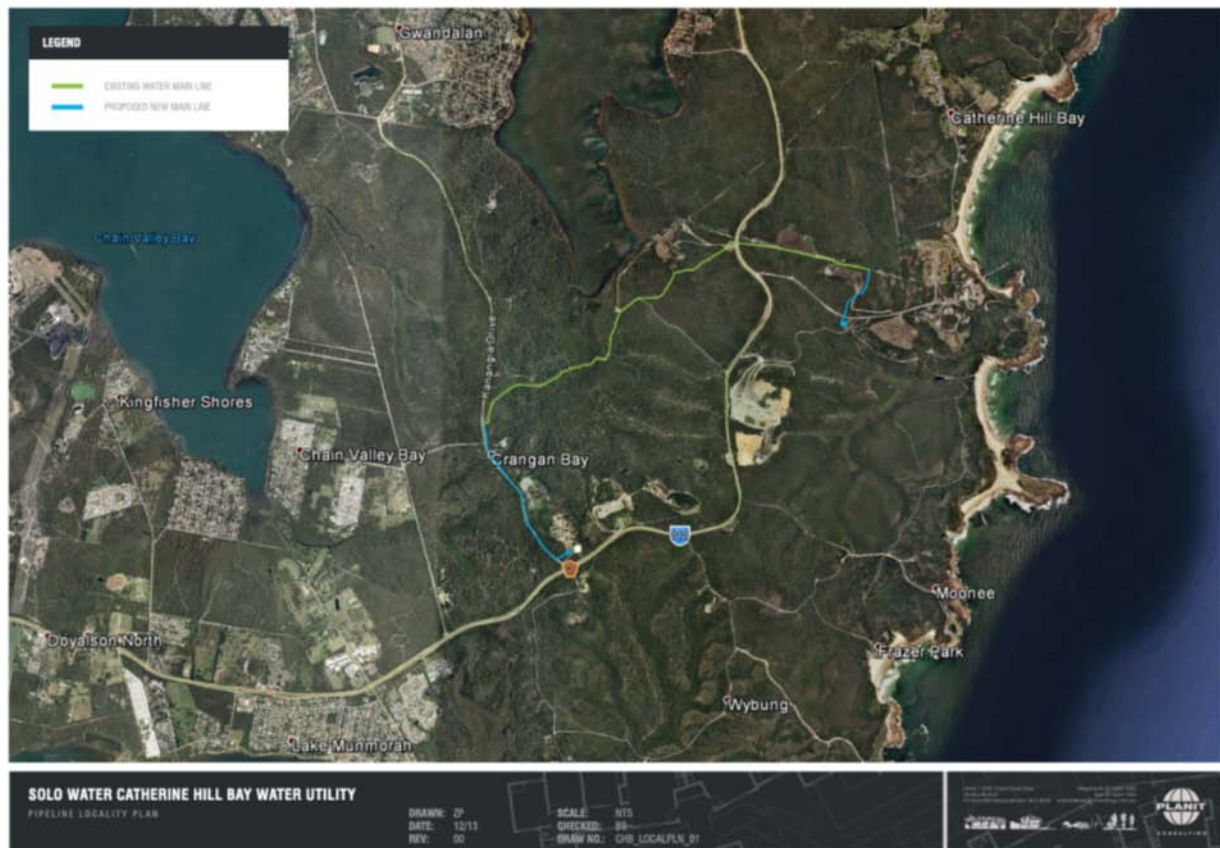


Figure 1 - Locality Plan Noting Proposed New and Existing Pipe Locations

The Waste Water Treatment Plant and Network (WWTPN) as presented in figures 2 and 3 below comprises three core elements. These being;

1. The Waste Water Treatment Plant and Recycled Water 'third pipe' Network – which is located within the existing approved development footprint;
2. Pump Station - to be built within the Wyong City Council Reservoir site on Kanangra Drive; and
3. Pipe network – 2.1km of new pipe (0.6km located within the approved development site and 1.5 to be built within Kanangra Road Reserve and within

the Water reservoir site) and 4.2km of existing pipeline located within the NPWS/RFS fire trails

This report is specific to element 1 of the WWTPN the Waste Water Treatment Plant and Recycled Water 'third pipe' Network, which is located within the existing approved development footprint as illustrated in Figures 2 and 3.

A separate report has been prepared for elements 2 and 3 as the pipeline route occurs within and / or adjoining State Conservation Areas (Lake Macquarie State Conservation Area: Cranagan Bay and Munmorah SCA). Office of Environment and Heritage approval under the National Parks and Wildlife Act 1974 or National Parks and Wildlife Regulation 2009 and a Conservation Risk Assessment is required for these elements.

The WWTPN is presented below;



Figure 2 - Waste Water Treatment Plant and Network (WWTPN) Layout Plan



Figure 3 – Waste Water Treatment Plant (WWTP) Site and Layout

The figures are contained in Attachment 2 which provides the proposal plans and detailed route survey.

As acknowledged the WWTPN is to facilitate an approved residential subdivision. The Waste water Treatment Plant (WWTP) as illustrated above in Figure 3, is located within the development footprint of the approved residential development. The residential development and specific area of the proposed WWTP were subject to lengthy studies and investigations as noted and utilised in this report. The concept plan for the approved development is provided below in Figure 4.

The proposed Waste Water Treatment plant site is located within approved Stage 5 for the development on areas nominated as allotments and has an approximate area of 1.45ha. The WWTP is here after referred to as the site.



Figure 4 - Approved Residential Estate Concept with WWTP Identification in Blue

As is noted in the Director Generals assessment report for the major project approval for the residential development, *'the subject site includes land to the east of the Pacific Highway and to the south and south west of the existing Catherine Hill Bay village (which includes approximately 90 dwellings and urban facilities). The proposed development site lies to the north of the Munmorah State Conservation Area.*

The land proposed to be developed is generally to the north, north west of Moonee Beach. The Catherine Hill Bay development site is located within the Lake Macquarie LGA, and is situated approximately 100 kilometers north of Sydney and 26 kilometers south of Newcastle. Is related includes the approximate 72 ha of land to the south of the existing Catherine Hill Bay village.

The approved residential development comprises several parcels of land to the south and south west of the existing Catherine Hill Bay village. The residential development is limited to land on the southern, south western and southern eastern edge of the existing village of Catherine Hill Bay between the village and the Munmorah State Recreation Area.

The subject land totals 72.3 hectare (ha) in total as set out below. The land is owned by Coastal Hamlets Pty Ltd, which forms part of the Rose Property Group Pty Ltd (the Proponent of the subdivision).

<i>Lot</i>	<i>Deposited Plan</i>	<i>Area (ha)</i>
100	1129872	12.52
101	1129872	44.7115
102	1129872	7.052
103	1129872	0.9816
106	1129872	2.41
1	1141989	0.039
1	1129299	1.547
1	1151628	3.108
Total Area		72.3791

The site forms part of the Wallarah Peninsula with the local topography comprising a dominant ridgeline running in an east-west direction extending from the Pacific Highway in the west to the headland in the east.

A large part of the site comprises disused mining lands with remaining concrete hard stand, former coal storage areas, mine infrastructure, roads, tracks, a dwelling, and parking and maintenance areas.'

The land surrounding the subject WWTP and WWTPN provides extensive and high quality habitat for flora and fauna species. The site is proximate to the Wallarah National Park and Lake Macquarie State Conservation Areas. The WWTP adjoins the Mummorah State Conservation Area as illustrated in Figure 5.

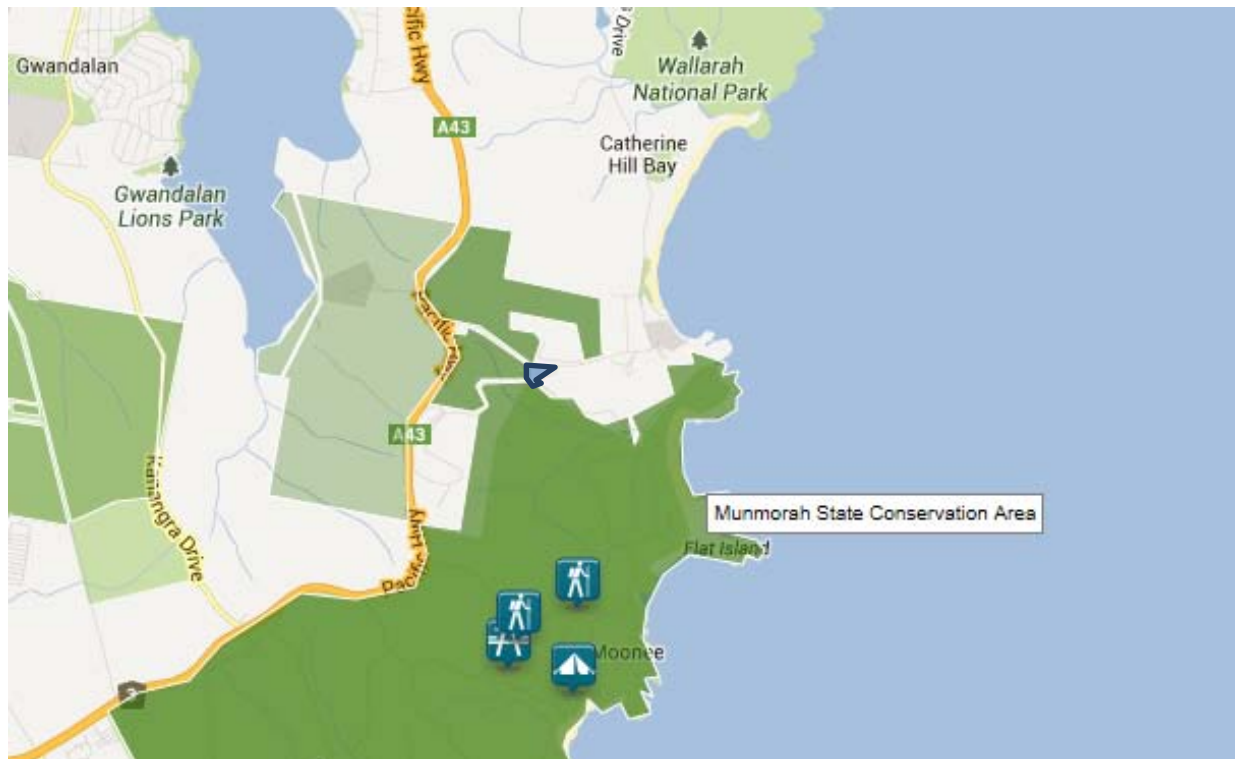


Figure 5 – Map of Adjoining Munmorah State Conservation Area with WWTP identified in Blue.

The WWTPN occurs across 2 Local government areas these being Lake Macquarie and Wyong. The WWTP occurs wholly within Lake Macquarie City Council and its zoning is presented in Figure 6. In accordance with SEPP (Major Developments), the site is currently zoned R2 low density residential.

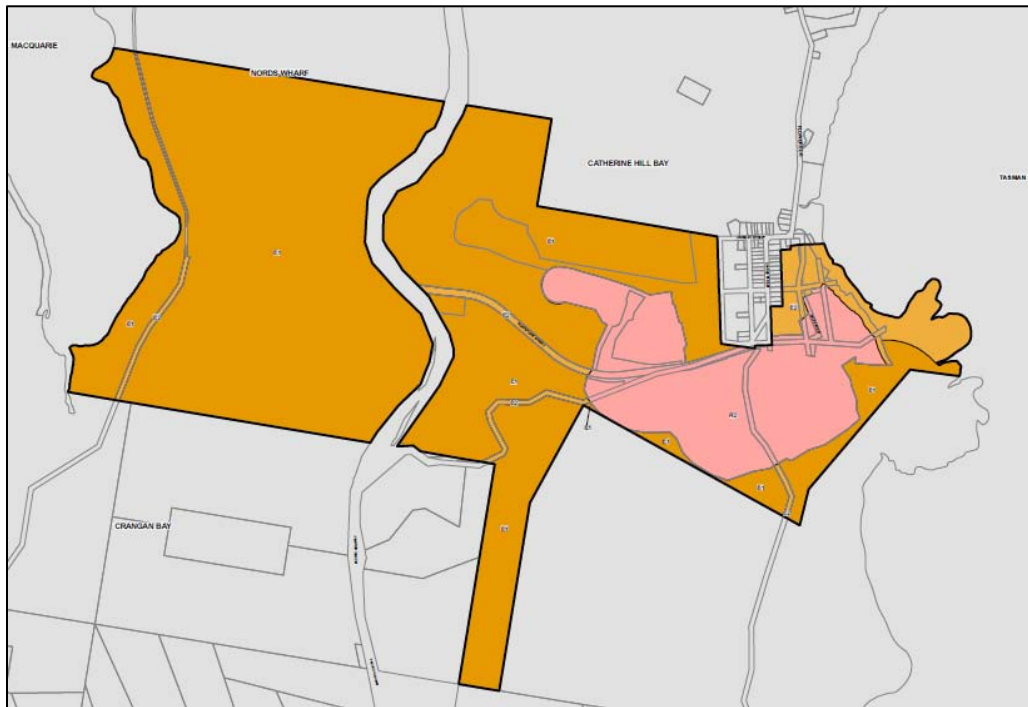


Figure 6 - Land Zoning Map (Source: LMCC 2013)

2.1 EXISTING USE & RESULTANT VEGETATION

Catherine Hill Bay is a secluded old coal mining village in the hinterland behind the Central Coast within the city of Lake Macquarie. In total, Catherine Hill Bay has an estimated population of 153 persons and represents a small and relatively undeveloped community located in natural surrounds.

New Wallsend Company opened up the mine in 1873 which was then taken over by the Wallarah Coal Company and Coal and Allied Group respectively. The Rose Group have obtained approval to develop a large residential estate bordering the existing village. The estate as illustrated in Figure 4 incorporates the proposed WWTP site.

The site features a wide range of flora species with Eucalypts species dominating the upper stratum. Other species such as *Casuarina*, *Xanthorrhoea* and *Acacias* also frequent the site. On the 17th of October 2013, a severe bushfire devastated the site and surrounding areas, modifying the communities. Prior to the bushfire, the site featured a dense understorey with fallen logs and leaf litter frequent.

The images in Figure 7 taken in November 2013 illustrate site conditions at the proposed WWTP.



Figure 7 – WWTP site images (November 2013)

The site vegetation has been extensively described and considered over a number of years and as part of the Major Project Approval for the residential estate by the Director General.

2.2 GEOLOGY MAPPING

Catherine Hill Bay lies in the northern reaches of the Sydney Basin - a major structural basin containing a thick Permian-Triassic (290 Ma - 200 Ma (million years old)) sedimentary sequence that is part of the much larger Sydney-Gunnedah- Bowen Basin.

The Permo-Triassic Sydney Basin is an on/offshore basin located along Australia's eastern margin. The onshore basin lies in New South Wales, while the offshore basin extends into 4500m water depths. The basin covers 64,000 sq. km., with the onshore comprising 36,000 sq. km. and the offshore 28,000 sq. km (Taubert 2002)

The geology of the Sydney Basin is best described by Herbert, (1983). It is predominantly the result of sedimentation and phases of earth movements. The underlying structure of the Basin was laid down during the Permian and earlier geological periods under marine and marshy conditions which, due to major earth movements, produced the sandstone and siltstone formations and intervening coal measures lying at considerable depths underneath the city of Sydney. These coal measures stretch north to Newcastle and outcrop in cliffs along the Hunter Coast.

The rock sequence in the Catherine Hill Bay area marks the transition from coal-bearing Permian strata (250-270 Ma) to barren fluvial Triassic sediments. In particular, the Moon Island Beach Subgroup of the Newcastle Coal Measures (Late Permian), together with basal units of the Triassic Narrabeen Group, outcrop in the Catherine Hill Bay area (Ziolkowski 1978, pp3-8).

The Newcastle Coal Measures are located adjacent to the New England Fold Belt, which was the dominant source of sediment deposited into the Sydney Basin throughout the Permian Era. Deformation and uplift of the New England Fold Belt in the late Early Permian led to the transformation of the Sydney Basin into a foreland basin. Erosion of the active New England Fold Belt led to the deposition of sediments into this basin. The large volume of sediments eroded from the topographically active New England Fold Belt led to a prolonged regressive sequence of deposition forming the Newcastle Coal Measures (McDonnell 2001).

A surface geology map of the Wyong LGA (figure 8) illustrates that the majority of the site features Narrabeen Group (sandstone, siltstone, conglomerate, sandstone, and claystone). Figure 9 illustrates that the majority of the site features in the Triassic Narrabeen Clifton Subgroup.

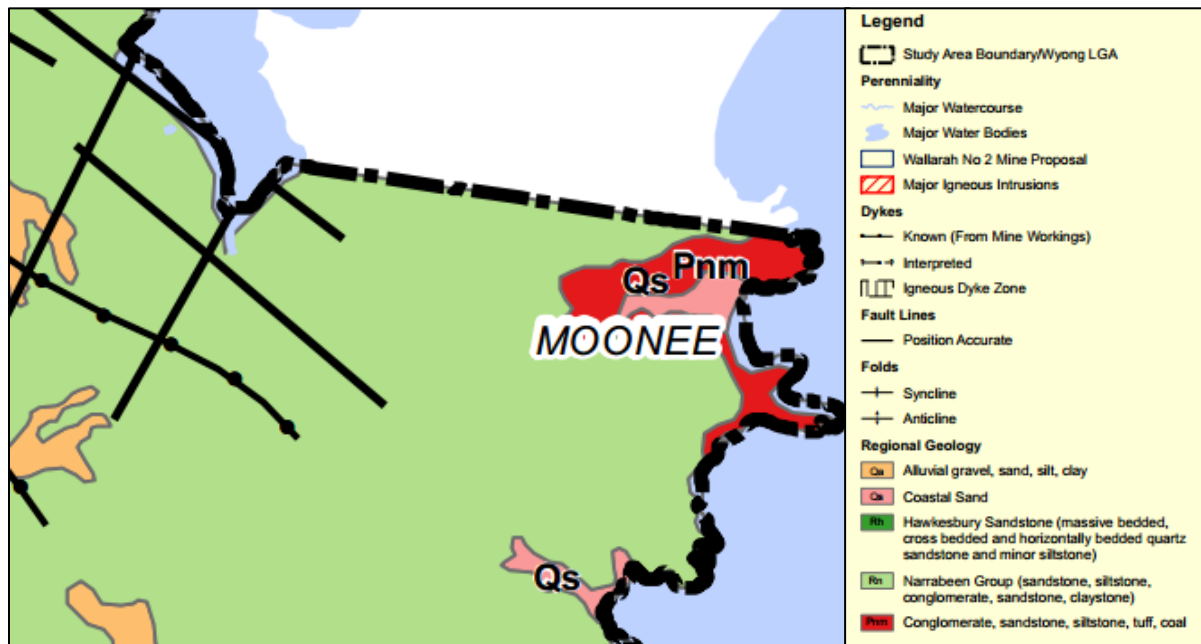


Figure 8 - Generalised Surface Geology Of The Wyong LGA (Source: DoP 2008)

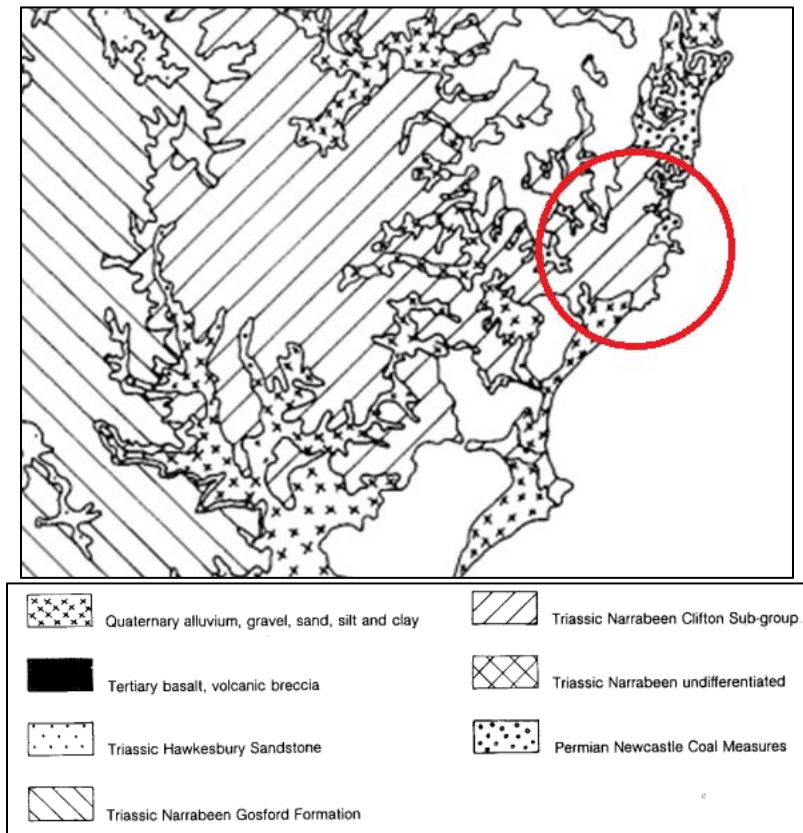


Figure 9 - Geological Map of the Gosford-Lake Macquarie map sheet area (Source: DoM 1966)

2.3 PROJECT DESCRIPTION

The Waste Water Treatment Plant and Network (WWTN) comprises three core elements. These being;

1. The Waste Water Treatment Plant and Recycled Water 'third pipe' Network – which is located within the existing approved development footprint;
2. Pump Station - to be built within the Wyong City Council Reservoir site on Kanangra Drive; and
3. Pipe network – 2.1km of new pipe (0.6km located within the approved development site and 1.5 to be built within Kanangra Road Reserve and within the Water reservoir site) and 4.2km of existing pipeline located within the NPWS/RFS fire trails

This report is specific to element 1 of the WWTPN, the WWTP and Recycled Water 'third pipe' Network, which is located within the existing approved development footprint and has an approximate area of 1.45ha.

A separate report has been prepared for elements 2 and 3.

2.4 EXISTING DRAINAGE

The site has a southerly fall from Montefiore Street with a defined ephemeral drainage line bisecting the lower portion of the site. This drainage ultimately drains to Munmorah State Conservation Area and discharges at Moonee Beach, south of the existing Township.

2.5 AIMS OF STUDY

The aim of this report is to describe the terrestrial flora and fauna habitat of the site and adjoining areas and to examine the potential for the occurrence of threatened species, populations or endangered ecological communities. In order to provide this information, the following objectives are followed:

- Determine and describe the existing flora, vegetation communities, fauna assemblage and associated habitats of the site and adjoining areas,
- Determine the occurrence, or likely occurrence, threatened species, populations, their habitats or endangered ecological communities as a result of survey and literature review,

- Undertake the 7-part test of significance pursuant to Section 5A of the Environmental Planning and Assessment Act 1979,
- Describe the potential direct and indirect impacts of the proposal on existing terrestrial ecological values,
- Propose amelioration measures to mitigate potential impacts upon the ecological values of the study area.

2.6 DEFINITIONS, TERMINOLOGY AND NOMENCLATURE

For the purposes of this assessment the following definitions apply:

Site: refers to the extent of the lands forming the boundaries of the site as described in Section 2.0

Study Area: refers to the site and additional areas which could be potentially affected by the development directly or indirectly. In this case the study area is considered to be that area incorporating the site and buffered by a zone of 50m (to allow for potential offsite impacts such as edge effects, silt deposition, transfer of dust from construction equipment travel on roadways, potential uncontrolled domestic animal predation [if allowed onsite] etc). It is acknowledged that any secondary impacts associated with water quality reduction may have impact further downstream of the site if unmitigated.

Locality: the area within a 10km radius of the centre of the Wastewater Treatment Plant site.

Additional terminology associated with significance assessments (i.e. threatened species, populations, communities, threatening process, direct impacts, indirect impacts etc) and the factors of such assessments (i.e. 7-part test) are taken to be those existing within the Threatened Species Conservation Act 1995, Environmental Planning and Assessment Act 1979, and the DEC (2008) document entitled 'Threatened Species Assessment Guidelines: The Assessment of Significance.' Additional terms within the report which warrant the source of the definition have been specifically referenced in the text.

Nomenclature for all plant species contained within this document follow Harden (1992, 1993, 2000 & 2003) The Flora of NSW Volumes 1-4. Scientific names for plants are used primarily in the document to avoid any confusion associated with use of common or descriptive plan names.

Nomenclature for all animal species contained within this document follows those utilised by the Department of the Environment and Climate Change/National Parks and Wildlife Service (2010) in association with the Atlas of NSW Wildlife. Scientific names for fauna are used

primarily in the document to avoid any confusion associated with use of common or descriptive animal names.

2.7 REPORT STRUCTURE

The structure and content of this flora and fauna assessment is as follows:

- Section 1: introductory statement
- Section 2: details the site description, location and outlines general background information relating to the project and this report including the aims and objectives
- Section 3: details the methodology for brief flora survey and resultant species, community descriptions and mapping
- Section 4: details the methodology for brief fauna survey and resultant species records and descriptions of the recorded assemblage
- Section 5: describes and discusses the recorded & potentially occurring scheduled communities, populations and species of conservation significance
- Section 6: contains the statutory assessments of significance (7-part test) pursuant to the Environmental Planning and Assessment Act 1979 and the SEPP 14, 26, 44, AND 71 assessments
- Section 7: describes the potential impacts of the proposal on the recorded flora and fauna values
- Section 8: describes the design, management and enhancement measures incorporated into the proposal to avoid and mitigate the impacts of the proposal on flora and fauna habitat

2.8 CONTRIBUTORS

Contributors to this report and their roles are tabulated below:

NAME	ORGANISATION	ROLE
Boyd Sargeant	Planit Consulting	Report preparation, flora/fauna survey and assessment, technical and quality assurance review

2.9 LICENCING

All work was performed under the appropriate licenses which are summarized:

Table 1 – Relevant licences

Authority	Licence/Permit	Title	Expiration	Permit No.
NSW DPI	Animal Research Authority	Fauna Surveying, Trapping & Release	30 June 2014	08/06865
NSW DPI	Animal Care & Ethics Committee	Fauna Surveying, Trapping & Release	30 June 2014	08/06865
NSW National Parks & Wildlife Service	Scientific Licence	Ecological Survey	31 May 2014	S100412

3.0 VEGETATION ASSESSMENT

To classify and identify vegetation communities and species which occur on-site, the following methodology was applied:

- Desktop analysis including:
 - i. Review of Council's Planning Scheme Mapping and Associated Reporting (i.e. Lake Macquarie LEP 2013 Maps, State of the Environment Reporting)
 - ii. Review of existing vegetation community documentation to confirm dominant elements, forest descriptions and conservation status of mapped forested remnants/ecosystems including:
 - Bell, S.A.J. (2002) The Natural Vegetation of the Wyong Local Government Area, Central Coast, NSW. A report prepared for Wyong Shire Council.
 - House, S (2003). Lower Hunter & Central Coast Regional Biodiversity Conservation Strategy, Technical Report, Digital Aerial Photo Interpretation & Updated Extant Vegetation Community Map.
 - Report to Lower Hunter & Central Coast Regional Environmental Management Strategy, Callaghan, NSW, May 2003.
 - NPWS – NSW National Parks and Wildlife Service (2000). Vegetation Survey, Classification and Mapping, Lower Hunter and Central Coast Region, Version 1.2. Lower Hunter and Central Coast Regional Environmental Management Strategy, Thornton, NSW.
 - iii. Review of threatened flora species and endangered ecological communities listed as occurring within the Wyong CMA sub-region of the Hunter/Central Rivers CMA (<http://www.environment.nsw.gov.au/threatenedSpeciesApp/cmaSearchResults.aspx?SubCmaId=94>)
 - iv. Review of search of the Atlas of NSW Wildlife database within a search area 10km surrounding the site to review threatened plant records
 - v. Review of Environment Australia Protected Matters data within a search area 10km surrounding the site to review threatened plant records.

- vi. Review of SEPP Mapping (Coastal Wetlands, Coastal Protection, and Littoral Rainforest) mapping to determine the indicative presence/absence of regional forest ecosystems reflective of wetland (marine, estuarine, riverine, lacustrine and/or palustrine) communities, Littoral Rainforests, and/or Coastal Protection areas.
- vii. Review of selected ecological surveys previously undertaken in the locality including:
- EcoBiological (2006a) Targeted Threatened Species Assessment: Lot 6 DP 774923, Lot 2 DP 809795, No. 595 Pacific Highway Crangan Bay, Rosegroup Pty Ltd.
 - EcoBiological (2006b) Environmental Constraints Assessment: Lot 6 DP 774923, Lot 2 DP 809795, Lot 5 DP 774923, Lot 2031 DP 841175 and Lot 4 DP 129341, No. 595 Pacific Highway Crangan Bay, Rosegroup Pty Ltd.
 - RPS Harper Somers O'Sullivan (2007) Ecological Assessment Report for Southern Lake Macquarie Lands. A report prepared for Rosecorp Pty Ltd, December 2007.
 - RPS Harper Somers O'Sullivan (2009) Ecological Assessment Report For a Proposed Hunter Water Board Reservoir. A report prepared for Rosecorp Pty Ltd, September 2009.
 - RPS Harper Somers O'Sullivan (2010) Ecological Assessment Report for Southern Lake
 - Macquarie Lands (updated). A report prepared for Rosecorp Pty Ltd, September 2010
 - Wildthing Environmental Consultants (2003a) Ecological Constraints Study for Lot 3 DP 588206, Kanangara Drive, Gwandalan, NSW, October 2003, Lakeside Living Pty Ltd.
 - Wildthing Environmental Consultants (2003b) Statement of Effect on Threatened Flora and Fauna for the proposed development of Part Lot 6 DP 774923, Catherine Hill Bay, NSW, December 2003, Coastal Hamlets Pty Ltd.
 - Wildthing Environmental Consultants (2004a) Statement of Effect on Threatened Flora and Fauna for the proposed development of Part Lot 2 DP 809795, Catherine Hill Bay, NSW, February 2004, Coastal Hamlets Pty Ltd.

- Wildthing Environmental Consultants (2004b) Statement of Effect on Threatened Flora and Fauna for the proposed development of Part Lot 2031 DP 841175, Catherine Hill Bay, NSW, February 2004, Coastal Hamlets Pty Ltd.

viii. Review of the following legislation to ensure the latest lists of threatened species and communities were noted as well as investigating the existence of any relevant recovery plans, threat abatement plans, key threatening processes or any preliminary determinations which may be applicable to the site and/or the proposed use/action:

- Threatened Species Conservation Act (1995)
- Environment Protection and Biodiversity Conservation Act (1999)

- Site survey including: site inspections in April, July and November 2013.

3.1.1 STRUCTURAL ANALYSIS

In this instance the dominant stratum (shrub or tree) height was determined via tape measure or estimated ocularly from the mean of two experienced observers. Height classes were then selected from classifications provided in Walker & Hopkins (in McDonald et al, 1998).

Crown cover % for the dominant layer was estimated using the mean of two experienced observers or measured via crown intercept method (Nelder et al, 2004, EPA, 2005). Structural formation classes were determined via an assessment of growth form and crown cover % information as per Walker & Hopkins (1998).

Table 2 - Height Classes & Names for Various Growth Forms (Walker & Hopkins, 1998: Table 15)

Height		Growth Form			
Height Class	Height Range (m)	Trees, vines, palms	shrub, heath shrub, chenopod shrub, mallee (tree or shrub form), cycads	tussock grass, hummock grass, forbs, rushes, sedges, ferns, Xanthorrhoea	Sod grasses, mosses, lichens, liverworts
9	>35.01	Extremely tall	N/A	N/A	N/A
8	20.01-35	Very Tall	N/A	N/A	N/A
7	12.01-20	Tall	N/A	N/A	N/A
6	6.01-12	Mid-high	Extremely tall	N/A	N/A
5	3.01-6	Low	Very tall	Extremely tall	N/A

4	1.01-3	Dwarf	Tall	Very tall	N/A
3	0.51-1	N/A	Mid-high	Tall	Extremely tall
2	0.26-0.5	N/A	Low	Mid-high	Tall
1	<0.25	N/A	Dwarf	Low	Low

Table 3 - Structural formation classes defined by growth form and crown separation (Walker & Hopkins, 1998: Tables 14a & 17)

<i>Crown Separation</i>	<i>D Closed dense or</i>	<i>M Mid-dense</i>	<i>S Sparse</i>	<i>B Very sparse</i>	<i>I Isolated plants</i>	<i>L Isolated clumps</i>
<i>Field criteria</i>	<i>Touching overlap</i>	<i>Touching -slight separation</i>	<i>Clearly separated</i>	<i>Well separated</i>	<i>Isolated</i>	<i>Isolated</i>
<i>Crown separation ratio</i>	<0	0-0.25	0.25-1	1-20	>20	>20
<i>Crown Cover %</i>	81-100%	52-81%	20-52%	0.2-20%	<0.2%	<0.2%
Growth Form Structural Formation Classes						
T Tree	Closed forest	Open forest	Woodland	Open woodland	Isolated trees	Isolated clump of trees
M Tree mallee	Closed mallee forest	Open mallee forest	Mallee woodland	Open mallee woodland	Isolated mallee trees	Isolated clump of mallee trees
S Shrub	Closed shrubland	Shrubland	Open shrubland	Sparse shrubland	Isolated shrubs	Isolated clump of mallee shrubs
Y Mallee shrub	Closed mallee shrubland	Mallee shrubland	Open mallee shrubland	Sparse mallee shrubland	Isolated mallee shrubs	Isolated clump of mallee shrubs
Z Heath shrub	Closed heathland	Heathland	Open heath	Sparse heath	Isolated heath shrubs	Isolated clump of heath shrubs
C Chenopod shrub	Closed chenopod shrubland	Chenopod shrubland	Open chenopod shrubland	Sparse chenopod shrubland	Isolated chenopod shrubs	Isolated clump of chenopod shrubs

Table 4 - Structural formation classes for ground covers (Walker & Hopkins, 1998: Table 14b)

<i>Crown class</i>	<i>D Closed dense or</i>	<i>M Mid-dense</i>	<i>S Sparse</i>	<i>B Very sparse</i>	<i>I Isolated plants</i>	<i>L Isolated clumps</i>
<i>Foliage cover</i>	>70	30-70	10-30	<10	<1	<1
Growth Form Structural Formation Classes						
G Tussock grass	Closed grassland	Grassland	Open grassland	Sparse grassland	Isolated grasses	Isolated clump of tussock grasses

H Hummock grass	Closed hummock grassland	Hummock grassland	Open hummock grassland	Sparse hummock grassland	Isolated hummock grasses	Isolated clump of hummock grasses
D Sod grass	Closed sod grassland	Sod grassland	Open sod grassland	Sparse sod grassland	Isolated sod grasses	Isolated clump of sod grasses
V Sedge	Closed sedgeland	Sedgeland	Open sedgeland	Sparse sedgeland	Isolated sedges	Isolated clump of sedges
R Rush	Closed rushland	Rushland	Open rushland	Sparse rushland	Isolated rushes	Isolated clump of rushes
F Forb	Closed forbland	Forbland	Open forbland	Sparse forbland	Isolated forbs	Isolated clump of forbs
E Fern	Closed fernland	Fernland	Open fernland	Sparse fernland	Isolated ferns	Isolated clump of ferns
O Moss	Closed mossland	Mossland	Open mossland	Sparse mossland	Isolated mosses	Isolated clump of mosses
L Vine	Closed vineland	Vineland	Open vineland	Sparse vineland	Isolated vines	Isolated clump of vines

It is noted that Qld EPA (2005) and Nelder et al (2004) have recently provided Structural formation Class Tables which vary slightly from Tables 3 and 4 above. This table is displayed below:

Table 5 - Structural formation classes for woody plant communities qualified by height: (classes defined by growth form, height and cover) [sensu EPA, 2005]

Foliage projective cover	70-100%	30-70%	10-30%	<10%
Crown separation	closed or dense	mid-dense	sparse	very sparse
Field criteria	touching-overlap	touching - slight separation	clearly separated	well separated
Crown separation ratio	<0	0-0.25	0.25-1	1-20
Crown cover %	81-100%	52-81%	20-52%	0.2-20%
Growth form	Structural Formation Classes (qualified by height)			
trees	tall	tall	tall	tall
> 30m	closed-forest	open-forest	woodland	open-woodland
trees				

10 – 30m	closed-forest	open-forest	woodland	open-woodland
trees	low	low	low	low
< 10m	closed-forest	open-forest	woodland	open-woodland
shrubs			tall	tall
2 – 8m	closed-scrub	open-scrub	shrubland	open-shrubland
shrubs				
1 – 2m	closed-heath	open-heath	shrubland	open-shrubland
shrubs			dwarf shrubland	dwarf
<1m	-	-		open-shrubland

The above methodology is considered to be reasonably consistent with the intent of the following documents:

- NSW Department of Infrastructure, Planning and Natural Resources (1997) *Interim Guidelines for Targeted and General Flora and Fauna Surveys under the Native Vegetation Conservation Act 1997*.
- NSWNPWS (2001) *The Community Biodiversity Survey Manual*. New South Wales National Parks & Wildlife Service.
- QLD Department of Environment and Heritage (1999) *Suggested Conservation Criteria for Development Assessment*.
- Gold Coast City Council (2004) *Guidelines for preparing Ecological Site Assessments during the Development Process (v1.1)*. G.C.C.C., Nerang.
- Shire of Maroochy (1997) *Flora and Fauna Assessment Requirements for Developments in Maroochy Shire*. M.S.C
- Brisbane City Council (1999) *Ecological Assessment Guidelines*. B.C.C.
- Walker, J. & Hopkins, M.S. (1998) Chapter 5: Vegetation in McDonald, R. C., Isbell, R.F., Speight, J.G., Walker, J. & Hopkins, M.S. *Australian Soil and Land Survey: Field Handbook Second Edition*. CSIRO Australia, Canberra.
- Nelder, V. J., Wilson, B.A., Thompson, E. J. & Dillewaard, H.A. (2004) *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland*. EPA, Brisbane.
- DEC (2004) *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities Working Draft*. DEC, NSW.

3.2 VEGETATION SURVEY RESULTS

As noted detailed ecological assessment has occurred over the site in association with the residential development, NSW Major Project approval and approvals issued under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

The Director Generals assessment report notes in respect of vegetation, the NSW Threatened Species Conservation Act (1995) And Environmental Protection And Biodiversity Conservation Act 1999 that *'the previous Concept Plan for the Catherine Hill Bay (and Gwandalan) development was identified as a controlled action under the EPBC Act as it was considered likely that the development would significantly impact on the following listed threatened species: Black Eyed Susan (Tetratheca juncea) and Cryptostylis hunteriana (Leafless Tongue Orchid).'*

On 27 February 2009 the Commonwealth issued an approval under the EPBC Act subject to conditions including:

- Removal of the Cryptostylis hunteriana individuals from Hamlet 6 (now area of proposed Stage 6) for the purposes of research; and*
- The preparation of and approval by the Minister a Cryptostylis hunteriana management plan.*

The EPBC approval applies to the area of the previous Concept Plan which comprises land at Catherine Hill Bay (in addition to land at Gwandalan). The existing approval under the EPBC Act remains valid and no additional approval is required for the current project application for subdivision. Conditions of the approval under the EPBC Act continue to apply to the subject development.

In terms of compliance with the TSC Act, an ecological assessment report has been undertaken by RPS. The impact of the proposal on flora and fauna is addressed in detail in Section 5.12 below. In summary it is considered that the requirements of the EPBC Act and TSC Act have been satisfied.

The DG assessment report further notes, *'An ecological assessment report has been submitted with the application which draws together previous ecological assessments and surveys and confirms the presence on site of two threatened flora species (Tetratheca juncea and Cryptostylis hunteriana) and four endangered ecological communities (EEC Swamp Sclerophyll Forest, EEC Swamp Oak Floodplain Forest, EEC Saltmarsh and EEC Freshwater Wetlands on Coastal Floodplains). Only two of these EECs are found within the Catherine Hill Bay site (EEC Swamp Sclerophyll Forest and EEC Freshwater Wetlands).*

The report includes an assessment of the proposal against the requirements of the NSW Threatened Species Conservation Act (TSC Act) and Commonwealth Environmental Protection and Biodiversity Conservation Act (EPBC Act) 1999 in relation to flora and fauna. It notes that an approval for a controlled action under the EPBC Act was issued for the previous Concept Plan

*in February 2009 and that the approval remains valid subject to compliance with relevant conditions of the approval. The action was considered a controlled action given the potential impact on listed threatened species: Black Eyed Susan (*Tetradlea juncea*) and Leafless Tongue Orchid (*Cryptostylis hunteriana*).*

Additional information has been provided in relation to this impact within the PPR. The additional letter from RPS notes that the proposed impact on the EEC represents approximately 0.25ha. It notes that the total impact of the combined Gwandalan and Catherine Hill Bay developments on the EEC represents 1.45ha of 12.42ha or approximately 12%. It further notes that given the extent and nature of the conservation offsets this impact is considered moderate and that on balance the impact is not considered significant given the in perpetuity conservation outcome that the offset lands will provide. It is considered that this argument is appropriate given the values of the conservation lands and the small area of EEC proposed to be impacted upon. In this regard it is also noted that DECCW has indicated that it is satisfied with the conservation outcome.'

A vegetation map, Figure 10 below was produced by RPS HSO (2010) for the Major Project approval and assessment. This illustrates the vegetation communities situated within the Catherine Hill Bay Area and residential area. This vegetation map is a combination of RPS HSO vegetation survey and mapping by EcoBiological 2006a and Wildthing (2003a, 2003b, 2004a, 2004b). Figure 11 identifies the site reflective of the WWTP with the vegetation mapping.

The proposed WWTP as illustrated in Figure 10 and 11 does not impact on the EEC Freshwater Wetlands or EEC Swamp Sclerophyll Forest.(refer further discussion above at Section 4.2.5 and 5.9 re: SEPP 14 Wetlands).

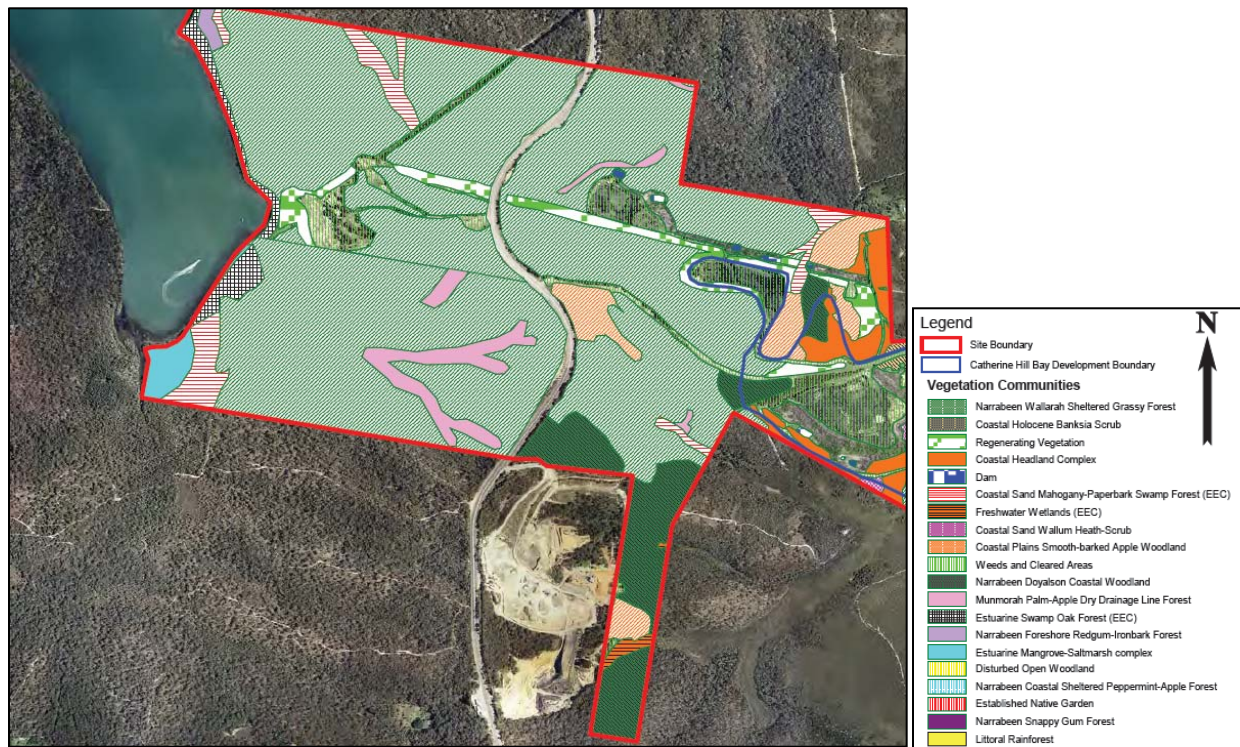


Figure 10 - Part Vegetation Map of the site from RPS HSO 2010

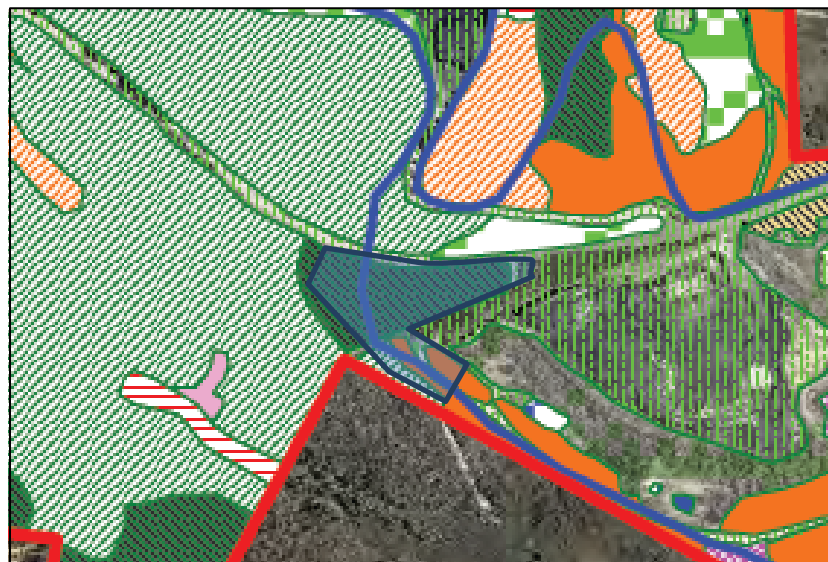


Figure 11 – Extract RPS HSO 2010 Vegetation Mapping noting WWTP Site in Blue

3.3 Vegetation Communities

This section describes the vegetation communities located within the WWTP footprint as illustrated in Figure 11 above and utilises the vegetation map produced for RPS HSO (2010) and additional site investigations.

The map indicates that the site is primarily covered in the Narrabeen Doyalson Coastal Woodland – approximately 7300m². The site also contains mapped areas of and or adjoins Narrabeen Wallarah Sheltered Grassy Forest (approximately 3000m²), Coastal Headland Complex (approximately 3500m²), Weeds and Cleared Areas (approximately 700m²).

A description of each community and classification into both adopted regional vegetation classification, being LHCCREMS (NPWS 2000; House 2003), is provided below. The description for each community is that outlined by RPS.

3.3.1 Community 1: Narrabeen Doyalson Coastal Woodland



Figure 12 - Narrabeen Doyalson Coastal Woodland November 2013

The Wastewater treatment plant and storage areas occur within this community. This vegetation community is commensurate with MU 31 – Narrabeen Doyalson Coastal Woodland (including variant a) as described by the Natural Vegetation of the Wyong Local Government Area (Bell, 2002) and MU 31 Coastal Plains Scribbly Gum Woodland as described by LHCCREMS (NPWS 2000; House 2003).

RPS note that, *‘This community varied considerably within the site. The portion which is within the southernmost section of the CHB Land Development site has a dense understorey of Banksia serrata (Old Man Banksia) in combination with Eucalyptus haemastoma (Scribbly Gum) and Corymbia gummifera (Red Bloodwood). The sections on the ridgetops have a more open woodland habitat dominated by Eucalyptus haemastoma (Scribbly Gum), Angophora costata (Smooth-barked Apple) and Corymbia gummifera (Red Bloodwood) with a healthy understorey’*. The recent bushfire may have modified this vegetation community since it was analysed by RPS

HSO (2013). Certain flora species which are sensitive to severe bushfires may have perished from the area.

Upper Stratum – 15 to 18m with a Projected Foliage Cover (PFC) of 20 to 30%, the dominant species being *Eucalyptus haemastoma* (Scribbly Gum), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus capitellata* (Brown Stringybark) and occasionally *Angophora costata* (Smooth-barked Apple).

Mid Stratum 1 – 5 to 15m with a PFC of 5%, the dominant species being, *Leptospermum trinervium* (Paperbark Tea-tree), *Xylomelum pyriforme* (Woody Pear) and *Banksia serrata* (Old Man Banksia).

Mid Stratum 2 – 1 to 5m with a PFC of 30 to 40%, the dominant species being, *Banksia aemula* (Wallum Banksia), *Leptospermum polygalifolium* (Lemon-scented Tea-tree), *Hakea dactyloides*, *Hakea bakeriana*, *Persoonia levis* (Broad-leaved Geebung), *Lambertia formosa* (Mountain Devil), *Ricinocarpos pinifolius* (Wedding Bush) and *Isopogon anemonifolius* (Drumsticks).

Lower Stratum – to 2m with a PFC of 70 to 80%, the dominant species being *Epacris pulchella* (NSW Coral Heath), *Ptilothrix deusta*, *Tetratheca thymifolia*, *Philothea salisoliifolia*, *Lomandra obliqua* (Fishbones), *Xanthorrhoea resinifera* (Forest Grass Tree), *Themeda australis* (Kangaroo Grass) and *Entolasia stricta* (Wiry Panic).



Figure 13 - Narrabeen Doyalson Coastal Woodland November 2013



Figure 14 - Narrabeen Doyalson Coastal Woodland November 2013

Regional Significance and Conservation status

The Narrabeen Doyalson Coastal Woodland is considered to be regionally significant by Lake Macquarie Flora and Fauna Guidelines (2001) within the Lake Macquarie LGA. This vegetation community is not listed as an EEC under the *TSC Act*.

Regionally Significant Flora Species in the Lake Macquarie LGA

Lake Macquarie Flora and Fauna Guidelines (2001) contain a list of regionally significant flora species. None of these species are known to occur in the Narrabeen Doyalson Coastal Woodland according to RPS HSO (2010).

This community is restricted to the Waste Water Treatment Plant location – processing tank, wet weather storage area. No additional significant species were recorded from this community through the surveying investigations. This element of the WWTP Network occurs within the approved development footprint of the residential estate which has been previously assessed and approved for development.

This community has been mapped as containing the Black Eyed Susan (*Tetratheca juncea*), further discussion on this species is provided in section 5.

We note and as evidenced by the site images, the bushfire of October had a significant affect and no Black Eyed Susan were evident at time of the survey in November.

3.3.2 Community 2: Coastal Headland Complex



Figure 15 - Coastal Headland Complex November 2013

This community may be found in small sections of the Wastewater Treatment Plant site aligned to the proposed internal road network and evaporation ponds. Searches for significant scheduled species did not locate any which had not been previously recorded. We note the recorded scheduled species were not observed post bushfire. This is discussed further in the report. This vegetation community prior the fires contined disturbed variants of the community where acacia were common as well as open heath structure where banksia were more common in the canopy.

This community is also commensurate with MU 48 Coastal Clay Heath as described by LHCCREMS (NPWS 2000; House 2003). The portions surveyed during the RPS HSO (2010) study were highly disturbed by weeds. Stunted Eucalypts occurred throughout the community which was interspersed with heath vegetation. The recent bushfire has modified this vegetation

community. The images above illustrates the severity of the bushfire which may have resulted in death of some flora species and regenerative triggers for others.

Upper Stratum – 4 to 10m with a Projected Foliage Cover (PFC) of 5%, scattered trees of *Corymbia gummifera* (Red Bloodwood).

Mid Stratum 2 – 2 to 4m with a PFC of 30 to 90%, the dominant species being *Westringia fruticosa* (Coast Westringia), *Banksia spinulosa* var. *collina* (Hairpin Banksia), *Allocasuarina distyla*, *Leptospermum laevigatum* (Coastal Tea Tree), *Melaleuca nodosa* (Ball Everlasting), *Banksia oblongifolia*, *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle) and *Lambertia formosa* (Mountain Devil).

Lower Stratum – to 1.5m with a PFC of 40 to 90%, the dominant species being *Lomandra obliqua* (Fish Bones), *Patersonia sericea* (Purple Flag Flower), *Patersonia glabrata*, *Austrostipa* sp., *Pultenaea elliptica*, *Xanthorrhoea latifolia* subsp. *latifolia* (Grass Tree), *Gonocarpus teucrioides* (Raspwort), *Ptilothrix deusta*, *Cassytha glabella* forma *glabella* (Slender Devil's Twine) and *Themeda australis* (Kangaroo Grass).

Regional Significance and Conservation status

The Coastal Headland Complex is considered to be regionally significant by Lake Macquarie Flora and Fauna Guidelines (2001) within the Lake Macquarie LGA. This vegetation community is not listed as an EEC under the *TSC Act*.

Regionally Significant Flora Species in the Lake Macquarie LGA

Lake Macquarie Flora and Fauna Guidelines (2001) contain a list of regionally significant flora species. *Hakea bakeriana* and *Xanthorrhoea resinifera* (Tree Form) are known to occur in Coastal Headland Complex vegetation communities and are listed under the guidelines.

This community is restricted to a small location of the proposed internal road network and evaporation ponds. Searches for significant scheduled species did not locate any.

3.3.3 Community 3: Weeds and Cleared Areas

This vegetation community occurs within and adjacent to the Wastewater Treatment Plant site aligned to trail edges and boundary to Montefiore Street reflective of edge effects. This community does intergrade with mapped Regenerating Vegetation Community and Disturbed Open Woodland. This community is not commensurate with any vegetation communities that have been described as a Natural Vegetation community of LHCCREMS (NPWS 2000; House 2003). These areas are highly disturbed and have high weed incursions. The recent bushfire did

affect this community and potentially provides an opportunity for its expansion given the severity of the October fires.

Upper Stratum – 15 to 18m with a Projected Foliage Cover (PFC) of 5%, the dominant species being *Eucalyptus punctata* (Grey Gum), *Eucalyptus robusta* (Swamp Mahogany), *Erythrina x sykesii* (Coral Tree) and *Ficus rubiginosa* (Port Jackson Fig).

Mid Stratum – to 2m with PFC of 20 to 30%, the dominant species being *Pteridium esculentum* (Bracken Fern), *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle), *Lantana camara* (Lantana), *Cinnamomum camphora* (Camphor Laurel), *Ligustrum sinense* (Small-leaved Privet) and *Chrysanthemoides monilifera* subsp. *rotundata* (BitouBush).

Lower Stratum – to 1m with a PFC of 80 to 90%, the dominant species being *Pennisetum clandestinum* (Kikuyu), *Pteridium esculentum* (Bracken Fern), *Cynodon dactylon* (Common Couch), *Hydrocotyle bonariensis* (Pennywort), *Chloris gayana* (Rhodes Grass), *Verbena bonariensis* (Purple Top), *Eragrostis tenuifolia* (Elastic Grass), *Stenotaphrum secundatum* (Buffalo Grass), *Richardia brasiliensis* (White Eye), *Andropogon virginicus* (Whisky Grass), *Hypochaeris radicata* (Flatweed), *Plantago lanceolata* (Ribwort), *Bidens pilosa* (Farmer's Friends), *Trifolium repens* (White Clover) and *Sida rhombifolia* (Paddy's Lucerne).

Regional Significance and Conservation status

The Weeds and Cleared Area vegetation community is not considered regionally significant according to both the Lake Macquarie LGA and the Wyong LGA. This vegetation community is not listed as an EEC under the *TSC Act*.

Regionally Significant Flora Species in the Lake Macquarie LGA

Lake Macquarie Flora and Fauna Guidelines (2001) contain a list of regionally significant flora species. *Eucalyptus robusta* are known to occur in the Weeds and Cleared Areas vegetation community and is listed under the guidelines.

3.3.4 Community 4: Narrabeen Wallarah Sheltered Grassy Forest



Figure 16 - Narabeen Wallarah Sheltered Grassy Woodland Prior The Bushfire (Source: RPS HSO 2010) and April 2013



Figure 17 - Narabeen Wallarah Sheltered Grassy Woodland April 2013



Figure 18 - Narabeen Wallarah Sheltered Grassy Woodland November 2013

This vegetation community as identified by RPS is the dominant vegetation community in the locality. A small portion of this community may be found in the WWTP. This community is locally dominate as illustrated in the RPS mapping.

This vegetation community is not commensurate with any vegetation units as described by LHCCREMS (NPWS 2000; House 2003).

RPS note this community was difficult to delineate due to the variable canopy layer in which no species was dominant. The presence of *Eucalyptus globoidea* (White Stringybark) and

Eucalyptus paniculata subsp. *paniculata* (Grey Ironbark) separates this community from the Coastal Plains Smooth-barked Apple Woodland. Variations of a dominance of *Eucalyptus propinqua* (Small-fruited Grey Gum) and *Eucalyptus acmenoides* (White Mahogany) occurs within the southern drainage lines of the Offset Lands. In contrast, the ridgelines within the western portion (Crangan Bay) of the vegetation community were dominated by a combination of *Angophora costata* (Smoothbarked Apple) and *Eucalyptus signata* (Scribbly Gum).

As illustrated by the images the fire has significantly affected the community.

Upper Stratum – 20 to 25m with a PFC of 30 to 60%, the dominant species being *Eucalyptus punctata* (Grey Gum), *Eucalyptus paniculata* subsp. *paniculata* (Grey Ironbark), *Eucalyptus globoidea* (White Stringybark), *Allocasuarina torulosa* (Forest Sheoak), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus piperita* (Sydney Peppermint), *Angophora costata* (Smooth-barked Apple), *Eucalyptus signata* (Scribbly Gum), and in the moist gullies *Eucalyptus resinifera* subsp. *resinifera* (Red Mahogany).

Mid Stratum 1 – 6 to 10m with a PFC of 20%, the dominant species being *Allocasuarina torulosa* (Black She-oak) and juvenile *Eucalyptus* species.

Mid Stratum 2 – 1 to 2m with a PFC of 10 to 30%, the dominant species being *Acacia longifolia* var. *longifolia* (Sydney Golden Wattle), *Dodonaea triquetra* (Common Hop Bush), *Bursaria spinosa* (Blackthorn), *Polyscias sambucifolia* (Elderberry Panax), *Podolobium ilicifolium* (Native Holly) and *Acrotriche divaricata*.

Lower Stratum – to 1m with a PFC of 30 to 60%, the dominant species being *Xanthorrhoea macronema* (Grass Tree), *Themeda australis* (Kangaroo Grass), *Entolasia stricta* (Wiry Panic), *Pratia purpurascens* (White Root) and *Dianella caerulea* var. *product* (Blue Flax Lily).

Regional Significance and Conservation status

The Narrabeen Wallarah Sheltered Grassy Forest is not considered to be regionally significant by Lake Macquarie Flora and Fauna Guidelines (2001) within the Lake Macquarie LGA. This vegetation community is not listed as an EEC under the *TSC Act*.

Regionally Significant Flora Species in the Lake Macquarie LGA

The Narrabeen Wallarah Sheltered Grassy Forest vegetation community is known to have *Eucalyptus signata* and *Xanthorrhoea resinifera* (Tree Form) within it. These two species are listed as regionally significant under the Lake Macquarie Flora and Fauna Guidelines (2001). These species are not present within the WWTP area.

As illustrated in Attachment 2 and 3 the proposed direct impacts from the WWTP Network will necessitate clearance of the Treatment Plant Site, which as noted in the previous studies and above contains native vegetation communities. Approval for vegetation removal has been considered and approved for this location through the approval of the residential estate which it is located within. As noted no scheduled species were observed during the surveys of November 2013. We note the area did contain scheduled species as mapped previously by RPS. Scheduled species are discussed further in Section 5. Relocation has been previously considered and approved for scheduled species should they be identified prior to clearing and have survived the fire.



Figure 19 - Waste Water Treatment Plant Site

A vegetation management plan has been produced to address clearing activities more broadly and minimising impacts to vegetation external to the development's footprint. This is contained in Attachment 6.

4.0 FAUNA ASSESSMENT

This section describes the site's fauna and associated habitat as identified through brief fauna surveying of the site. The methodology applied to arrive at the species list is outlined and significant species have been identified where relevant. It is relevant to note that the surveying associated with the WWTP was done concurrently with the surveying done for elements 2 and 3. Desktop analysis including:

- i. Review of Council's Planning Scheme Mapping and Associated Reporting (i.e. Lake Macquarie LEP 2013 Maps, State of the Environment Reporting)
- ii. Review of threatened fauna species and endangered populations listed as occurring within the Wyong CMA sub-region of the Hunter/Central Rivers CMA (<http://www.environment.nsw.gov.au/threatenedSpeciesApp/cmaSearchResults.aspx?SubCmaId=94>)
- iii. Review of search of the Atlas of NSW Wildlife database within a search area 10km surrounding the site to review threatened fauna records
- iv. Review of Environment Australia Protected Matters data within a search area 10km surrounding the site to review threatened fauna records.
- v. Review of SEPP Mapping (Coastal Wetlands, Coastal Protection, and Littoral Rainforest) mapping to determine the indicative presence/absence of regional forest ecosystems reflective of wetland (marine, estuarine, riverine, lacustrine and/or palustrine) communities, Littoral Rainforests, and/or Coastal Protection areas.
- vi. Review of selected ecological surveys previously undertaken in the locality including:
 - o EcoBiological (2006a) *Targeted Threatened Species Assessment: Lot 6 DP 774923, Lot 2 DP 809795, No. 595 Pacific Highway Crangan Bay*, Rosegroup Pty Ltd.
 - o EcoBiological (2006b) *Environmental Constraints Assessment: Lot 6 DP 774923, Lot 2 DP 809795, Lot 5 DP 774923, Lot 2031 DP 841175 and Lot 4 DP 129341, No. 595 Pacific Highway Crangan Bay*, Rosegroup Pty Ltd.
 - o RPS Harper Somers O'Sullivan (2007) *Ecological Assessment Report for Southern Lake Macquarie Lands*. A report prepared for Rosecorp Pty Ltd, December 2007.
 - o RPS Harper Somers O'Sullivan (2009) *Ecological Assessment Report For a Proposed Hunter Water Board Reservoir*. A report prepared for Rosecorp Pty Ltd, September 2009.
 - o RPS Harper Somers O'Sullivan (2010) *Ecological Assessment Report for Southern Lake Macquarie Lands (updated)*. A report prepared for Rosecorp Pty Ltd, September 2010.
 - o Wildthing Environmental Consultants (2003a) *Ecological Constraints Study for Lot 3 DP 588206, Kanangara Drive, Gwandalan, NSW, October 2003*, Lakeside Living Pty Ltd.

- Wildthing Environmental Consultants (2003b) *Statement of Effect on Threatened Flora and Fauna for the proposed development of Part Lot 6 DP 774923, Catherine Hill Bay, NSW, December 2003*, Coastal Hamlets Pty Ltd.
 - Wildthing Environmental Consultants (2004a) *Statement of Effect on Threatened Flora and Fauna for the proposed development of Part Lot 2 DP 809795, Catherine Hill Bay, NSW, February 2004*, Coastal Hamlets Pty Ltd.
 - Wildthing Environmental Consultants (2004b) *Statement of Effect on Threatened Flora and Fauna for the proposed development of Part Lot 2031 DP 841175, Catherine Hill Bay, NSW, February 2004*, Coastal Hamlets Pty Ltd.
- vii. Review of the following legislation to ensure the latest lists of threatened species and communities were noted as well as investigating the existence of any relevant recovery plans, threat abatement plans, key threatening processes or any preliminary determinations which may be applicable to the site and/or the proposed use/action:
- Threatened Species Conservation Act (1995)
 - Environment Protection and Biodiversity Conservation Act (1999)
- Field survey, April, July and November of the fauna populations located within and immediately adjacent to the study area to review habitat values;
 - The following fauna field survey methods were implemented during April, July and November 2013 - (4 nights (including trapping) April and July and 2 nights x 1(excluding trapping) November in general accordance with the following:
 - DEC (2004) *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities Working Draft*. DEC, NSW.
 - NSWNPWS (2001) *The Community Biodiversity Survey Manual*. New South Wales National Parks & Wildlife Service.
 - Gold Coast City Council (2006) Planning Scheme Policy 8: *Guidelines for Ecological Assessments*. G.C.C.C., Nerang.
 - Shire of Maroochy (1997) *Flora and Fauna Assessment Requirements for Developments in Maroochy Shire*. M.S.C
 - Department of Land and Water Conservation (1997) *Interim Guidelines for Targeted and General Flora and Fauna Surveys under the Native Vegetation Conservation Act 1997*. NSWDLWC, Parramatta.
 - Brisbane City Council (1999) *Ecological Assessment Guidelines*. B.C.C.
 - Redland Shire's *Planning Scheme Policy 4-Ecological Impacts*

4.1 DIURNAL SURVEY

- Active searches were conducted for key habitat components and potential macro- and micro- habitat components for rare and threatened species;
- Binocular search and identification of all fauna heard or sighted;
- Opportunistic sightings/audible identifications were conducted and recorded whilst all survey works were being undertaken;
- Bird identification surveys were conducted in association with dawn and dusk activity and comprised walked transects through each vegetation community;
- Detailed ground track/trace survey was performed including:
 - Scat/pellet examination
 - Scratch/trace examination of trees
 - Diggings, burrow, trace and track examination
 - Humus/crevice examination
 - Examination and assessment of tree hollows, hanging bark, termite mounds, flowering and nesting trees
- Diurnal frog-call recognition and identification during rainfall events and opportunistically performed during other survey works,
- Trapping for fauna was performed in accordance with NSW DPI and NPWS permits issued to Planit Consulting. Type 'A' & 'B' Elliot traps and open wire traps (hook baited and foot paddle spring-loaded) of various sizes were utilised. Traps were set at intervals of approximately 10 – 20 metres depending on habitat complexity within the surveyed vegetation. In the areas identified in Attachment 4.

Trapping was undertaken over a 96 hour period, checked and emptied (where necessary) every morning. Baits utilized within the traps included rolled oats & golden syrup, rolled oats & peanut butter, dog biscuits, tuna and chicken.

Leaf litter and/or grass was placed within all traps to protect captured fauna from potential hypothermia and to provide nesting refuge during the period between trapping and release. All animals were released at the point of capture following positive species identification. In association with this survey no animals were needed to be taken as voucher specimens.

Trapping was only conducted during the April and July events at locations commensurate with the Pump Station and WWTP. Due to the site conditions and likely stress of animals trapping in November was not conducted.

Table 6 – Review of Trapping Program

	Elliot Traps	Cage Traps
No. of trap lines	2	2
No. of nights per line	4(x 2)	4(x2)
No. of traps per line	10	4
Total no. of trap nights	160	64



Figure 20 - Rattus rattus pair

- Four motion triggered trail cameras (ScoutGuard SG550PV-31B) were deployed commensurate to the location of the Pump Station and WWTP. Continuous motion monitoring 4 x 2 and 2 x 2 day/nights.

4.2 NOCTURNAL SURVEY

Nocturnal survey included the following survey techniques:

- Audible survey for calls, scratching and landings;
- Spotlighting utilising:
 - Short duration-long distance white light, and

- Long duration-short distance red light



Figure 20 – Species recorded during surveying

- Naked eye observation utilising dawn/dusk/moon light for bats and fauna returning to potential nest/shelter areas.
Duration: One researcher on 10 nights for 120 minutes each night (10 nights)
- Passive digital recording (for nocturnal birds, mammals and amphibians) was undertaken utilizing Songmeter TM. The recorder was programmed to 'wake up' and record continuously for 10 minutes, 'sleep' for 20 minutes, begin recording for 10 minutes over a period of three hours (commencing at 6.30pm). Recordings were analyzed audibly by experienced ecologists and with Songscope Bioacoustics software. All avifauna reference calls were sourced from reputable organizations such as Naturesound and BOCA;

Duration: 4 nights recording at 2 locations

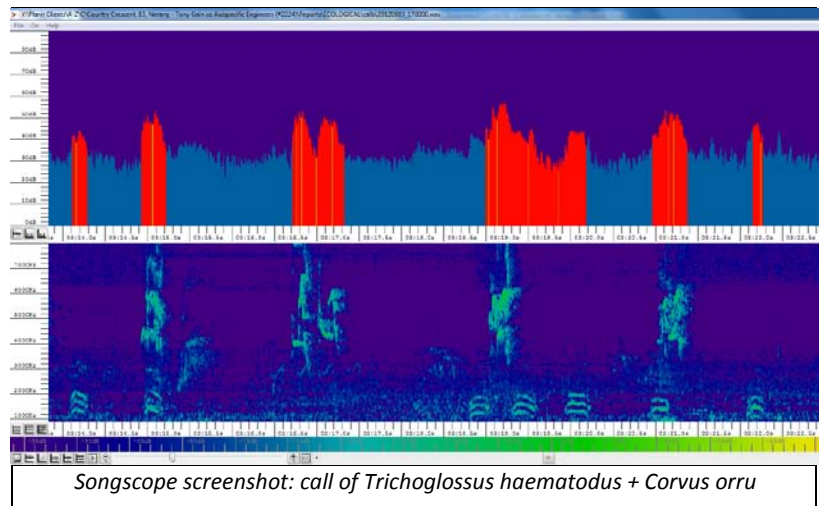


Figure 22 - Call of *Trichoglossus haematodus*

- Anabat detection system was utilized to record echolocation of microchirpteran bats at fixed points and along spotlighting transects. Recordings were undertaken in areas most likely to attract bat species including standing water, drainage lines, remnant edges, areas of flowering vegetation and sites of high insect activity. Calls were analyzed utilizing Analook 49j and accepted reference keys.

Duration: Ten night's continuous recording between 1730 and 0000 hrs.

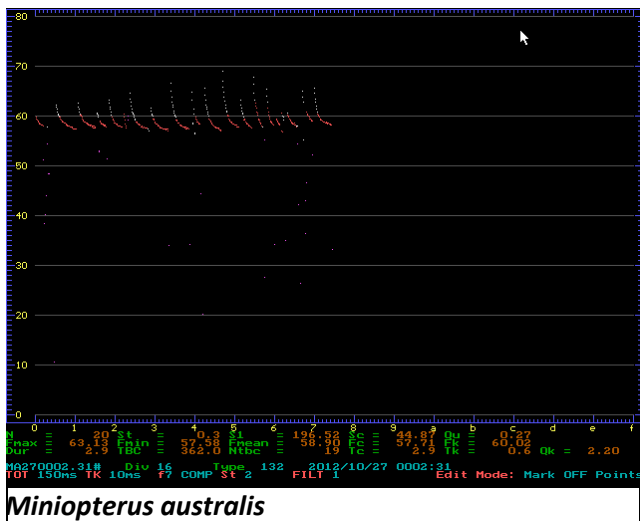


Figure 23 - *Miniopterus australis*

- Amplified call recording/playback for avifauna, mammals and amphibians. Playback of pre-recorded calls included the following threatened species:
 - Bush-stone Curlew
 - Bush Hen

- Grass Owl
- Koala
- Woompoo Fruit-dove
- White-eared Monarch
- Glossy Black-cockatoo
- Regent Honeyeater
- Rose-crowned Fruit-dove
- Wallum Froglet
- Black Bittern
- Powerful Owl (*Ninox strenua*)
- Masked Owl (*Tyto novaehollandiae*)
- Sooty Owl (*Tyto tenebricosa*)
- Plumed/Marbles Frogmouth (*Podargus ocellatus*)
- Koala (*Phascolarctos cinereus*)
- Squirrel Glider (*Petaurus norfolcensis*)
- Spotted-tailed Quoll (*Dasyurus maculatus*)

Each call playback session comprised of the following:

- A 15min listening period for unelected fauna calls
 - 5min call playback for relevant species on a 25W Toa Megaphone
 - 10min search/spotlight for fauna at the playback site
-
- Four motion triggered trail cameras (ScoutGuard SG550PV-31B) were deployed as discussed in 'diurnal' above

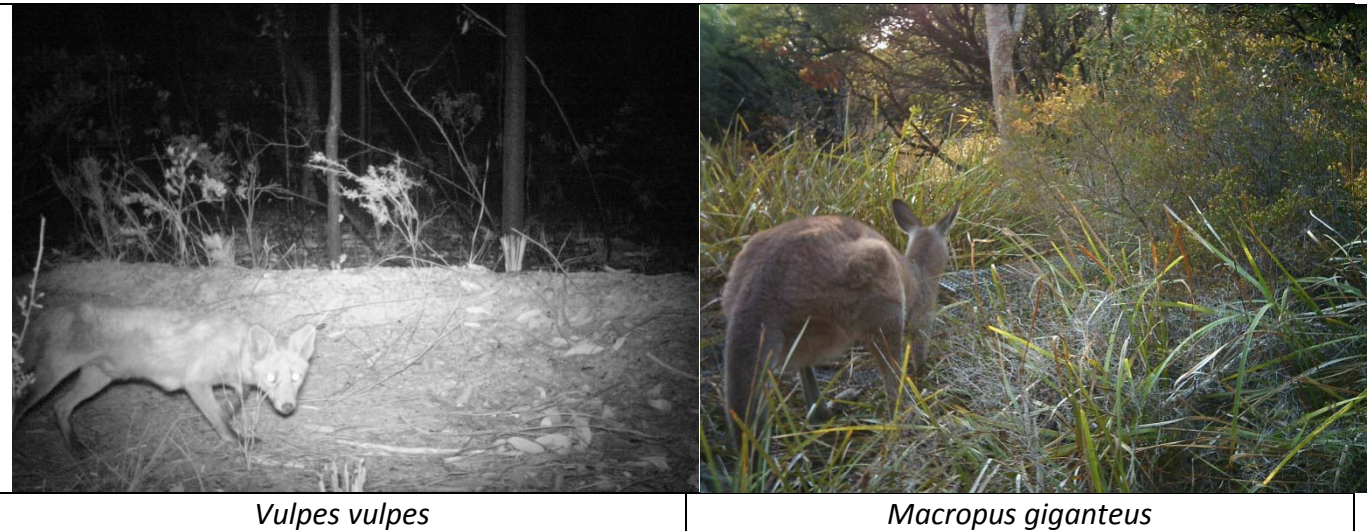


Figure 24 – Species recorded on camera during surveying

Such passive camera traps were deployed in accordance with DSEWPC (2011) ‘Survey guidelines for Australia’s threatened mammals: Guidelines for detecting mammals listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999. “Passive systems are single units that use heat and motion detectors to trigger the camera (Kelly & Holub 2008). Infrared sensors work better at cooler ambient temperatures and are less consistent in warm environments (Swann et al. 2004). Camera trapping has been found to be the most effective method of detecting species at low or moderate densities (Vine et al. 2009 in DSEWPC, 2011: 32).”

DSEWPC (2011) note that ‘recent surveys have found remote cameras to be the most cost-effective technique and allow concurrent data to be collected on other carnivores, particularly cats and foxes.’

Cameras were fixed to trees (or a driven metal stake where no trees were available) approximately 75-100cm from ground level and aimed at a bait station. Cameras were programmed to operate 24 hours and take 3-image bursts triggered by motion. A 60 second delay was programmed between bursts.

Each bait station consisted of either a fresh chicken frame or tuna mixture (carnivore) or a mixture of oats, peanut butter and golden syrup (generalist). To reduce the ability for a single animal to move the bait away from the camera station the chicken frames were tied to a log or to the ground and secured with tent pegs. The generalist bait was placed within a 50mm PVC vent cowl which was also secured via a tent peg (per Paull et al, 2011).

In addition either tuna oil (carnivore) or golden syrup/aniseed mixture (generalist) was sprayed in an approximate 5m radius around each bait station to act as an attractant. All fauna images were identified to genus or species level by experience ecologists/environmental planners.

Depending on the targeted species playback was undertaken at dawn, dusk and/or after dark. All call files were obtained from BOCA or NATURESOUND.

The approximate locations of fauna survey plots (for defined methods such as trapping, call playback, spotlighting etc) across the site are depicted in Attachment 4.

Table 7 – Summary of Fauna Survey Effort

Fauna Group	Survey Technique	Period
Mammals		
Small terrestrial	Type A Elliot traps	As per above table
	Scout Camera	4 cameras x 10 days at 2 locations
Medium-large terrestrial	Type B Elliott traps/open wire traps	As per above table
	Scout Camera	4 cameras x 10 days at 2 locations
Arboreal mammals	Faecal pellet searches	Opportunistic survey
	Scratch/trace trunk examination	Opportunistic survey
	Spotlighting	Min 20 person hours
	Call playback	10 evenings
	Passive Digital Recordings	2 locations location over six nights and 1 location over 4 nights nights as described above.
Microchiropteran bats	Anabat detection	1730hrs-0000hrs on 10 nights
Megachirpteran bats	Spotlighting	Min 20 person hrs
	Diurnal camp/roost search	Opportunistic survey
Birds		
Diurnal	Dusk/dawn observations/audible detection	Opportunistic survey during trap release, vegetation survey and other survey works
	Call playback	One session for each species
	Transects observation points	Avifauna transects: 30 min [replicated ten times at dawn +/- 30 minutes] 30 min [replicated ten times times at dusk +/- 30 minutes]
Nocturnal	Call playback/audible detection	One session for each species
	Spotlighting	Min 20 person hours
	Passive Digital Recordings	4 cameras x 10 days at 2 locations.
Reptiles		
Diurnal/Nocturnal	Opportunistic recording	Opportunistic survey
	Active searches, rock/timber roll	30 minute x 0.5ha habitat search on 10 days at two sites
	Spotlighting	Min 20 person hours
	Scout Camera	4 cameras x 10 days at 2 locations
Amphibians		

Diurnal/Nocturnal	Audible detection	Opportunistic survey during other works
	Call playback	Three sessions for each species
	Spotlighting	Min 20 person hours

4.3 SURVEY LIMITATIONS

Whilst the duration of flora surveys and inspections of the property are considered appropriate for the intended purpose of an ecological constraints scoping exercise, it was not practical to intensively search all areas of the site (~5ha). Additional undetected threatened or other native flora species may be present on the property. Seasonal surveys would also be necessary to detect flora species that are dormant or inconspicuous for part of the year (i.e. from the Asteraceae, Orchidaceae, Cyperaceae, Poaceae etc). Some of these species (dormant or non flowering) may have been undetected or under-represented within the survey period. Further ungerminated seed of various species may have been present within the soil seed bank.

Whilst the duration and sampling methodology of the fauna survey is considered appropriate, it is acknowledged that the entire seasonal fauna assemblage is unlikely to be recorded. It is also accepted that although assessments of habitat and species ecology does provide an additional measure to anticipate the presence of species (as a surrogate for its actual observation), there is no absolute certainty to the absence of a species from marginal or potential habitat. Additionally, there may be some species that may utilise the habitats within the site but have remained undetected due to their rarity, elusive nature or the sporadic utilisation of the habitats (i.e. the Long-nosed Potoroo, Common Planigale and Dunnart are elusive species that are difficult to trap or observe directly; the Black-necked Stork, Powerful Owl, Spotted-tail Quoll and Red Goshawk may only visit an area occasionally within a much larger home-range; the Swift Parrot and Regent Honeyeater may only visit an area during peak flowering periods etc).

The conclusions of this report are therefore based upon data available at the time and the results of field works undertaken and are therefore indicative of the environmental condition of the site at the time of sampling, including the presence or otherwise of species. It should be acknowledged that site conditions, including the presence of threatened species, can change over time.

The above limitations have been taken into account and the likelihood of such threatened species occurring within the site assessed through habitat assessment, records of the species within the locality and aspects of species ecology (refer Section 5).

Notwithstanding the above, it is considered reasonably unlikely that threatened flora or fauna species have been overlooked in the areas proposed for development.

4.4 BROAD HABITAT ASSESSMENT

Prior to the commencement of the abovementioned survey works on site a broad habitat assessment was conducted in association with vegetation survey works. The purpose of this overview was to determine which species were likely to be present based on available habitat components and to target areas for detailed surveying of protected fauna species. The site incorporated the following broad habitat features as a result of previous landuse, vegetation types (refer Section 3), surrounding uses and hydraulic regime:

Table 8 - Habitat Elements Summary

Habitat Element/Feature	Comment
Presence of hollow bearing trees	Absent form WWTP site present in adjacent bushland
Presence of koala habitat and/or favoured koala tree	Present. <i>Eucalyptus punctate</i> , <i>E. haemastoma</i> , <i>E. signata</i> all found on site.
Presence of caves, culverts or disused buildings suitable for roosting of microchiropteran bat species	Absent
Presence of megabat roosting sites	Suitable roosting sites were located within the drainage lines in the area (Wildthing 2004a)
Presence of scratches or feeding scars on tree trunks	Recorded in previous surveys
Presence of creeklines, estuaries, mudflats, mangroves and/or riparian vegetation	Ephemeral drainage line on site.
Presence of dams, ponds, lakes and/or other natural or constructed permanent water source	Absent on site
Presence of dense understorey and ground cover vegetation	Dense prior to bushfire.
Presence of deep leaf litter layer and/or debris (fallen logs act)	Fallen leaf litter and ground logs/branches were abundant prior to the bushfire.
Presence of fruiting flora species	Sparse
Presence of flowering species	Abundant. Banksias, Casuarinas and Eucalypts all abundant within site
Presence of interconnected vegetation remnants (internal and external to site)	Present. Site is adjacent to Wallarah National Park and Munmorah State Conservation Area
Presence of large stick nests indicative of raptor presence	Not recorded.
Presence of rocky outcrops and/or extensive exposed rocky areas favouring reptile populations	Present in adjacent conservation network
Presence of extensive forested (core) habitat with limited exposure to clearing, fragmentation or associated 'edge effects'	Present in conservation network

4.5 SITE SURVEY RESULTS

The following section(s) list the fauna species recorded on the subject site during surveying and lists the methods by which each species was identified. Results are grouped by the Class of species recorded. Those techniques utilised to record fauna are listed below and correlate with

the acronyms included within the Survey Methods column of the grouped Survey Results tables.

Survey Method Codes:

O	Direct Observation
SL	Direct Observation with Spotlight
Sc	Scat
C	Call (Audible) Detection, Recording and/or response to playback
CAM	Passive Camera Trap
HT	Hair tube/funnel
Scr	Scrape
Scrt	Scratch
Sh	Shell/Shell Fragment/Skeleton
Trk	Track/Trace
T	Trapped/hand captured
Ana	ANABAT Detection
Rk	Road-kill

* All birds were either directly observed through diurnal survey, spotlighting or call identification.

** Introduced/feral species

*** Recorded in offsite adjacent areas or circling overhead

4.5.1 Mammals

FAMILY	SCIENTIFIC NAME	COMMON NAME	METHOD
Canidae	** <i>Canis lupus</i>	Dog	O, Trk, Sc
Canidae	** <i>Vulpes vulpes</i>	Fox	O, SL, Trk, Sc, CAM
Dasyuridae	<i>Antechinus stuartii</i>	Brown Antechinus	O
Felidae	<i>Felis catus</i>	Cat	O
Leporidae	<i>Lepus capensis</i>	Rabbit	O
Leporidae	** <i>Oryctolagus cuniculus</i>	Rabbit	O
Macropodidae	<i>Macropus/Wallabia spp</i>	Unidentified Wallaby	Sh
Macropodidae	<i>Macropus giganteus</i>	Eastern Grey Kangaroo	CAM, O
Macropodidae	<i>Wallabia bicolor</i>	Swamp Wallaby	SL, Trk, Sc
Molossidae	<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	Ana
Molossidae	<i>Mormopterus planiceps</i>	Little Mastiff-bat	Ana
Molossidae	<i>Tadarida australis</i>	White-striped Freetail-bat	Ana
Muridae	<i>Melomys burtoni</i>	Grassland Melomys	T
Muridae	** <i>Mus musculus</i>	House Mouse	T
Muridae	<i>Rattus fuscipes</i>	Bush Rat	T
Muridae	** <i>Rattus rattus</i>	Black Rat	T
Peramelidae	<i>Isodon macrourus</i>	Northern Brown Bandicoot	Trk, T, CAM
Petauridae	<i>Petaurus breviceps</i>	Sugar Glider	SL

FAMILY	SCIENTIFIC NAME	COMMON NAME	METHOD
Petauridae	<i>Petaurus norfolcensis</i>	Squirrel Glider	SL
Pseudocheiridae	<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	SL
Pteropodidae	<i>Pteropus poliocephalus</i>	Grey headed Flying-fox	SL
Phalangeridae	<i>Trichosurus vulpecula</i>	Common Brushtail Possum	SL
Tachyglossidae	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna	SL
Vespertilionidae	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	Ana
Vespertilionidae	<i>Chalinolobus morio</i>	Chocolate Wattled Bat	Ana
Vespertilionidae	<i>Miniopterus australis</i>	Little Bentwing-bat	Ana
Vespertilionidae	<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	Ana
Vespertilionidae	<i>Miniopterus australis</i>	Little Bentwing-bat	Ana
Vespertilionidae	<i>Scotorepens orion</i>	Eastern Broad-nosed Bat	Ana
Vespertilionidae	<i>Vespadelus pumilus</i>	Eastern Forest Bat	Ana
Vespertilionidae	<i>Vespadelus vulturnus</i>	Little Forest Bat	Ana

4.5.2 Reptiles

FAMILY	SCIENTIFIC NAME	COMMON NAME	METHOD
Agamidae	<i>Physignathus lesueurii</i>	Water Dragon	O
Agamidae	<i>Pogona barbata</i>	Bearded Dragon	O
Colubridae	<i>Boiga irregularis</i>	Brown Tree snake	SL
Colubridae	<i>Dendrelaphis</i>	Common Tree Snake	SL
Elapidae	<i>Demansia psammophis</i>	Yellow-faced Whip Snake	O
Scincidae	<i>Carlia foliorum</i>	Skink	O, T
Scincidae	<i>Cryptoblepharus virgatus</i>	Cream-striped Shinning-skink	O,T
Scincidae	<i>Ctenotus robustus</i>	Eastern Striped Skink	O,T
Scincidae	<i>Eulamprus quoyii</i>	Eastern Water-skink	O,T
Scincidae	<i>Lampropholis delicata</i>	Grass Skink	O,T
Scincidae	<i>Saiphos equalis</i>	Three-toed Skink	O,T
Scincidae	<i>Tiliqua scincoides</i>	Eastern Blue-tongue	O
Varanidae	<i>Varanus varius</i>	Goana	O

4.5.3 Amphibians

FAMILY	SCIENTIFIC NAME	COMMON NAME	METHOD
Hylidae	<i>Litoria dentata</i>	Bleating Tree Frog	C, SL
Hylidae	<i>Litoria carulea</i>	Green Treefrog	SL
Hylidae	<i>Litoria fallax</i>	Eastern Sedgefrog	C, SL
Hylidae	<i>Litoria nasuta</i>	Rocket Frog	C, T
Myobatrachidae	<i>Crinia signifera</i>	Common eastern Froglet	C, T
Myobatrachidae	<i>Limnodynastes peronii</i>	Brown-striped Frog	C, T

Myobatrachidae	<i>Uperoleia fusca</i>	Dusky Toadlet	C, T
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4.5.4 Birds*

Family	Species Name	Common Name
Acanthizidae	<i>Acanthiza pusilla</i>	Brown Thornbill
Acanthizidae	<i>Sericornis frontalis</i>	White-browed Scrubwren
Accipitridae	<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk
Accipitridae	<i>Haliastur indus</i>	Brahminy kite***
Alcedinidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra
Anatidae	<i>Anas superciliosa</i>	Pacific black duck
Anatidae	<i>Chenonetta jubata</i>	Australian Wood Duck
Ardeidae	<i>Ardea ibis</i>	Cattle Egret
Artamidae	<i>Artamus cyanopterus</i>	Dusky Woodswallow
Artamidae	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow
Artamidae	<i>Cracticus nigrogularis</i>	Pied Butcherbird
Artamidae	<i>Gymnorhina tibicen</i>	Australian Magpie
Artamidae	<i>Strepera graculina</i>	Pied Currawong
Cacatuidae	<i>Cacatua roseicapilla</i>	Galah
Cacatuidae	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo
Cacatuidae	<i>Cacatua sanguine</i>	Little Corella
Cacatuidae	<i>Calyptorhynchus funereus</i>	Yellow-tailed Black Cockatoo
Cacatuidae	<i>Cracticus torquatus</i>	Grey Butcherbird
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike
Campephagidae	<i>Coracina tenuirostris</i>	Cicadabird
Centropodidae	<i>Centropus phasianinus</i>	Pheasant Coucal
Charadriidae	<i>Vanellus miles</i>	Masked lapwing
Cisticolidae	<i>Cisticola exilis</i>	Golden-headed Cisticola
Climacteridae	<i>Cormobates leucophaea</i>	White-throated treecreeper
Columbidae	<i>Geopelia humeralis</i>	Bar-shouldered Dove
Columbidae	<i>Lopholamius antarctius</i>	Topknot Pigeon
Columbidae	<i>Ocyphaps lophotes</i>	Crested Pigeon
Columbidae	<i>Phaps chalcoptera</i>	Common Bronzewing
Coraciidae	<i>Eurystomus orientalis</i>	Dollarbird
Corvidae	<i>Corvus coronoides</i>	Australian Raven
Corvidae	<i>Corvus orru</i>	Torresian crow
Cuculidae	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo
Dicruridae	<i>Grallina cyanoleuca</i>	Magpie-lark
Dicruridae	<i>Rhipidura fuliginosa</i>	Grey fantail
Estrildidae	<i>Neochimia temporalis</i>	Red-browed Finch
Eupetidae	<i>Psophodes olivaceus</i>	Eastern whipbird
Hirundinidae	<i>Hirundo neoxena</i>	Welcome Swallow
Laridae	<i>Choicocephalus novaehollandiae</i>	Silver Gull
Maluridae	<i>Malurus cyaneus</i>	Superb Fairy-wren
Maluridae	<i>Malurus lamberti</i>	Variegated Fairy-wren
Maluridae	<i>Malurus melanocephalus</i>	Red-backed Fairy-wren
Meliphagidae	<i>Anthochaera chrysoptera</i>	Little Wattlebird

Family	Species Name	Common Name
Meliphagidae	<i>Entomyzon cyanotis</i>	Blue-faced honeyeater
Meliphagidae	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater
Meliphagidae	<i>Lichmera indistincta</i>	Brown Honeyeater
Meliphagidae	<i>Manorina melanocephala</i>	**Noisy miner
Meliphagidae	<i>Philemon citreogularis</i>	Little Friarbird
Meliphagidae	<i>Plectorhyncha lanceolata</i>	Striped Honeyeater
Meliphagidae	<i>Phylidonyris niger</i>	White-cheeked honeyeater
Megaluridae	<i>Megalurus timoriensis</i>	Tawny Grassbird
Monarchidae	<i>Grallina cyanoleuca</i>	Magpie-lark
Monarchidae	<i>Myiagra rubecula</i>	Leadend Flycatcher
Nectariniidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird
Oriolidae	<i>Sphecotheres vieilloti</i>	Australasian Figbird
Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Shrike-thrush
Pachycephalidae	<i>Colluricincla pectoralis</i>	Golden Whistler
Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous whistler
Pardalotidae	<i>Gerygone olivacea</i>	White-throated gerygone
Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote
Phasianidae	<i>Coturnix ypsiolophora</i>	Brown Quail
Podargiidae	<i>Podargus strigoides</i>	Tawny Frogmouth
Psittacidae	<i>Platycercus elegans</i>	Crimson Rosella
Psittacidae	<i>Platycercus eximius</i>	Eastern Rosella
Psittacidae	<i>Trichoglossus chlorolepidotus</i>	Scaly-breasted Lorikeet
Psittacidae	<i>Trichoglossus haematodus</i>	Rainbow lorikeet
Rhipiduridae	<i>Rhipidura leucophrys</i>	Willie Wagtail
Strigidae	<i>Ninox novaeseelandiae</i>	Southern Boobook
Timaliidae	<i>Zosterops lateralis</i>	Silvereye

4.6 DISCUSSION OF SURVEY RESULTS

As noted the subject site has been subject detailed previous assessments this assessment provides continued fauna based assessment specific to the areas of the proposal.

We note from the Director Generals assessment report that 'In terms of threatened fauna species the report notes that 15 species were recorded or considered likely to occur within the development lands (Catherine Hill Bay and Gwandalan). These species included Wallum Froglet, Glossy Black Cockatoo, Regent Honeyeater, Swift Parrot, Powerful Owl, Masked Owl, Eastern Pygmy Possum, Grey-headed Flying Fox, Little Bentwing-Bat, Eastern Bentwing-Bat, Eastern Freetail Bat, Yellow Bellied Sheath-tailed Bat, Eastern False Pipistrelle, Large-footed Myotis and Greater Broad-noised bat.

4.6.1 BIRDS

Sixty - eight (68) species of bird were recorded during surveys of the subject site. One species scheduled as vulnerable under the *Threatened Species Conservation Act 1995* was recorded on the site during fauna survey works.

The majority of bird species recorded are diurnal species including:

- Nectar feeders (i.e. lorikeets, honeyeaters, friarbirds, etc)
- Insectivores which forage for invertebrates in the leaves, branches and bark of trees/shrubs in the air spaces provided by canopy gaps, and amongst litter, woody debris and groundcovers (i.e. fairy wrens, whistlers, fantails, whipbird, treecreeper, tawny grassbird, cisticola etc)
- Large generalist omnivores (i.e. butcherbirds, magpies, crows etc)
- Waterbirds (herons, egrets etc)
- Coastal raptors (brahminy kite)
- Granivores (finches)

Subsequent to the fauna survey, it is considered that the site exhibits habitat favorable for nectarivorous birds (in association with paperbark forest and acacia species within the open/regrowth areas), common generalist species typically found within modified habitats (i.e. magpies, crows etc) and insect feeding forest/woodland birds. Frugivores (figbird, oriole, fruit-doves, pigeons, varied triller) were poorly represented due to an absence of favoured habitat.

The proximity of extensive coastal wetlands (estuarine and freshwater) has resulted in the recording of numerous waterfowl such as Ducks and Ibis. Some species were also encountered foraging within the more open areas adjacent to the site.

The existence of substantial areas of heathland, riparian forest and eucalypt forest within the locality is likely the reason for the presence of a relatively diverse assemblage of avifauna encountered on the site.

The proximate / adjacent conservation reserve networks Wallarah National Park and Munmorah State Conservation Area provide extensive and high quality habitat for fauna. This reserve system and protected beach/dune areas encompass an altitudinal sequence of habitats rising from the ocean foreshore, sedgeland, heathlands, swamp sclerophyll, dry sclerophyll and wet sclerophyll forest through to Lake Macquarie including mangroves.

Continuous habitat gradients such as this provide avifauna with a range of resources throughout the year and are likely to have importance in connecting breeding populations

across the landscape. A wide diversity of avifauna moving through the locality (particularly) throughout the year is therefore likely to be encountered.

The recorded and potential occurrence of threatened bird species is discussed within Section 5 below.

4.6.2 MAMMALS

A total of thirty – one (31) mammal species were recorded on the subject site. Five species listed as vulnerable under the *Threatened Species Conservation Act 1995* were recorded on the site during fauna survey works. These species are discussed individually within the later sections of the report.

Ground-dwelling Mammals

All terrestrial mammals require vegetated cover for shelter and to facilitate movement. Small terrestrial mammals prefer areas within a complex vegetation structure which is dense within the lower strata and subsequently provides shelter/nesting sites and refuge from predators. Larger terrestrial mammals (larger wallabies, kangaroos) also generally require dense cover for refuge but tend to favour more open areas for grazing/feeding.

Suitable structural forest variation and/or dense understorey components were present in the adjacent conservation reserve system and adjoining properties. The site provided dense understorey prior to the bushfire event.

Trapping resulted in the recording of several native species including rats, melomys and bandicoots. The introduced house mouse and black rat were also common.

Several macropod and scats were noted and whilst they were not sent away for identification they are associated with the kangaroo and wallaby observed. These were also recorded through digital cameras.

Arboreal Mammals

Arboreal mammals previously noted to occur within the vicinity of the site are all noted to be hollow dependent with the exception of the Koala and the Ringtail Possum (which does utilize hollows but will also construct leaf dreys) (Strahan eds, 2002; Gibbons and Lindenmayer, 2002). It is widely accepted that a reduction in senescent trees is a limiting factor in hollow dependent arboreal mammal populations (Smith and Lindenmayer, 1998; Gibbons and Lindenmayer, 2002; Lindenmayer, 2002; Lunney, 1987).

Within the site, principally Kanangra Drive Pump station location there exists an absence of hollow bearing trees (HBT) with associated Eucalypt Woodland/Open Forest also absent. The

habitat value for hollow dependent arboreal mammals is accordingly considered to be low on site however abundant adjacent to it.

The scheduled Vulnerable Squirrel Glider was recorded north of the site during inspections of the existing pipeline near Mangrove Gully Creek.

Arboreal mammals were not observed within the WWTP site.

Flying Mammals

One species of flying fox (Grey-headed Flying Fox) was recorded flying over and foraging within the adjoin conservation reserve during spotlighting along Kanangra Drive. No roosting was recorded onsite.

Anabat Detection survey also recorded the following bat species on site:

- Eastern Freetail-bat
- Little Mastiff-bat
- White-striped Freetail-bat
- Yellow-bellied Sheath-tail Bat
- Gould's Wattled Bat
- Chocolate Wattled Bat
- Little Bentwing-bat
- Eastern Bentwing-bat
- Southern Myotis
- Little Bentwing-bat
- Eastern Broad-nosed Bat
- Eastern Forest Bat
- Little Forest Bat

It is considered that the site contains a variety of suitable foraging spaces for recorded microchiropteran bats (i.e. the modified grassland areas and the space above the regrowth areas provide 'uncluttered open space'; the ecotonal areas between the forest copses and the shrubland, and the fragmented canopy of the paperbark areas provide 'edge' space, the lower canopy zone of the Eucalypt Forest provides 'cluttered' space', Lake Macquarie provides 'over water surfaces' [per Schnitzerler and Kalko, 2001]).

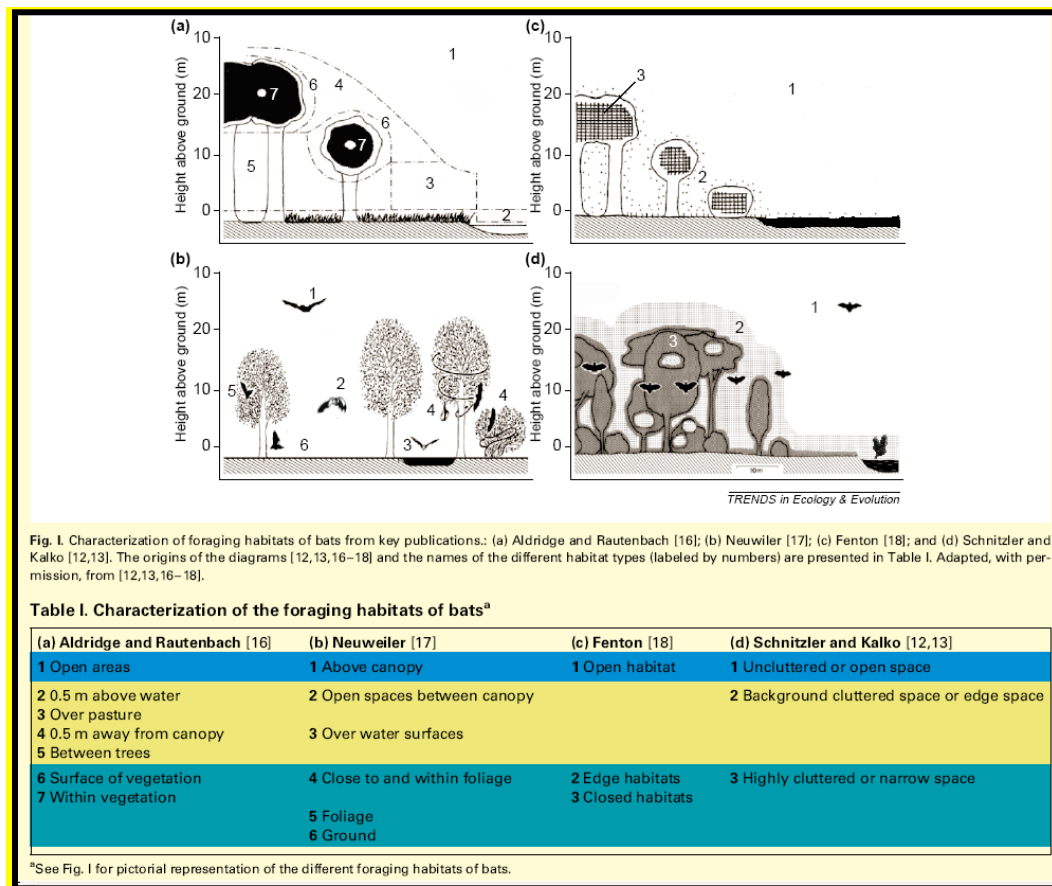


Figure 25 - Review of Micro-Bat Foraging Habitats (Sourced From Schnitzler Et Al, 2003)

A review of the bats recorded on the site (and within the locality) indicates that tree cavities and caves/crevices are necessary for roosting/breeding. In addition to providing shelter, maternity places and retreats for hibernation, roosts are also important places for social interactions among bats. The availability of suitable roosts is therefore critical for the survival of forest bats (Herr, 1998).

Within the site it is considered that cave/mine potential breeding sites are absent and hollow bearing trees are scarce, however the Pump Station site does contain a number of over mature Scribbly Gum which contains hollows. This area was affected by the recent bushfire with a number of the individual trees being destroyed. Notwithstanding the sites low abundance of hollows the adjoin conservation network does contain numerous / abundant hollow bearing trees as observed during the pipeline route inspections.

It is acknowledged also that unobserved hollows within paperbarks may have also been present and these are known to be utilised by Gould's Long-eared Bat and the Greater Broad-nosed Bat [Campbell, 2001]). Palm fronds which are suitable for species such as the Eastern Long-eared Bat are also found within the adjoin conservation reserves system and potentially suitable for

various species (i.e. Gould's Wattled Bat, Yellow-bellied Sheath-tail Bat, Eastern Broad-nosed Bat).

Table 9 - Roosting Types of Recorded Micro-Bats*

Species Name	Common Name	Roost Type
<i>Miniopterus australis</i>	Little Bentwing Bat	<p>Caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day (DECC 2005). DECC (2005) note the following additional particulars with regard to roosting of little bentwing bat:</p> <ul style="list-style-type: none"> • Maternity colonies form in spring. Males and juveniles disperse in summer. • Only five nursery sites /maternity colonies are known in Australia. • They often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters. • In NSW the largest maternity colony is in close association with a large maternity colony of Common Bentwing-bats (<i>M. schreibersii</i>) and appears to depend on the large colony to provide the high temperatures needed to rear its young.
<i>Myotis macropus</i>	Southern Myotis	Caves, tree hollows, amongst vegetation, under bridges, mines, tunnels and storm water drains
<i>Tadarida australis</i>	White-striped Freetail Bat	Roosts in tree hollows either singly or in groups. Research in Brisbane shows <i>T. australis</i> to roost in hollows in old eucalypt trees, especially in Forest Red Gums (<i>E. tereticornis</i>) and in Grey Gums (<i>E. propinqua</i>) with colony sizes up to 300 individuals. Such studies in Brisbane have also identified occasional roost cohabitation with the Brushtail Possum where neither species appeared to show any aggression toward the other (Rhodes, 2001; Rhodes, 2006).
<i>Mormopterus planiceps</i>	Little Mastiff-bat	Little Northern Freetail Bats usually roost in hollow trees and under loose bark. They also roost in the cracks of poles and in buildings. Many hundreds of them may roost together in a colony - See more at: (http://australianmuseum.net.au/Little-Northern-Freetail-Bat#sthash.uSx3F5o8.dpuf)
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	<p>Mostly within tree cavities although occasionally within other areas [tree stump, disused birds nests, building roofs, canvas roll, tractor exhaust] (Chruszcz and Barclay, 2002).</p> <p>Victoria studies conducted by Lumsden and Bennett (1995) and later by Lumsden (2004) found roost switching was common in individuals faithful to a roost area. Roosts used on successive days</p>

Species Name	Common Name	Roost Type
		were usually within 300m of each other. Lumsden (2004) showed a strong bias for roost trees within floodplain forests and preference toward large Blue Gum/River Red Gums. Colonies are generally small (up to 30) within individuals (primarily males) also roosting individually (Dixon and Lumsden in Van Dyck and Strahan, 2008).
<i>Mormopterus norfolkensis</i>	Eastern Freetail Bat	Tree hollows but occasionally found in buildings (Parnaby, Coles and Hoyer, 1999). All known natural roosts have occurred within the hollow spouts of large mature eucalypts (Hoyer et al in Van Dyck and Strahan, 2008).
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail Bat	Roosting may occur within hollow trees and buildings and also within caves and derelict mines (NPWS, 2004; Richards in Van Dyck and Strahan, 2008). DECC (2005) also notes that burrows of terrestrial mammals in treeless areas or bird nests or sugar glider nests may be utilized.
<i>Vespadelus vulturnus</i>	Little Forest Bat	All roosts were located in dead timber, 11 in severely decayed remains of eucalypt trees, and five in dead sections of live trees. Roost trees were compared with randomly chosen trees from within the available habitat, for a range of tree characteristics .Campbell in Wildlife Research 32(2) 183–191 http://dx.doi.org/10.1071/WR04039
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures, http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10534
<i>Vespadelus pumilus</i>	Eastern Forest Bat	Hollows, structures (http://www.environment.nsw.gov.au/resources/pnf/07359batroosts.pdf)
<i>Scotorepens orion</i>	Eastern Broad-nosed Bat	Hollows, structures (http://www.environment.nsw.gov.au/resources/pnf/07359batroosts.pdf)

* sourced from Lumsden, 2004; Herr, 1998; DEC, 2005; Richards & Martin, 2001; Birt et al, 2001; Rhodes & Richards, 2008; Rhodes and Wardell-Johnson, 2006; Rhodes, 2006; Richards, Reardon and Pennay, 2008; Lumsden, Bennett and Silins, 2002; Aust. Museum, 1999; NPWS, 2004; Richards in Van Dyck and Strahan, 2008; Tidemann & Parnaby in Van Dyck and Strahan, 2008; Law and Anderson, 2000.

4.4.3 REPTILES

A total of thirteen (13) reptile species were recorded on the subject site. No species listed as endangered or vulnerable under the *Threatened Species Conservation Act 1995* were recorded on the site during fauna survey works.

Within the site a variety of lizards were recorded all of which are considered to be common species. Prior to the recent fires the site provided suitable dense shelter refuge. No reptiles were observed during the November inspections. Skinks were also common particularly the striped skink. Several skinks were also encountered along roadways and footpaths as these areas provide suitable basking sites. The water dragon was noted to be common in areas immediately adjacent to Mangrove Gully Creek fire trail crossing.

Three species of common snake were recorded both during investigation along the pipeline route. Additional species such as the carpet python, green tree snake, red-bellied black snake and bandy-bandy are also known from the locality.

4.4.4 AMPHIBIANS

Seven (7) species of native were recorded on the subject site. No species listed as endangered or vulnerable under the *Threatened Species Conservation Act 1995* were recorded on the site during fauna survey works.

The frog species are considered common and/or generalist species which are typical to modified environments. These species were recorded in association with inspections along the pipe route and not within the subject WWTP or Pump Station Site. The absence of standing water within the site is considered a significant factor in the reduced diversity of amphibians encountered within it.

The recorded frog species recorded can be attributed to adult and breeding habitat guilds (per Ecotone, 2007) based upon habitat information (Cogger, 1992; Robinson, 1998; Barker et al, 1995) and breeding information (Anstis, 2002, Tyler, 1999).

Table 10 – Frog Habitat Guilds

Species	Common Name	Adult Habitat	Breeding Habitat
<i>Litoria dentata</i>	Bleating Tree Frog	tree frog	coastal lagoons, ponds and swamps, in heathland, eucalypt forest, farmland
<i>Litoria caerulea</i>	Green Treefrog	tree frog & ground	Ephemeral pool/lentic. Highly adaptable. Roadside ditches, flooded grassland. Ponds, swamps and water troughs.
<i>Litoria nasuta</i>	Rocket frog	ground	Ephemeral pool/lentic

			Shallow waterbodies such as swamps, flooded grassland and ponds.
<i>Litoria fallax</i>	Eastern Sedgefrog	tree frog & ground	Permanent-temporary pools/lentic. Dams, ponds and swamps especially those with emergent reeds.
<i>Uperoleia fusca</i>	Dusky Toadlet	ground	inhabits coastal forest, bushland, heathland and wet or dry sclerophyll forest. Frogs call during spring and summer, normally from dams, swamps, roadside ditches or flooded grassland areas
<i>Limnodynastes peronii</i>	Brown-striped Frog	ground	Permanent-temporary pools/lentic. Dams, flooded grassland, roadside ditches, still pools of streams and suburban gardens.
<i>Crinia signifera</i>	Common eastern Froglet	ground	ponds, dams, swamps, flooded grassland, ditches and hollows

5.0 DISCUSSION OF RECORDED & POTENTIALLY OCCURRING SCHEDULED COMMUNITIES, POPULATIONS AND SPECIES OF CONSERVATION SIGNIFICANCE

5.1 ENDANGERED ECOLOGICAL COMMUNITIES

As noted above the Director Generals assessment report identifies 'four endangered ecological communities (EEC Swamp Sclerophyll Forest, EEC Swamp Oak Floodplain Forest, EEC Saltmarsh and EEC Freshwater Wetlands on Coastal Floodplains)' from the previous ecological assessments associated with the residential development of the site. Of these the assessment report acknowledges only 'two of these EECs are found within the Catherine Hill Bay site (EEC Swamp Sclerophyll Forest and EEC Freshwater Wetlands)'.

As illustrated in Attachment 3 and discussed above the WWTP does not occur within these or other EEC's.

5.2 ENDANGERED POPULATIONS

Endangered populations are listed under Schedule 1, Part 2 of the *Threatened Species Conservation Act 1995*. The following species is classified as an Endangered Population under the *TSC Act* and are found in the areas surrounding Catherine Hill Bay:

- *Eucalyptus parramattensis* C. Hall subsp. *Eucalyptus parramattensis* C. Hall subsp. *parramattensis* population in Wyong and Lake Macquarie local government areas

The species usually occurs from the Goulburn Valley on the Central West slopes to Hill Top on the Central Coast. The endangered population in the Lake Macquarie and Wyong local government areas is at the north-eastern limit of the species range and is quite separate from other known populations. The majority of the population occurs within Wyong in the Porter's Creek and the Wallarah Creek catchments (OEH 2013ac).

This species is associated with low moist areas alongside drainage lines and adjacent to wetlands. It is often found in woodland on sandy soils. The endangered population occurs on sandy alluvium within a floodplain community which also supports *Eucalyptus robusta* (Swamp mahogany), *E. tereticornis* (Forest Red Gum), *E. gummifera* (Sydney Bloodwood) as well as *Melaleuca* (Paperbark) species (OEH 2013ac).

This Endangered Population is described by the scientific committee (online @ <http://www.environment.nsw.gov.au/determinations/EucalyptusParramattensisCentralCoastPopEndSpListing.htm>) as follows:

1. *Eucalyptus parramattensis* subsp. *parramattensis* (family Myrtaceae) is a small tree described by K.D. Hill (2002) in *Flora of New South Wales*. page 118, Volume 2, Revised Edition, Harden G.J. (ed.). UNSW Press, Sydney.
2. *Eucalyptus parramattensis* subsp. *parramattensis* is not currently listed as an endangered species in Part 1 of Schedule 1 and as a consequence populations of this species are eligible to be listed as endangered populations. (A different subspecies, *E. parramattensis* subsp. *decadens* is listed as a vulnerable species in Schedule 2 of the Threatened Species Conservation Act).
3. The population of *Eucalyptus parramattensis* subsp. *parramattensis* in Wyong and Lake Macquarie local government areas is at the north eastern limit of the range of the species and is disjunct from other known populations of the subspecies.
4. The current population of the subspecies is estimated to be about 1300 trees in Wyong local government area and about 10 trees in Lake Macquarie local government area.
5. The population is threatened by grazing (which may affect regeneration), localised clearing and effects of septic overflow. Planned road construction and future development may substantially reduce the population and its habitat.
6. In view of the above the Scientific Committee is of the opinion that the population of *Eucalyptus parramattensis* C. Hall subsp. *parramattensis* in Wyong and Lake Macquarie local government areas is facing a high risk of becoming extinct in nature in New South Wales and it is of conservation value at the State or regional level for the following reason: it is disjunct or near the limit of its geographic range.

It is considered that this Endangered Population does not occur within the study area. The future development is unlikely to impact this population. Previous surveys of the locality did not detect any individuals. The Atlas of Living Australia (figure 28) produced one record of the species within 5km of the development site. This population is too far away from the proposal site to be affected.

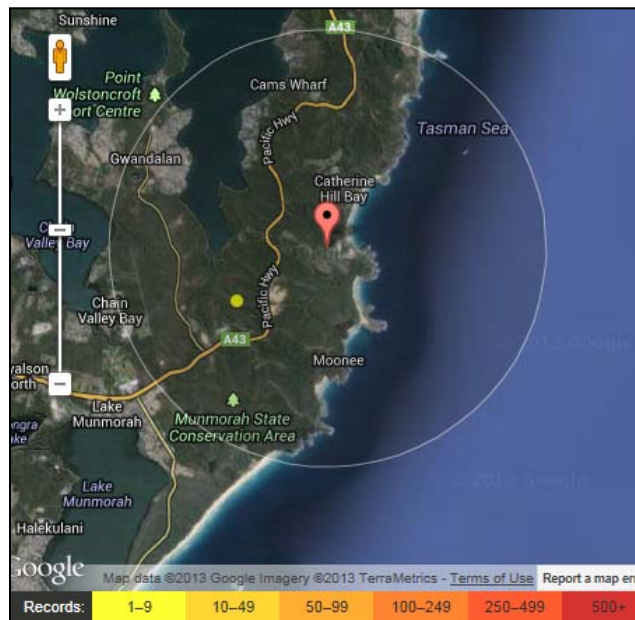


Figure 26 - The Atlas of Living Australia records of the *Eucalyptus parramattensis* C. Hall subsp. *parramattensis* population (Source: ALA 2013)

5.3 THREATENED FLORA SPECIES

A search of the *NPWS 'Atlas of NSW Wildlife' [2010]* has determined that thirteen species of threatened flora have been previously recorded within the locality (search area North: -33.1 West: 151.56 East: 151.66 South: -33.2). Attachment 5 provides the Bionet Search results for the 10km area including the site.

As noted above previous detailed surveys associated with the residential development of the site have occurred over parts of the site. These have identified a number of scheduled flora as occurring within the locality and specifically two species have been identified as occurring within the proposed WWTPN. These include Black Eyed Susan (*Tetratheca juncea*) which has been extensively mapped and described as occurring within the location of the Waste Water Treatment Plant Site and pipe network. The Leafless Tongue Orchid (*Cryptostylis hunteriana*) has been identified in a number of locations proximate to the pipe network.

It is relevant to note approvals for the removal of these scheduled species has been issued subject to detailed management plans at a state and federal level.

Targeted surveying associated with the extended pipe network and development components at Kanangra drive did not locate additional individuals.

As noted within the report the bushfire of October 2013 has had a significant affect on the location with the WWTPN and WWTP area being significantly altered by fire. Whilst it is acknowledged this is a natural process the event has clearly impacted on species diversity at

the site and potentially the continued presence of scheduled species on site. No individuals were observed during the November inspection. It is not proposed to alter the approved management documents for these species and if located during further site investigations these would be managed in accordance with the plans.



Figure 27 - Waste Water Treatment Plant Site November 2013


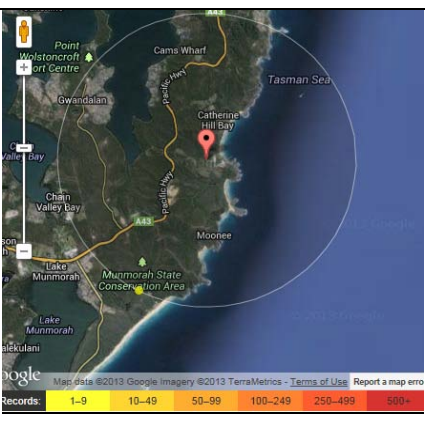
5.3.1 Scheduled Flora

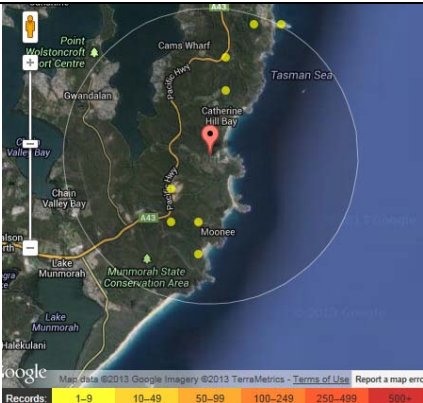
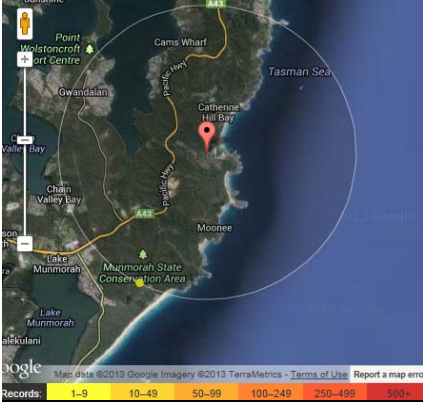
Based on habitat assessment and the known distribution of these species within the NSW bioregion, a number of these are considered unlikely to be present within the site.

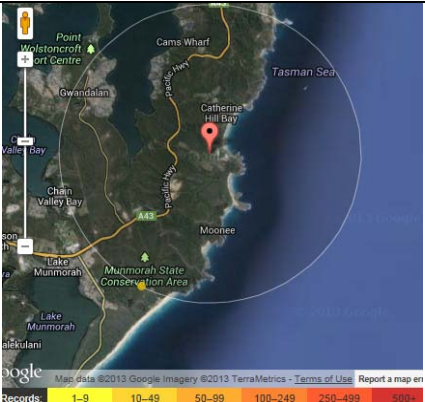
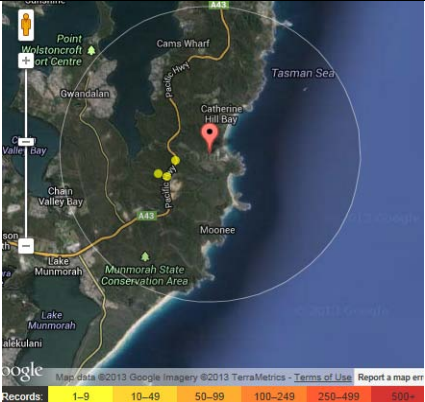
It is considered suitable habitat for many of the species may be present but were not recorded during field surveys associated with the WWTPN. These investigations have been confined to the immediate area of the WWTPN. As noted the WWTPN is located within areas previously approved for development or involve installation of new pipes within cleared / disturbed trails and road reserve. Additionally the pump station on Kanangra Drive is located within a disturbed recreation reserve. In this context we are able to comment on likely impacts to the scheduled species.

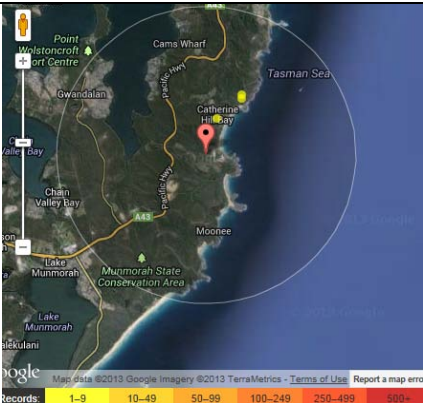
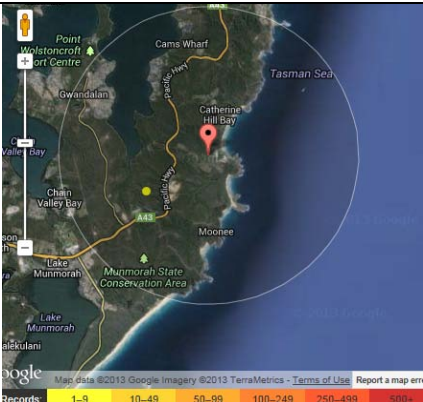
Table 11- Potentially Occurring Threatened Flora

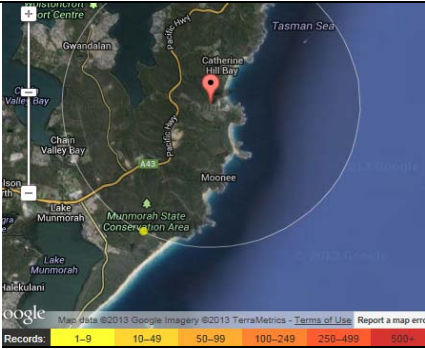
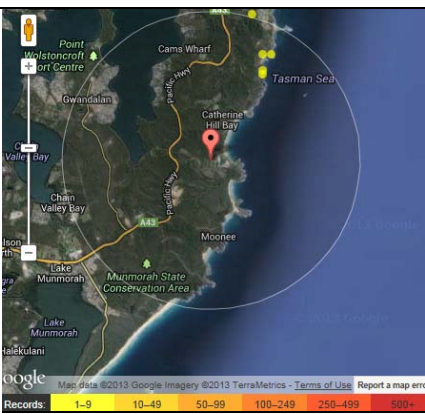
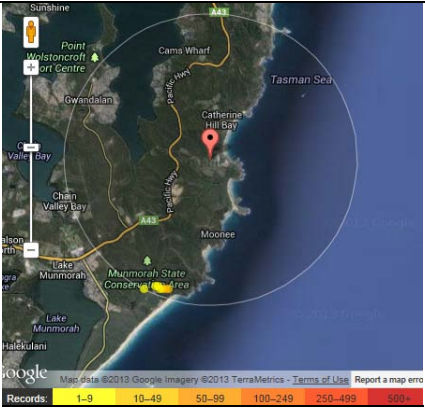
Species Name	Preferred Habitat	TSCA Status	Expected Impact	Atlas of Living Australia Records (<5km) (Source: ALA 2013)

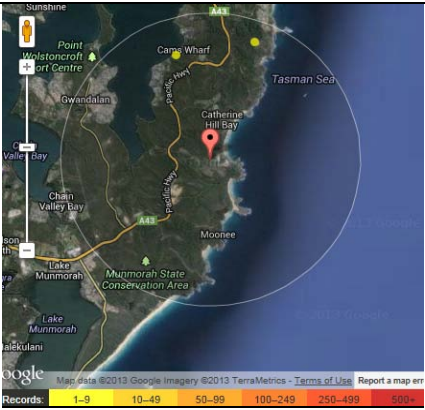
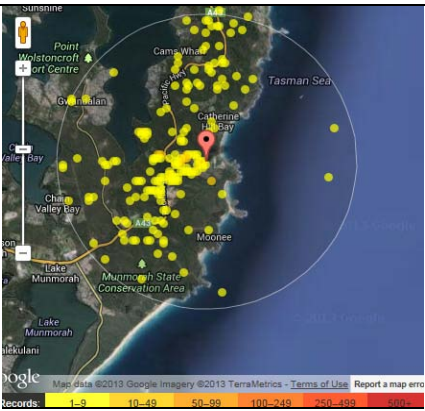
Species Name	Preferred Habitat	TSCA Status	Expected Impact	Atlas of Living Australia Records (<5km) (Source: ALA 2013)
<i>Angophora inopina</i>	Occurs most frequently in four main vegetation communities: (i) <i>Eucalyptus haemastoma</i> – <i>Corymbia gummifera</i> – <i>Angophora inopina</i> woodland/forest; (ii) <i>Hakea teretifolia</i> – <i>Banksia oblongifolia</i> wet heath; (iii) <i>Eucalyptus resinifera</i> – <i>Melaleuca sieberi</i> – <i>Angophora inopina</i> sedge woodland; (iv) <i>Eucalyptus capitellata</i> – <i>Corymbia gummifera</i> – <i>Angophora inopina</i> woodland/forest (OEH 2013v)	V	<p>Potential habitat is present in association with eucalypt and <i>Corymbia</i> woodland/forest</p> <p>Not recorded in previous surveys.</p> <p>No new individuals recorded during surveys associated with WWTPN</p> <p>No impact is expected.</p>	 <p>14 records</p>
<i>Caladenia tessellata</i>	Generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil (OEH 2013w).	E1	<p>Marginal habitat is present in association with grassy sclerophyll woodland on sandy soils.</p> <p>Not recorded in previous surveys.</p> <p>No new individuals recorded during surveys associated with WWTPN</p> <p>No impact expected.</p>	 <p>6 Records</p>

Species Name	Preferred Habitat	TSCA Status	Expected Impact	Atlas of Living Australia Records (<5km) (Source: ALA 2013)
<i>Callistemon linearifolius</i>	Grows in dry sclerophyll forest on the coast and adjacent ranges (OEH 2013x)	V	<p>Marginal habitat is present in association with dry sclerophyll forest.</p> <p>Not recorded in previous surveys.</p> <p>No new individuals recorded during surveys associated with WWTPN</p> <p>No impact expected.</p>	 <p>12 Records</p>
<i>Cryptostylis hunteriana</i>	The larger populations typically occur in woodland dominated by Scribbly Gum (<i>Eucalyptus sclerophylla</i>), Silvertop Ash (<i>E. sieberi</i>), Red Bloodwood (<i>Corymbia gummifera</i>) and Black Sheoak (<i>Allocasuarina littoralis</i>); appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (<i>C. subulata</i>) and the Tartan Tongue Orchid (<i>C. erecta</i>) (OEH 2013y).	V	<p>Species recorded previously in the area and through surveys associated with the residential estate. No new individuals recorded during surveys associated with WWTPN</p> <p>We note preferred habitat occurs in the WWTPN route.</p> <p>No significant impact expected. Individuals found to be safely relocated to an offset site.</p>	 <p>1 Record</p>

Species Name	Preferred Habitat	TSCA Status	Expected Impact	Atlas of Living Australia Records (<5km) (Source: ALA 2013)
<i>Diuris praecox</i>	Grows on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey (OEH 2013z)	V	Not recorded in previous surveys. No new individuals recorded during surveys associated with WWTPN. No impact expected.	 <p>15 Records</p>
<i>Eucalyptus camfieldii</i>	Poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges. Occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas (OEH 2013aa)	V	Marginal habitat is considered present in association with sandy soils, however, favoured habitat associated with coastal heath is absent. Not recorded in previous surveys but known to occur in the locality. No new individuals recorded during surveys associated with WWTPN No impact expected.	 <p>3 Records</p>

Species Name	Preferred Habitat	TSCA Status	Expected Impact	Atlas of Living Australia Records (<5km) (Source: ALA 2013)
<i>Eucalyptus parramattensis subsp. decadens</i>	Generally occupies deep, low-nutrient sands, often those subject to periodic inundation or where water tables are relatively high. It occurs in dry sclerophyll woodland with dry heath understorey. It also occurs as an emergent in dry or wet heathland. Often where this species occurs, it is a community dominant (OEH 2013ab)	V	<p>Marginal habitat is present in association with sandy substrates and dry sclerophyll woodland, however, the site is not inundated with water periodically.</p> <p>Not recorded in previous surveys.</p> <p>No new individuals recorded during surveys associated with WWTPN</p> <p>No impact expected.</p>	 <p>3 Records</p>
<i>Eucalyptus parramattensis subsp. parramattensis</i>	This species is associated with low moist areas alongside drainage lines and adjacent to wetlands. It is often found in woodland on sandy soils. The endangered population occurs on sandy alluvium within a floodplain community which also supports <i>Eucalyptus robusta</i> (Swamp mahogany), <i>E. tereticornis</i> (Forest Red Gum), <i>E. gummifera</i> (Sydney Bloodwood) as well as <i>Melaleuca</i> (Paperbark) species (OEH 2013ac)	E2	<p>Favoured habitat considered to be absent.</p> <p>Not recorded in previous surveys.</p> <p>No new individuals recorded during surveys associated with WWTPN</p> <p>No impact expected.</p>	 <p>1 Record</p>

Species Name	Preferred Habitat	TSCA Status	Expected Impact	Atlas of Living Australia Records (<5km) (Source: ALA 2013)
<i>Genoplesium insignis</i>	Grows in patches of <i>Themeda australis</i> (Kangaroo Grass) amongst shrubs and sedges in heathland and forest (OEH 2013ad)	E1	<p>Marginal habitat is present in association with Kangaroo Grass.</p> <p>Not recorded in previous surveys.</p> <p>No new individuals recorded during surveys associated with WWTPN</p> <p>No impact expected.</p>	 <p>1 Record</p>
<i>Pultenaea maritima</i>	The species occurs in grasslands, shrublands and heath on exposed coastal headlands (OEH 2013ae)	V	<p>Favoured habitat is considered to be absent.</p> <p>Not recorded in previous surveys.</p> <p>No new individuals recorded during surveys associated with WWTPN</p> <p>No impact expected.</p>	 <p>6 Records</p>
<i>Rutidosia heterogama</i>	Grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides (OEH 2013af)	V	<p>Favoured habitat is considered to be absent.</p> <p>Not recorded in previous surveys.</p> <p>No new individuals recorded during surveys associated with WWTPN</p>	

Species Name	Preferred Habitat	TSCA Status	Expected Impact	Atlas of Living Australia Records (<5km) (Source: ALA 2013)
			No impact expected.	120 Records
<i>Syzygium paniculatum</i>	On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (OEH 2013ag)	E1	<p>Favoured habitat is considered to be absent.</p> <p>Not recorded in previous surveys.</p> <p>No new individuals recorded during surveys associated with WWTPN</p> <p>No impact expected.</p>	 <p>2 Records</p>
<i>Tetratheca juncea</i>	It is usually found in low open forest/woodland with a mixed shrub understorey and grassy groundcover. However, it has also been recorded in heathland and moist forest (OEH 2013h)	V	<p>Favourable habitat is present throughout the site.</p> <p>Recorded frequently in previous surveys but none in the latest.</p> <p>No new individuals recorded during surveys associated with WWTPN</p> <p>Any individuals found will be safely relocated to an offset site. No impact expected.</p>	 <p>615 Records</p>

5.4 Tetratheca juncea – Black Eyed Susan

A population of this species (189) was recorded by RPS HSO (2010) on November 2007. These individuals were recorded within the Narrabeen Doyalson Coastal Woodland, Coastal Plains Smooth-barked Apple Woodland and the Narrabeen Wallarah Sheltered Grassy Forest within the Catherine Hill Bay Development Site.

The report notes *Tetratheca juncea* spot flowers throughout the year and November is considered to be late in the flowering season. Therefore, since some individuals are likely to have been missed, the population within CHB Development Lands may be larger than currently estimated (RPS HSO 2010). Location of the recordings for the specie is presented below.

This species was recorded throughout the CHB Development Lands by Wildthing (2003) and EcoBiological (2006) during its flowering season. However, none were recording in the Wastewater Treatment Plant site.

A survey by RPS HSO in July 2008 found 1024 clumps of *Tetratheca juncea* in the Catherine Hill Bay Development Site. This survey was taken outside the peak flowering period for the species. It is believed that the sites surveyed will contain more individuals than observed.

According to the EPBCA (2013), there are approximately 8013 numbers of *Tetratheca juncea* plant clumps within Catherine Hill Bay. Prior to the devastating bushfire, it was estimated that the population of *Tetratheca juncea* within the conservation reserves at Wallarah Peninsula is at least 31,044 to date.

As is evident for the plans the species was recorded in areas of the proposed WWTP site and approved residential allotments as illustrated in Figure 19 and 20.

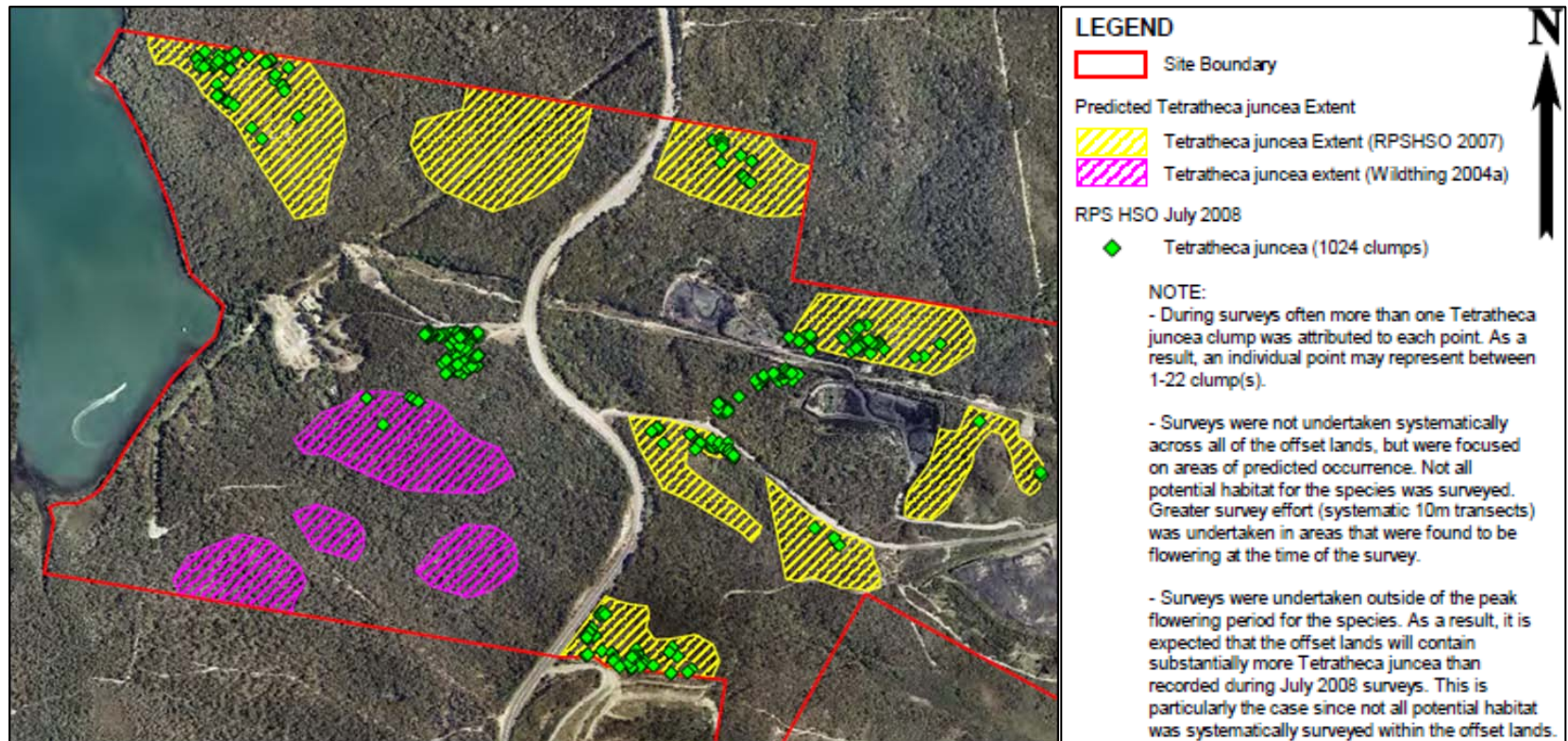


Figure 28 - *Tetratheca juncea* counts within the CHB Development Lands on July 2008 (Source: RPS HSO 2010)



Figure 29 - *Tetratheca juncea* counts within the Wastewater Treatment Plant site on November 2007 (Source: RPS HSO 2010)

Table 12 - Known Distribution of *Tetratheca juncea* within the Wallarah Peninsula within Conservation Reserves (Source: RPS HSO 2010)

Site at Wallarah Peninsula	Numbers of <i>Tetratheca juncea</i>
Walarah National Park and Habitat Corridor at Murrays Beach*	9900
Munmorah State Conservation Area**	296
Lake Macquarie State Conservation Area**	29
Coal & Allied Catherine Hill Bay Proposed Offset Lands	7,057
Coal & Allied Gwandalan Proposed Offset Lands	6,591
Coal & Allied Nords Wharf Proposed Offset Lands	5,933
Rosegroup Offset Lands***	1,238
Total in Conservation Reserves at Wallarah Peninsula	31,044

* Data from Conacher Travers (2007) , ** Data from Payne (2000), *** Data from RPSHSO (2010) and Wildthing (2003)

A similar and more detailed examination on the recordings from disjunct and proximate conservation areas was outlined by RPS in their study for the Proposed Hunter Water Board

Reservoir at Montefiore Street, Catherine Hill Bay, NSW 2009. The report includes the following table on recordings and distribution.

Table 13 - Known distribution of *Tetratheca juncea* plant clumps within the region

Source	Numbers of <i>Tetratheca juncea</i> plant clumps
Atlas of NSW Wildlife Records ⁴	828
Awabakal Nature Reserve ²	87
Coal & Allied Catherine Hill Bay Proposed Offset lands ³	7,596
Coal & Allied Gwandalan Proposed Offset lands ³	8,222
Coal & Allied Nords Wharf Proposed Offset lands ³	5,933
Glenrock Nature Reserve ² & ⁴	1,220
Jillaby State Recreation Area ⁴	1
Karuah Nature Reserve ⁴	5
Lake Macquarie State Conservation Area ²	29
Munmorah State Conservation Area ²	296
Proposed Rose Group Offset lands ³	1,016
Tingira Heights Nature Reserve ⁴	2
Wallarah National Park and Habitat Corridor at Murrays Beach ¹	9,900
Wallaroo Nature Reserve ⁴	1
TOTAL IN REGION	35,144

¹ Data from Conacher Travers (2006)

² Data from Payne (2000)

³ Data from RPS HSO (2007) and Wildthing (2003a)

⁴ Atlas of NSW Wildlife Records

As outlined a significant bushfire occurred in the Wallarah Peninsula during the 2 and 3 weeks of October 2013. As illustrated through the images below this also affected the occurrence of these recordings and within WWTPN.

Tetratheca juncea are threatened by bushfires with severe ones known to wipe out the species from areas. Although fire is an integral part of the Black-eyed Susan life cycle, breaking seed dormancy and promoting germination, inappropriate fire regimes threaten its long term survival. Slow cool and high intensity fires kill Black-eyed Susan by completely burning out the rootstock. High frequency of such fires, apart from eliminating Black-eyed Susan plants,

subsequently allows the infiltration and establishment of weeds against which Black-eyed Susan is unable to compete for resources (EPBCA 2013).

As a result of the bushfire and in the most recent survey, no *Tetratheca juncea* were found in the WWTP site or in locations identified by RPS HSO (2010) in their assessment of November 2007, refer Figure 21.

Until flora begins to germinate once again, the affects from the bushfire on *Tetratheca juncea* in the development site and potentially other locations adjacent to the WWTPN is unclear. If any *Tetratheca juncea* are found during the construction of the project, it will be safely relocated to an offset site in accordance with the approved management plans for the species.



Figure 30 - Waste Water Treatment Plant Site November 2013

5.5 *Cryptostylis hunteriana* - Leafless Tongue Orchid

Cryptostylis hunteriana has been recorded within and in proximity to approved residential development. The species was not recorded within the proposed Waste Water Treatment Plant Site, however individual are found within Stage six of the residential development and adjacent to the proposed pipe alignment. No individuals were observed along the existing NPWS/RFS fire trail containing the pipeline or in areas associated with the WWTPN at Kanangra.

The RPS Ecological Assessment Report Southern Lake Macquarie Lands identifies that ‘Nine patches of *C. hunteriana* were found resulting in 43 flowering stems being recorded within the Narrabeen Doyalson Coastal Woodland of the CHB proposed offset area. *C. hunteriana* has a history of flowering sporadically, going for years at a time not producing any flower which makes it difficult to accurately determine potential population sizes.’

The report further notes ‘Several other records for this species occur within the local area. This find is significant as this species is extremely difficult to locate due to sporadic flowering (Bell, 2001). There are six locations where this species has been located in the Wyong LGA and southern Lake Macquarie LGA being Charmhaven, Wyee, Chain Valley Bay, Vales Point and Freemans Waterhole (Bell, 2001). In recent times, an individual was located within the Wallarah Peninsula, at Murrays Beach (Conacher Travers, 2004). Thus the find of a seventh population within the area is significant.

The location of the species within Scribbly Gum habitat is also consistent with the habitat in which this species has been found to be growing. Other locations include Bulahdelah, Nelson Bay, Lemon Tree Passage, Ben Boyd NP, Gilbrater Range NP, Ku-ring-gai Chase NP, Pigeon House, and the south coast.

Mapping for the recordings is presented below in Figure 31.

As noted the WWTP does not affect the recorded locations of the individuals.

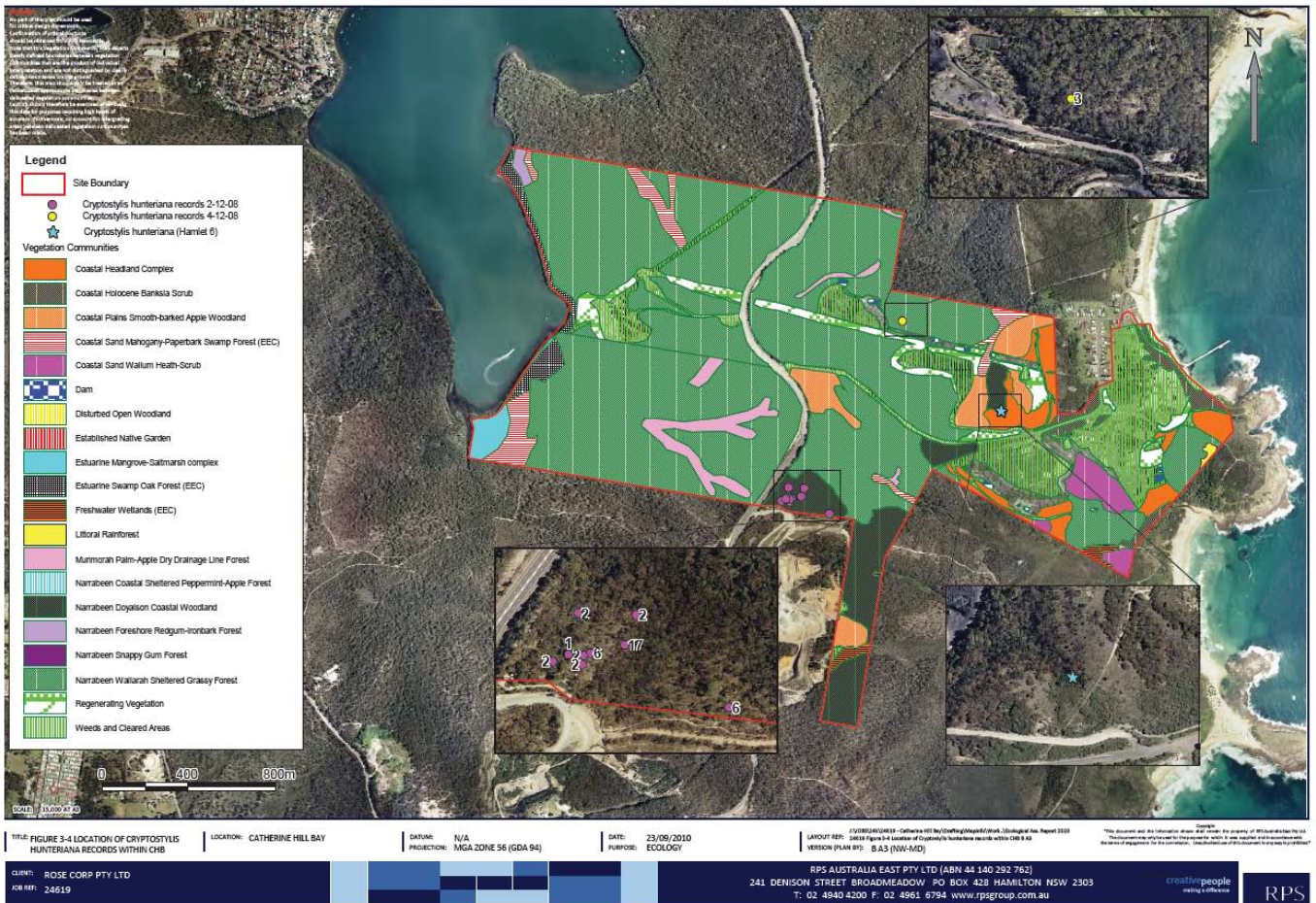


Figure 31 - RPS *Cryptostylis hunteriana* Mapping 2010.

5.6 THREATENED FAUNA SPECIES

A search of the NPWS 'Atlas of NSW Wildlife' [2010] has determined that thirty-five species of threatened fauna have been previously recorded within the locality (search area North: -28.26 West: 153.51 East: 153.62 South: -28.36).

A review of available habitats and the ecology of the database listed species (i.e. range, preferred habitat, home range etc) indicate that it is unlikely that all of these previously recorded species in the locality would rely on the habitats of the subject site or be significantly affected by any proposed development of the site.

Subsequently several such threatened species are considered unlikely to be significantly affected by a future development of the site for one or more of the following reasons:

- Core/favoured habitats were not recorded in the study area

- Resources used by the species are unlikely to be adversely affected or only likely to be minimally affected by the proposal.

Details of threatened species requirements and reasons for not considering impacts to such species further are explained below. Furthermore, a number of threatened species have been excluded from discussion below where they are considered reasonably unlikely occurrences and impacts are unlikely to be occasioned as a result of the proposal due to the following:

- Being a marine reptile or mammal (i.e. whale, turtle, seal)
- Being a pelagic seabird

For species considered a potential occurrence (based upon distribution, database recording, suitable habitat present etc) or which were recorded within or directly adjacent the site during either survey period or for which it is considered that the species would be affected by the proposal (i.e. impact on feeding, roosting, nesting, behaviour and associated habitat), the seven-part test of significance is required.

5.6.1 Recorded Species

Through the site surveying six threatened species were recorded. All species are listed as Vulnerable under the TS Act. These were;

- *Petaurus norfolcensis* - Squirrel Glider
- *Pteropus poliocephalus* - Grey Headed Flying Fox
- *Mormopterus norfolkensis* - Eastern Freetail-bat
- *Miniopterus australis* - Little Bentwing-bat
- *Miniopterus schreibersii oceanensis* - Eastern Bentwing-bat
- *Myotis macropus* - Southern Myotis

These and other potentially occurring species recorded under the Atlas which may be present on or utilise the site features are discussed below:

***Crinia tinnula* (Wallum Froglet)**



Figure 32 - Distribution range of *Crinia tinnula* (source: OEH 2013a)

Description

Wallum Froglets are small frogs, no more than 30 mm long. They are extremely variable in colour and pattern, from light grey or brown to dark grey above and usually white or light brown below (sparsely flecked with darker patches). A fine median line of white dots often occurs on the underside on the throat. They have no webbing on their feet and toe pads are absent. Pupils are horizontal (OEH 2013a).

Distribution

This Australian endemic occurs from Litabella National Park on the south-east coast of Queensland, south to Kurnell in mid-eastern New South Wales. It also occurs on a number of offshore islands including Fraser Island, Bribie Island, Moreton and North Stradbroke Island (Hines *et al.* 2004).

Habitat and Ecology

Wallum Froglets are found in a wide range of habitats, usually associated with acidic swamps on coastal sand plains. They occur in sedgelands, wet heathlands, paperbark swamps and drainage lines within other vegetation communities. They will also persist in disturbed areas (OEH 2013a). The species breeds in swamps with permanent water as well as shallow ephemeral pools and drainage ditches (OEH 2013a).

Diet

An adult Wallum Froglet's diet consists of several species of arthropods, whereas the tadpole diet consists of sediment and algae (Cogger *et al.* 1983).

Comments

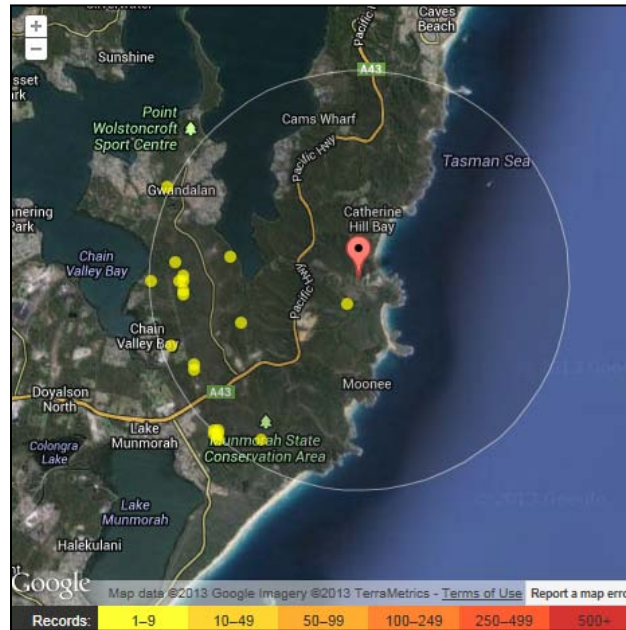


Figure 33 - The Atlas of Living Australia records of the Wallum Froglet (Source: ALA 2013)

Suitable habitat for the Wallum Froglet occurs in the Coastal Sand Mahogany-Paperbark Swamp Forest. No Wallum Froglets were observed in the previous surveys of the study site. The NSW office of Environment and Heritage (figure 32), illustrates that the Wallum Froglet is known to occur within and surround areas of the study site.

The Atlas of Living Australia (figure 33) states that the Wallum Froglet frequents the surrounding area with 28 records of the species within 5km of the study site, possibly where water or drainage lines are present. With more favorable habitats located in the reserves of the area, it is highly unlikely that the future development will significantly impact the Wallum Froglet.

***Litoria aurea* (Green and Golden Bell Frog)**

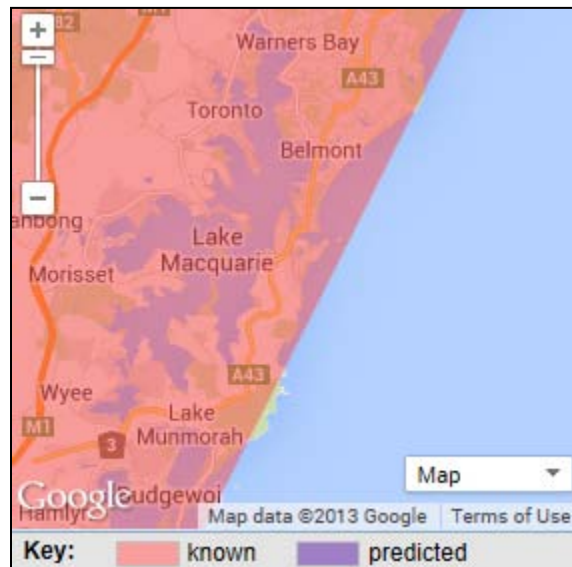


Figure 34 - Distribution range of *Litoria aurea* (source: OEH 2013b)

Description

A relatively large, stout frog, ranging in size from approximately 45 mm to approximately 100 mm snout to vent length. Diagnostic features are a gold or creamish white stripe running along the side, extending from the upper eyelids almost to the groin, with a narrow dark brown stripe beneath it, from nostril to eye. It also has blue or bluish-green colour on the inside of the thighs. The colour of the body varies. Usually a vivid pea-green, splotched with an almost metallic brassy brown or gold. The backs of some individuals may be almost entirely green; in others golden-brown markings may dominate (OEH 2013b).

Distribution

Formerly distributed from the NSW north coast near Brunswick Heads, southwards along the NSW coast to Victoria where it extends into east Gippsland. Records from west to Bathurst, Tumut and the ACT region. Since 1990 there have been approximately 50 recorded locations in NSW, most of which are small, coastal, or near coastal populations. These locations occur over the species' former range, however they are widely separated and isolated. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast (one an island population). There is only one known population on the NSW Southern Tablelands (OEH 2013b).

Habitat and Ecology

The species inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.) (OEH 2013b). Optimum habitat includes waterbodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available (OEH 2013b). A bell frog study in 2002, on Kooragang Island in the Hunter River estuary, found that greater vegetation diversity on the banks of waterbodies was positively associated with the presence of Green and Golden Bell Frogs, and that the frogs were more likely to occur together with the plants *Juncus kraussii*, *Schoenoplectus litoralis* and *Sporobolus virginicus*.

Individuals were found sheltering in and basking on these plants (Pyke and White 2002). Breeding habitat in NSW includes water bodies that are still, shallow, ephemeral, unpolluted (but the frog can be found in polluted habitats), unshaded, with aquatic plants and free of Mosquito Fish (*Gambusia holbrooki*) and other predatory fish, with terrestrial habitats that consisted of grassy areas and vegetation no higher than woodlands, and a range of diurnal shelter sites (Pyke & White 1996).

Diet

Tadpoles feed on algae and other plant-matter while adults eat mainly insects, but also other frogs (OEH 2013b).

Comments

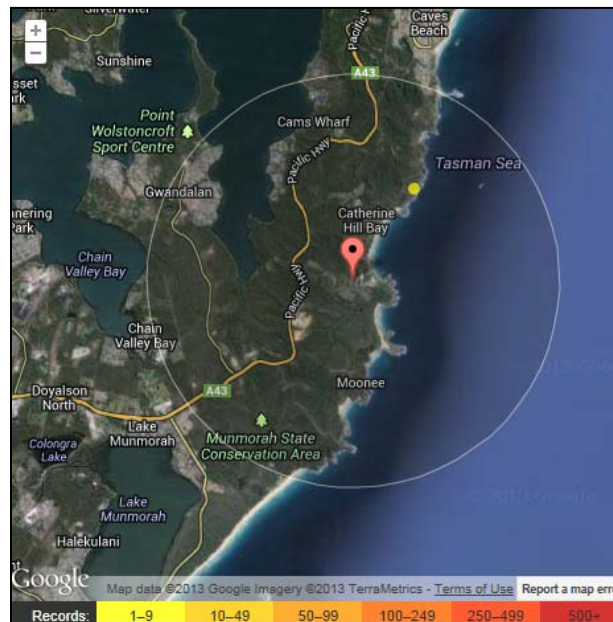


Figure 35 - The Atlas of Living Australia records of the Green and Golden Bell Frog (Source: ALA 2013)

This species potential habitat occurs in the Coastal Sand Mahogany-Paperbark Swamp Forest. The NSW office of Environment and Heritage (figure 34) states that the Green and Golden Bell Frog is known to occur in the surrounding areas of the site. The Atlas of Living Australia has however only recorded the species once within 5km of the site (figure 35).

The most recent survey of the area did not find any Green and Golden Bell Frogs. Previous surveys in the area by (Wildthing 2003a) and (EcoBiological 2006a) also found no records of the Green and Golden Bell Frog. It is highly unlikely that the future development will significantly impact the Green and Golden Bell Frog due to its scarcity in the area and more suitable habitat in offset lands.

***Ptilinopus regina* (Rose-crowned Fruit-Dove)**

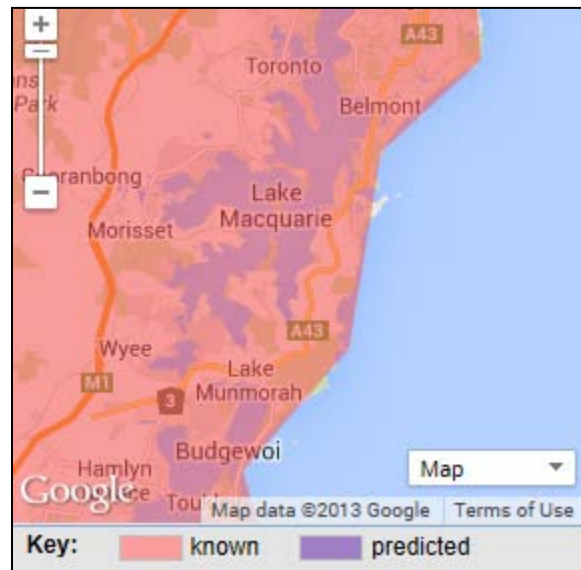


Figure 36 - Distribution range of *Ptilinopus regina* (source: OEH 2013c)

Description

Rose-crowned Fruit-doves are small, colourful rainforest pigeons to 24 cm in length. Males have a rose crown edged with yellow, and the head and breast are blue-grey, spotted white. The upper parts are grey-green, the tail-tip yellow and the abdomen are orange. Females are mostly grey-green (OEH 2013c).

Distribution

Coast and ranges of eastern NSW and Queensland, from Newcastle to Cape York. Vagrants are occasionally found further south to Victoria (OEH 2013c).

Habitat and Ecology

This species generally occurs within sub-tropical rainforest, camphor laurel and occasionally wet sclerophyll and swamp forests which contain suitable fruiting species for foraging (Recher *et al* 1995). The Rose-crowned Fruit-dove's nest is a flimsy platform of twigs and tendrils in a fork in a rainforest mid-storey shrub, sapling or vine (NSC 2008).

Diet

They feed entirely on fruit from vines, shrubs, large trees and palms, and are thought to be locally nomadic as they follow the ripening of fruits (OEH 2013c).

Comments

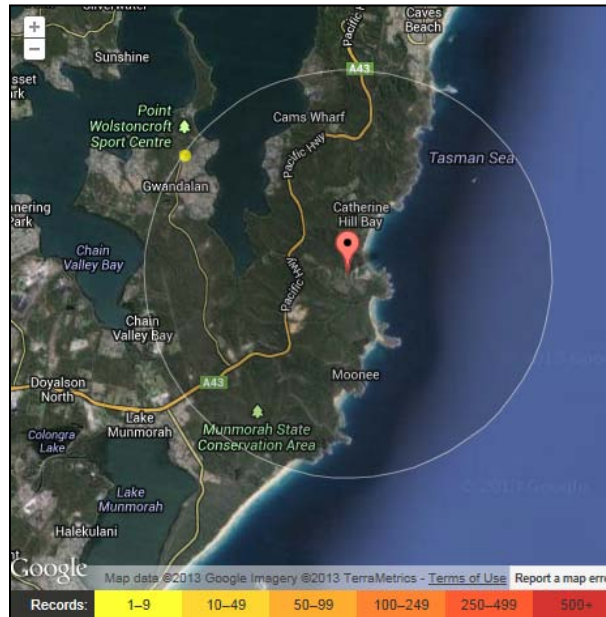


Figure 37 - The Atlas of Living Australia records of the Rose-crowned Fruit-Dove (Source: ALA 2013)

Suitable foraging habitat for the Rose-crowned Fruit-Dove is absent from the area with no fruit trees present. Suitable nesting habitats are present; however is unlikely to occur due to the absence of individual fruit trees available within the area.

The Atlas of Living Australia recorded the species once within 5km of the site (figure 38). This species was recorded in a residential area where fruit trees may be present in backyards.

The NSW office of Environment and Heritage (figure 36) does state that the Rose-crowned Fruit-Dove is known to occur in the surrounding areas, possibly where a more suited habitat occurs.

Absence of fruiting species and vegetation found on site would dictate it's highly unlikely that the future development will significantly impact the species.

***Calyptrorhynchus lathamii* (Glossy Black-Cockatoo)**

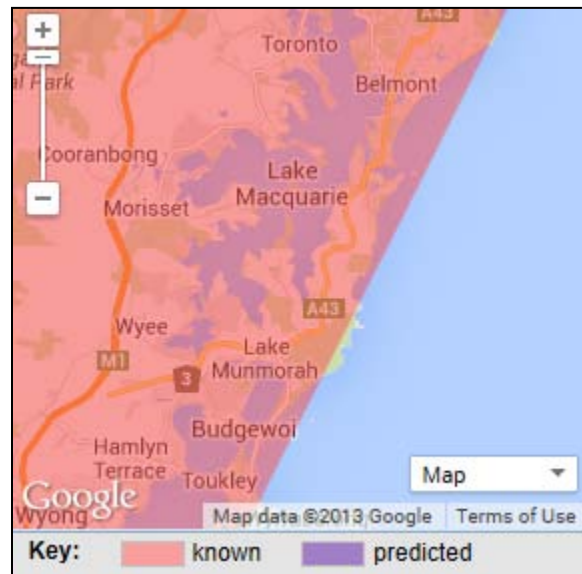


Figure 38 - Distribution range of *Calyptrorhynchus lathamii* (source: OEH 2013d)

Description

The Glossy Black-Cockatoo is a small brown-black cockatoo with a massive, bulbous bill and a short crest. Males have a prominent red tail panel, while that of females is yellow to orange-red. The coloured tail panel is barred black in juvenile birds, with the extent of barring decreasing with age. The female usually has irregular pale-yellow markings on the head and neck, and may have yellow flecks on the underparts and underwing (OEH 2013d).

Distribution

The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW (OEH 2013d).

Habitat and Ecology

Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur (OEH 2013d). It's dependent on large hollow-bearing eucalypts for nest sites (OEH 2013d).

Diet

Feeds almost exclusively on the seeds of several species of sheoak (*Casuarina* and *Allocasuarina* species), shredding the cones with the massive bill (OEH 2013d).

Comments

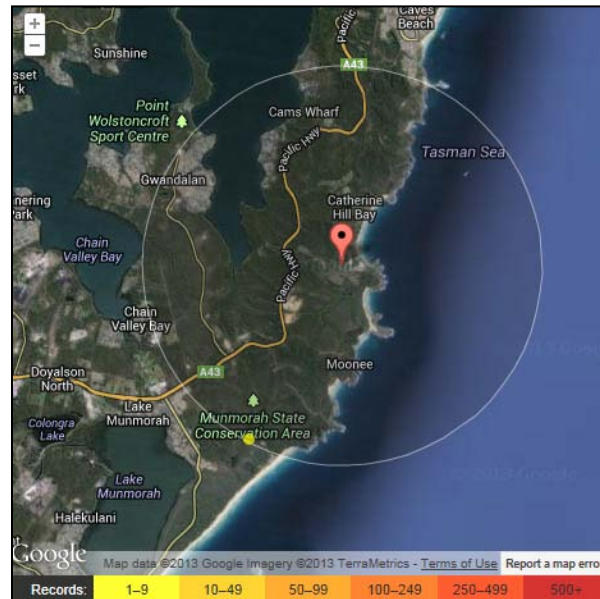


Figure 39 - The Atlas of Living Australia records of the Glossy Black-Cockatoo (Source: ALA 2013)

The site is abundant with several species of sheoak (*Casuarina* and *Allocasuarina* species) in which it forages and roosts. Suitable nesting habitat occurs within the site with an abundance of hollow *Eucalyptus* spp. available in the area. The NSW office of Environment and Heritage illustrates that the Glossy Black-Cockatoo is known to occur in the surrounding areas (figure 38). The Atlas of Living Australia database states that there have been two records of the species within 5km of the site (figure 39).

A previous survey from (Wildthing 2003b) recorded the species within the Catherine Hill Bay Development Lands. Even though the site features favourable foraging, nesting and roosting trees, it is unlikely that the future development will significantly impact the species due to the size of the development site in comparison to the Wallarah National Park and Munmorah State Conservation Area nearby which features similar habitat types.

***Glossopsitta pusilla* (Little Lorikeet)**

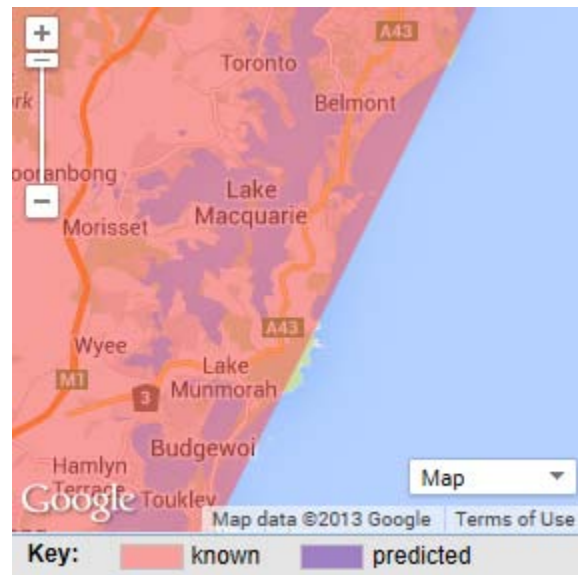


Figure 40 - Distribution range of *Glossopsitta pusilla* (source: OEH 2013e)

Description

The Little Lorikeet is a small (16-19 cm; 40 g) bright green parrot, with a red face surrounding its black bill and extending to the eye. The undertail is olive-yellow with a partly concealed red base, and the underwing coverts are bright green. The mantle is imbued with light brown (OEH 2013e).

Distribution

The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability, although some areas retain residents for much of the year and 'locally nomadic' movements are suspected of breeding pairs (OEH 2013e).

Habitat and Ecology

Forages primarily in the canopy of open *Eucalyptus* forest and woodland, yet also finds food in *Angophora*, *Melaleuca* and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity (OEH 2013e). Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species (OEH 2013e).

The Little Lorikeet nests in proximity to feeding areas if possible, most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts. Entrance is small (3 cm) and usually high above the ground (2–15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Riparian trees are often chosen, including species like *Allocasuarina* (OEH 2013e).

Diet

It feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards (OEH 2013e).

Comments

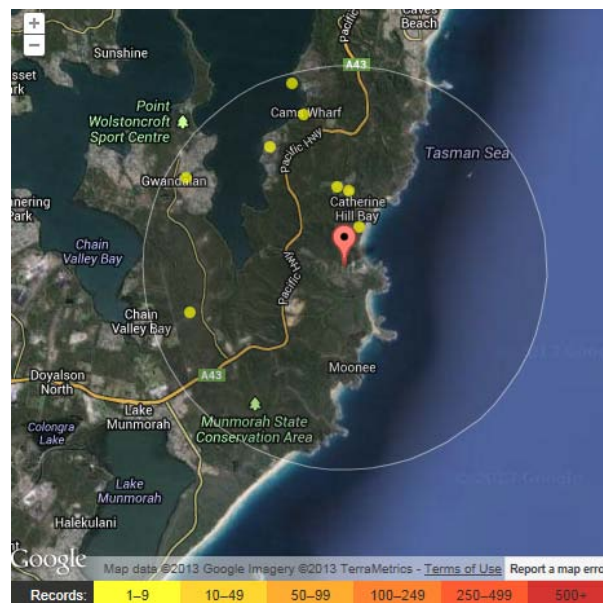


Figure 41 - The Atlas of Living Australia records of the Little Lorikeet (Source: ALA 2013)

Favourable habitat types for the Little Lorikeet are present with *Eucalyptus* forests and woodlands abundant in the area. Species of *Angophora* and *Melaleuca* are also frequent within the area. Favourable nesting habitat is present in the area with hollow *Eucalyptus* and *Allocasuarina* trees present. The NSW office of Environment and Heritage states that the Little Lorikeet is known to occur within the area (figure 40).

The Atlas of Living Australia database illustrates that there have been 11 records of the Little Lorikeet within 5km of the area (figure 41). The future development will unlikely significantly impact the species due to the small size of the development site in comparison to the nearby Wallarah National Park and Munmorah State Conservation Area with similar habitats.

It must be noted that a certain nest site will be repeatedly used for decades. Attempts to offset these nest sites should be considered.

The species was not observed and is unlikely to be affected by minor tree removal associated Waste Water treatment Plant site will affect this species.

***Lathamus discolor* (Swift Parrot)**



Figure 42 - Distribution range of *Lathamus discolor* (source: OEH 2013f)

Description

The Swift Parrot is a small parrot about 25 cm long. It is bright green with red around the bill, throat and forehead. The red on its throat is edged with yellow. Its crown is blue-purple. There are bright red patches under the wings. One of most distinctive features from a distance is its long (12 cm) thin tail, which is dark red. This distinguishes it from the similar lorikeets, with which it often flies and feeds (OEH 2013f).

Distribution

The species breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW it mostly occurs on the coast and south west slopes (OEH 2013f).

Habitat and Ecology

Key habitats for the species on the coast and coastal plains of New South Wales include Spotted Gum (*Corymbia maculata*), Swamp Mahogany (*E. robusta*), Red Bloodwood (*Eucalyptus gummifera*) and Forest Red Gum (*E. tereticornis*) forests (Saunders and Heinsohn 2008). These tree species provide foraging and roosting habitat for the species. In northern New South Wales and south-eastern Queensland, Narrow-leaved Red Ironbark (*E. crebra*), Forest Red Gum forests and Yellow Box forest are commonly utilized (Kennedy & Tzaros 2005). While on the western slopes Mugga Ironbark (*Eucalyptus sideroxylon*) and Grey Box (*Eucalyptus microcarpa*) woodlands are used (Saunders & Heinsohn 2008). This species breeds in Tasmania.

Diet

The Swift Parrot feeds mostly on nectar, mainly from eucalypts, but also eats psyllid insects and lerps, seeds and fruit (DE 2013a).

During the non-breeding season this species feeds extensively on nectar and lerp and other items from eucalypt foliage. Mugga Ironbark (*E. sideroxylon*), Red Ironbark (*E. tricarpa*), White Box (*E. albens*), Grey Box (*E. macrocarpa*) and Yellow Gum (*E. leucoxylon*) are important sources of nectar in the box-ironbark forests and woodlands of Victoria and New South Wales (Kennedy and Tzaros 2005). Grey Box, River Red Gum (*E. camaldulensis*) and White Box are major sources of lerps in these areas at times. Swamp Mahogany (*E. robusta*), Spotted Gum (*Corymbia maculata*), Coastal Grey Box (*Eucalyptus moluccana*) and Red Bloodwood (*Corymbia gummifera*) are important nectar sources in coastal parts of the non-breeding range.

Forest Red Gum (*E. tereticornis*) and Yellow Box (*E. melliodora*) are used in northern New South Wales and south-eastern Queensland (Saunders and Heinsohn 2008). There are also several records of the species foraging on lerps in the foliage of Blackbutt (*E. pilularis*) in the Wollongong area of New South Wales. Over large parts of their box-ironbark winter range, they also consume both developed and undeveloped racemes of Golden Wattle (*Acacia pycnantha*) (Kennedy and Tzaros 2005).

Comments

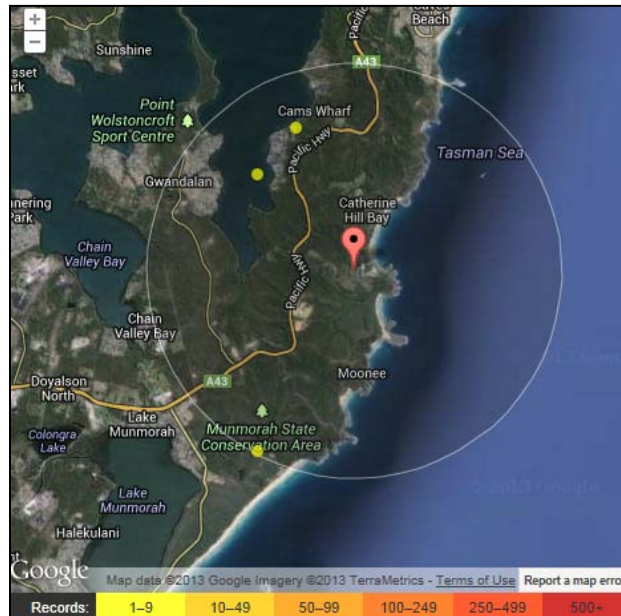


Figure 43 - The Atlas of Living Australia records of the Swift Parrot (Source: ALA 2013)

Favourable foraging and roosting habitats are present with the abundance of Spotted Gum, Swamp Mahogany, Red Bloodwood, and Forest Red Gum forests. The site features a vast ray of *Eucalyptus* species for the Swift Parrot to forage on during the winter months. Breeding holes/nests aren't important for the site as the species breeds in Tasmania. The NSW office of Environment and Heritage illustrates that the species is known to occur in the surrounding areas of the study site (figure 42).

The Atlas of Living Australia also states that the species is located in the area with eight records within 5km of the site (figure 43). The site is unlikely to significantly impact the Swift Parrot due to the proposal site being a small portion of the habitat available in the surrounding area.

The species was not observed and is unlikely to be affected by removal of 1.45ha of vegetation from this larger habitat system.

***Ninox strenua* (Powerful Owl)**

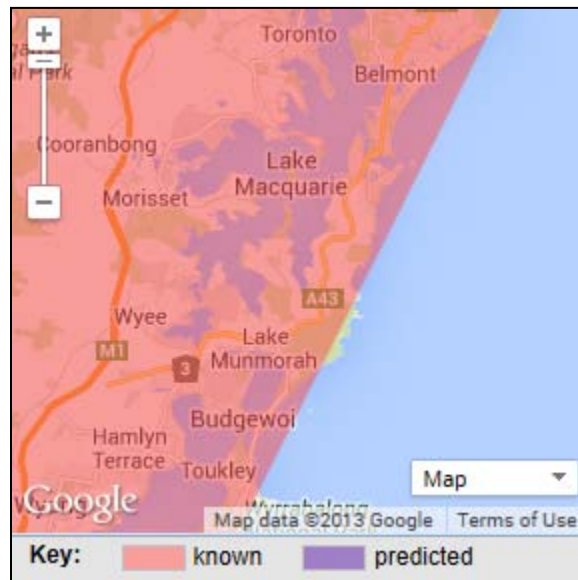


Figure 44 - Distribution range of *Ninox strenua* (source: OEH 2013g)

Description

The Powerful Owl is the largest owl in Australasia. It is a typical hawk-owl, with staring yellow eyes and no facial-disc. Adults reach 60 cm in length, have a wingspan of up to 140 cm and weigh up to 1.45 kilograms. Males are larger than females. The upper parts of the Powerful Owl are dark, greyish-brown with indistinct off-white bars. The underparts are whitish with dark greyish-brown V-shaped markings. Juvenile Powerful Owls have a white crown and underparts that contrasts with its small, dark streaks and dark eye patches (OEH 2013g).

Distribution

The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered, mostly historical records on the western slopes and plains. Now uncommon throughout its range where it occurs at low densities (OEH 2013g).

The species is noted as occurring within the adjoining conservation network.

Habitat and Ecology

The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest (OEH 2013g).

The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats (OEH 2013g). It roosts by day in dense vegetation comprising species such as Turpentine *Syncarpia glomulifera*, Black She-oak *Allocasuarina littoralis*, Blackwood *Acacia melanoxylon*, Rough-barked Apple *Angophora floribunda*, Cherry Ballart *Exocarpus cupressiformis* and a number of eucalypt species (OEH 2013g). Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old (OEH 2013g).

Diet

The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider (OEH 2013g).

Comments

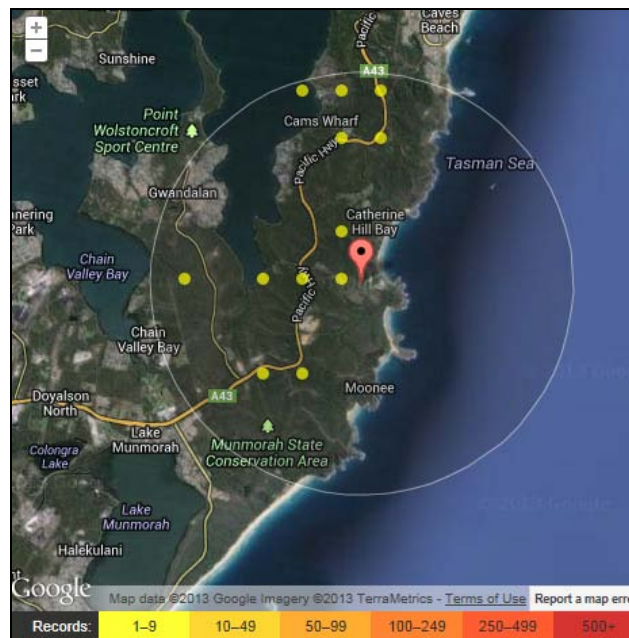


Figure 45 - The Atlas of Living Australia records of the Powerful Owl (Source: ALA 2013)

Favourable hunting grounds for the Powerful Owl occur in abundance with woodland and open sclerophyll forests frequent. Favourable dense vegetation comprising of *Syncarpia glomulifera*, *Allocasuarina littoralis*, *Acacia melanoxylon*, *Angophora floribunda*, and *Exocarpus cupressiformis* has all been recorded in the area.

Large *Eucalyptus* trees with large hollows in which the Powerful Owl breeds have also been recorded in the area. The Atlas of Living Australia database has recorded the Powerful Owl 14

times within 5km of the development site (figure 45). The NSW office of Environment and Heritage also notes that the species occurs within the area (figure 44). The future development will unlikely significantly impact the Powerful Owl due to the small portion of the development site in comparison to the surrounding area with similar habitats and prey species.

The proposal involves removal of a small area of vegetation, approximately 1.45ha, which did not contain hollows. This would affect distribution of arboreal mammals and thus forage areas for the Powerful Owl. Surveying did not record the species and it is considered the proposal will not affect the occurrence of this species.

***Tyto novaehollandiae* (Masked Owl)**

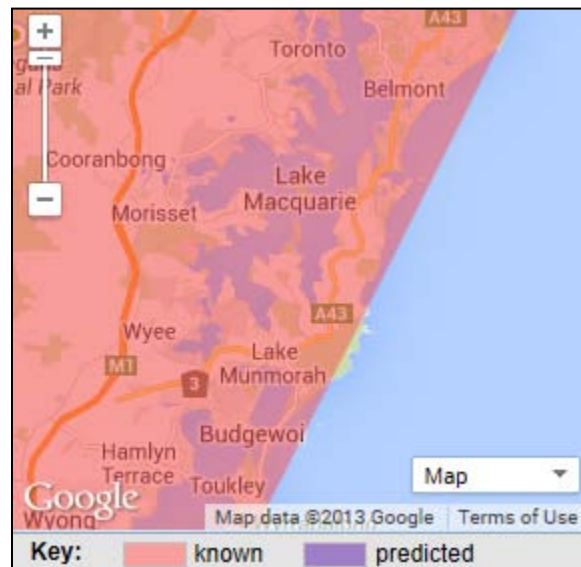


Figure 46 - Distribution range of *Tyto novaehollandiae* (source: OEH 2013h)

Description

A medium-sized owl to 40 - 50 cm long, with dark eyes set in a prominent flat, heart-shaped facial disc that is encircled by a dark border. The feet are large and powerful, with fully feathered legs down to the toes. The owl exists in several colour forms, with wide variation in plumage. The upperparts are grey to dark brown with buff to rufous mottling and fine, pale spots. The wings and tail are well barred. The underparts are white to rufous-brown with variable dark spotting. The palest birds have a white face with a brown patch around each eye; the darkest birds have a chestnut face. The dark form of the Masked Owl is much browner than the Sooty Owl *Tyto tenebricosa* (OEH 2013h).

Distribution

Extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90% of NSW, excluding the most arid north-western corner. There is no seasonal variation in its distribution (OEH 2013h).

Habitat and Ecology

The Masked Owl is primarily a bird of coastal and sub-coastal open forests and woodlands and adjacent clearings, but on the mainland its distribution extends far inland in riparian woodlands with hollow trees or in other vegetation types where caves may provide alternative daytime shelter and nesting sites (Kavanagh 1996). It Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting (OEH 2013h).

Diet

The diet of the Masked Owl is perhaps the best known aspect of their ecology; they prey extensively on ground-dwelling mammals, supplemented by a few arboreal marsupials and birds (Kavanagh and Murray 1996).

Comments

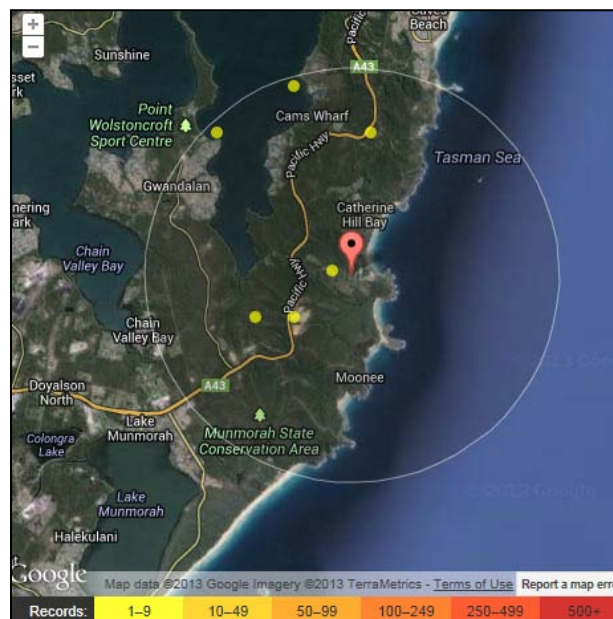


Figure 47 - The Atlas of Living Australia records of the Masked Owl (Source: ALA 2013)

Suitable habitats for both the Masked Owl and its prey are associated with the site. Open forests and woodlands and adjacent clearings all feature in the areas of the site. Eucalypt trees with large hollows bearing in them are present on site.

Previous surveys by (Wildthing 2003a) and (Wildthing 2003b) recorded the Masked Owl in the area. The Atlas of Living Australia notes that the Masked Owl has been recorded six times within 5km of the site (figure 47). The NSW office of Environment and Heritage also states that the species is known to occur in the surrounding areas if the habitat suits (figure 46). The future development will unlikely significantly impact the Masked Owl due to the small size of the development site and resulting vegetation removal in comparison to the surrounding areas with similar habitat types to be removed.

***Daphoenositta chrysoptera* (Varied Sittella)**

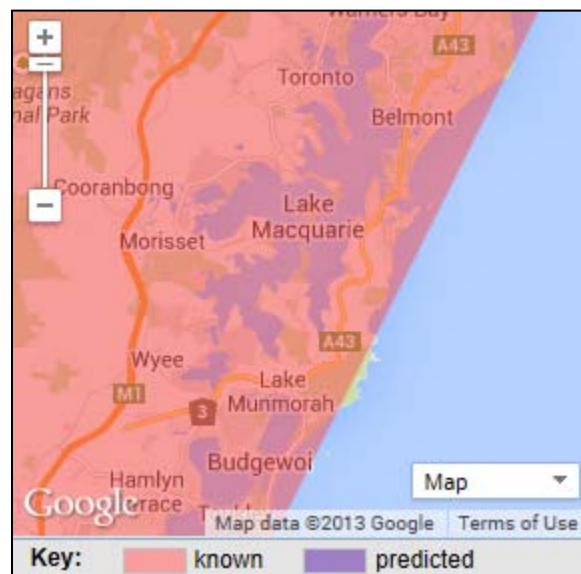


Figure 48 - Distribution range of *Daphoenositta chrysoptera* (source: OEH 2013i)

Description

The Varied Sittella is a small (10 cm) songbird with a sharp, slightly upturned bill, short tail, barred undertail, and yellow eyes and feet. In flight the orange wing-bar and white rump are prominent. In NSW most individuals have a grey head and are streaked with dark brown, but in the extreme north-east they have a white head, and in the extreme south-west a black cap (OEH 2013i).

Distribution

The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far

west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades (OEH 2013i).

Habitat and Ecology

It inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland (OEH 2013i). During breeding season it builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years (OEH 2013i).

Diet

Feeds on arthropods gleaned from crevices in rough or decortivating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy (OEH 2013i).

Comments

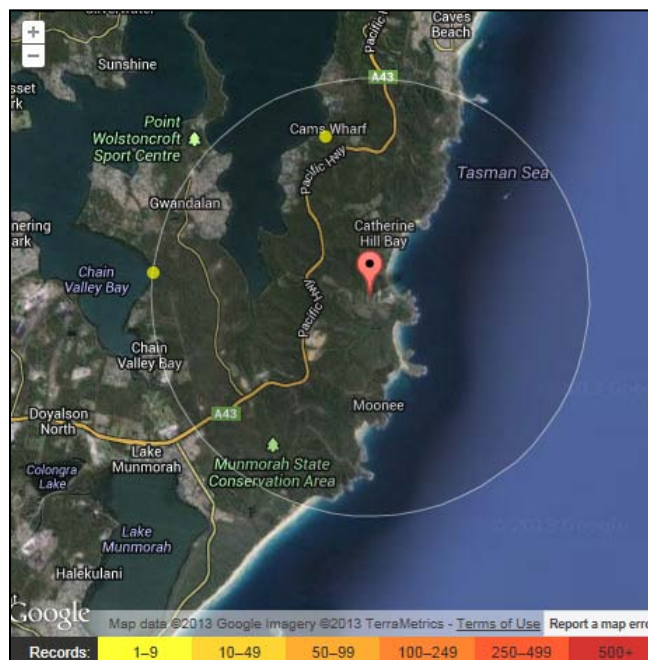


Figure 49 - The Atlas of Living Australia records of the Varied Sittella (Source: ALA 2013)

Suitable foraging and nesting habitats of the Varied Sittella frequent the site with the abundance of *Eucalypt* forests and woodlands, as well as *Acacia* trees. The NSW office of Environment and Heritage states that the Varied Sittella is known to occur within the area (figure 48). The Atlas of Living Australia recorded the species twice within 5km of the site (figure 49).

Minor vegetation removal associated with the WWTP removal is insignificant to the available forage resource in the surrounding conservation network i.e. Wallarah National Park and Munmorah State Conservation Area. It is unlikely that the development will significantly impact the Varied Sittella.

***Dasyurus maculatus* (Spotted-tailed Quoll)**

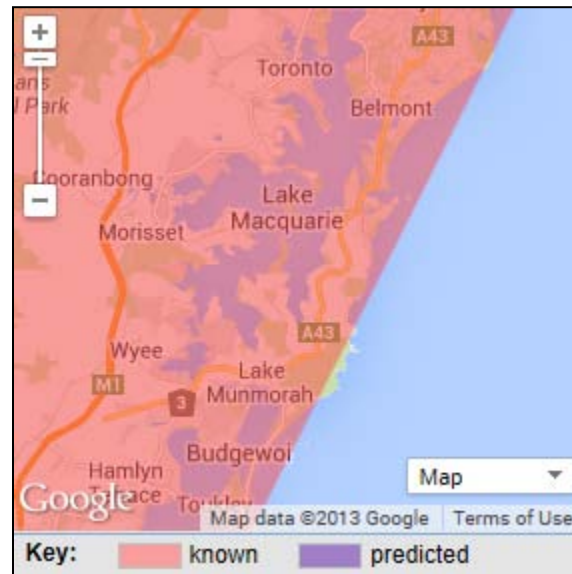


Figure 50 - Distribution range of *Dasyurus maculatus* (source: OEH 2013j)

Description

The Spotted-tailed Quoll is about the size of a domestic cat, from which it differs most obviously in its shorter legs and pointed face. The average weight of an adult male is about 3500 grams and an adult female about 2000 grams. It has rich-rust to dark-brown fur above, with irregular white spots on the back and tail, and a pale belly. The spotted tail distinguishes it from all other Australian mammals, including other quoll species. However, the spots may be indistinct on juvenile animals (OEH 2013j).

Distribution

The range of the Spotted-tailed Quoll has contracted considerably since European settlement. It is now found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland. Only in Tasmania is it still considered common (OEH 2013j).

Habitat and Ecology

The Spot-tailed Quoll has a preference for mature wet forest habitat (Belcher 2000), especially in areas with rainfall 600 mm/year (Edgar & Belcher 2008). Unlogged forest or forest that has been less disturbed by timber harvesting is also preferable (Catling *et al.* 2000). This subspecies has been recorded from a wide range of habitats, including: temperate and subtropical rainforests in mountain areas, wet sclerophyll forest, lowland forests, open and closed eucalypt woodlands, inland riparian and River Red Gum (*Eucalyptus camaldulensis*) forests, dry 'rainshadow' woodland, sub-alpine woodlands, and coastal heathlands (DE 2013b).

Habitat requirements include suitable den sites such as hollow logs, tree hollows, rock outcrops or caves (DE 2013b).

Diet

The main prey items include: Ringtail Possum (*Pseudocheirus pererinus*), Common Brushtail Possum (*Trichosurus vulpecula*), Mountain Brushtail Possum (*Trichosurus caninus*), Greater Gilder (*Petauroides volans*) and Rabbit (Belcher 2000). Additionally, the subspecies consumes insects, lizards, crayfish, poultry, birds, small mammals, frogs, fish, plant material and refuse that have been discarded by humans (Dawson 2005; Jones *et al.* 2001).

Comments

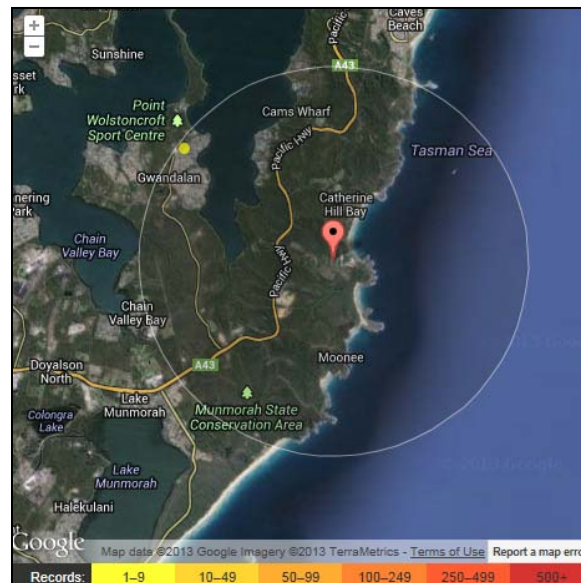


Figure 51 - The Atlas of Living Australia records of the Spotted-tailed Quoll (Source: ALA 2013)-

Potential habitat types for the Spotted-tailed Quoll are abundant within the area. Large tree and log hollows are present in the area which is suitable for nesting. The development site features known Spotted-tailed Quoll prey.

Reported sightings in the local area are quite rare with no Spotted-tailed Quolls recorded in the survey by (Wildthing 2003a) and only one record by Atlas of Living Australia in 1998 (figure 51). This could be due to the site being close to urban development in which the Spotted-tailed Quoll generally doesn't occur.

The NSW office of Environment and Heritage does however state that the Spotted-tailed Quoll is known to occur in the surrounding area (figure 50). Potential hunting and nesting habitat is present within the site but it's unlikely that the Spotted-tailed Quoll will be significantly affected by the development due to its rarity in the area. Suitable habitats are known to occur in the surrounding Wallarah National Park and Munmorah State Conservation Area.

***Phascolarctos cinereus* (Koala)**

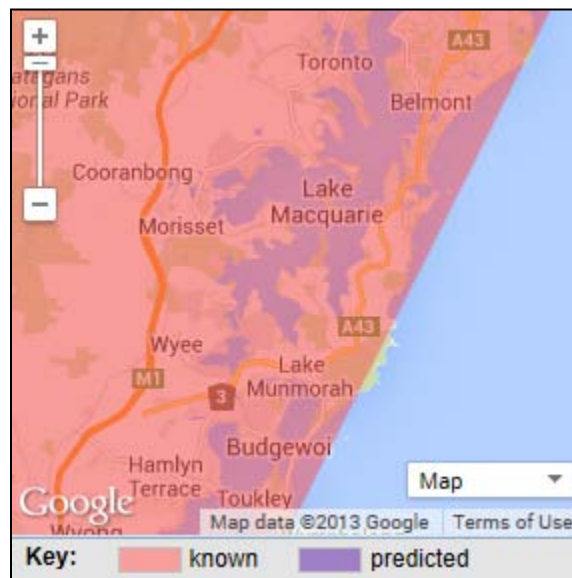


Figure 52 - Distribution range of *Phascolarctos cinereus* (source: OEH 2013k)

Description

The Koala is an arboreal marsupial with fur ranging from grey to brown above, and is white below. It has large furry ears, a prominent black nose and no tail. It spends most of its time in trees and has long, sharp claws, adapted for climbing. Adult males weigh 6 - 12 kg and adult females weigh 5 - 8 kg (OEH 2013k).

Distribution

The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In NSW it mainly occurs on the central and

north coasts with some populations in the west of the Great Dividing Range. It was briefly historically abundant in the 1890s in the Bega District on the south coast of NSW, although not elsewhere, but it now occurs in sparse and possibly disjunct populations. Koalas are also known from several sites on the southern tablelands (OEH 2013k).

Habitat and Ecology

Koalas naturally inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by *Eucalyptus* species (Martin and Handasyde 1999). Along the Great Dividing Range and the coastal belt throughout the species' range, Koalas inhabit moist forests and woodlands mostly dominated by *Eucalyptus* species (DE 2013c). In coastal lowlands in Queensland and NSW, Koalas are also found in vegetation communities dominated by *Melaleuca* or *Casuarina* species (TSSC 2012).

Diet

Its diet is restricted mainly to foliage of *Eucalyptus* spp. It may also consume foliage of related genera, including *Corymbia* spp., *Angophora* spp. and *Lophostemon* spp. and at times supplement its diet with other species, including *Leptospermum* spp. and *Melaleuca* spp. (Martin and Handasyde 1999; Moore & Foley 2000).

Comments

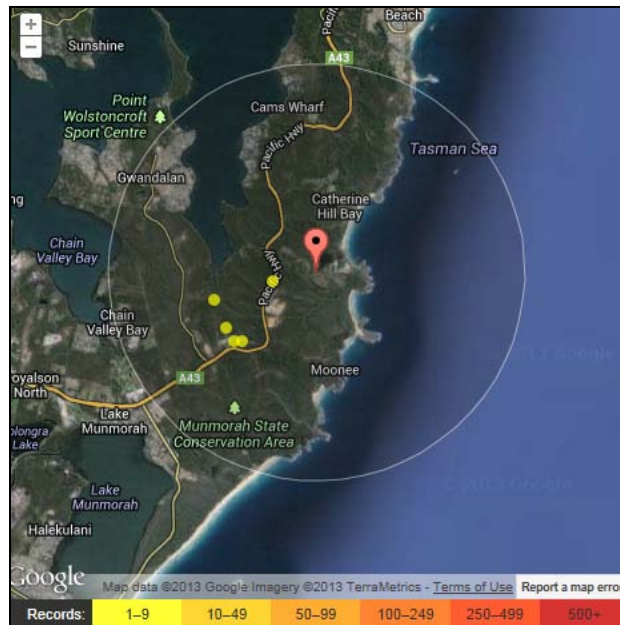


Figure 53 - The Atlas of Living Australia records of the Koala (Source: ALA 2013)

Suitable Koala habitat is known to occur within the area with an abundance of *Eucalyptus* spp, as well as *Melaleuca* and *Casuarina* species. The Atlas of Living Australia recorded the Koala five times within 5km of the site (figure 53). The NSW office of Environment and Heritage states that the Koala is known to occur within the area (figure 52). Even with suitable habitat present and records of the Koala being present nearby, it is unlikely that the future development will significantly impact the species due to the small size of the site in comparison to the nearby Wallarah National Park and Munmorah State Conservation Area.

Previous surveys of the area did not record any evidence of Koalas during the scat searches and spotlighting (RPS HSO 2010) and no evidence of use within the WWTP was found.

***Cercartetus nanus* (Eastern Pygmy-possum)**

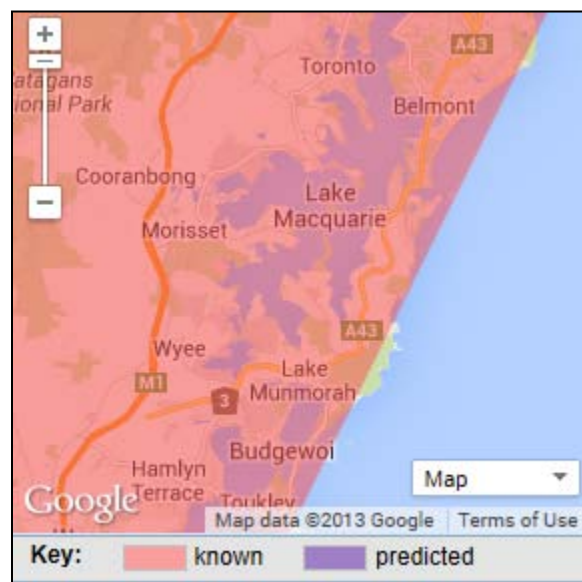


Figure 54 - Distribution range of *Cercartetus nanus* (source: OEH 2013I)

Description

Eastern Pygmy-possums are tiny (15 to 43 grams) active climbers, with almost bare, prehensile (capable of curling and gripping) tails, and big, forward-pointing ears. They are light-brown above and white below. Adults have a head and body length between 70 - 110 mm and a tail length between 75 - 105 mm (OEH 2013I).

Distribution

Cercartetus nanus has a wide but patchy distribution in Tasmania (Harris *et al.* 2008) and along the eastern seaboard of mainland Australia from south-eastern Queensland (Harris *et al.* 2007), through New South Wales (Bowen and Goldingay 2000), Australian Capital Territory (Dickman

and Happold 1988) and Victoria (Harris and Goldingay 2005), and into south-eastern South Australia (van Weenen and Harris 2006).

Habitat and Ecology

Across its range, *C. nanus* is a midstory specialist inhabiting shrubby components of a variety of habitats including rain forest, sclerophyll forest, shrubland, heathland, and woodland (Harris 2008). Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (*Pseudocheirus peregrinus*) dreys or thickets of vegetation, (e.g. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks (OEH 2013l).

Diet

Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable (OEH 2013l). It also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests (OEH 2013l).

Comments

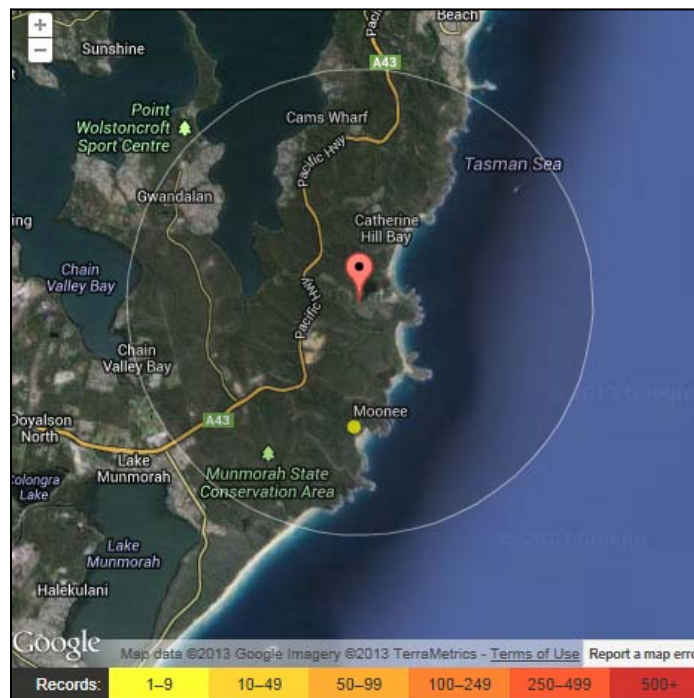


Figure 55 - The Atlas of Living Australia records of the Eastern Pygmy-possum (Source: ALA 2013)

Suitable habitat is present for the Eastern Pygmy-possum with the presence of *Banksia* and *Eucalypt* species. Suitable nesting habitat is also present with large tree hollows available. The Eastern Pygmy-possum is uncommon in the area with the Atlas of Living Australia recording the species only once within 5km of the site (figure 55), in the Munmorah State Conservation Area.

The NSW office of Environment and Heritage illustrates that the species is known to occur in the surrounding areas (figure 54). The future development is unlikely to significantly impact the Eastern Pygmy-possum due to the small scale of the site in comparison to nearby reserves with similar habitats.

***Petaurus norfolcensis* (Squirrel Glider) RECORDED**

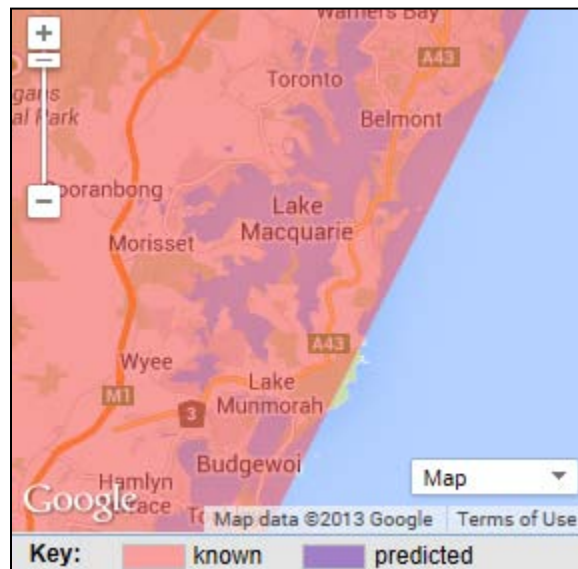


Figure 56 - Distribution range of *Petaurus norfolcensis* (source: OEH 2013m)

Description

Adult Squirrel Gliders have a head and body length of about 20 cm. They have blue-grey to brown-grey fur above, white on the belly and the end third of the tail is black. There is a dark stripe from between the eyes to the mid-back and the tail is soft and bushy averaging about 27 cm in length. Squirrel Gliders are up to twice the size of Sugar Gliders, their facial markings are more distinct and they nest in bowl-shaped, leaf lined nests in tree hollows (OEH 2013m).

Distribution

The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria (OEH 2013m).

Habitat and Ecology

Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas (OEH 2013m). It prefers mixed species stands with a shrub or Acacia midstorey (OEH 2013m). The Squirrel Glider requires abundant tree hollows for refuge and nest sites (OEH 2013m).

Diet

Diet varies seasonally and consists of *Acacia* gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein (OEH 2013m).

Comments

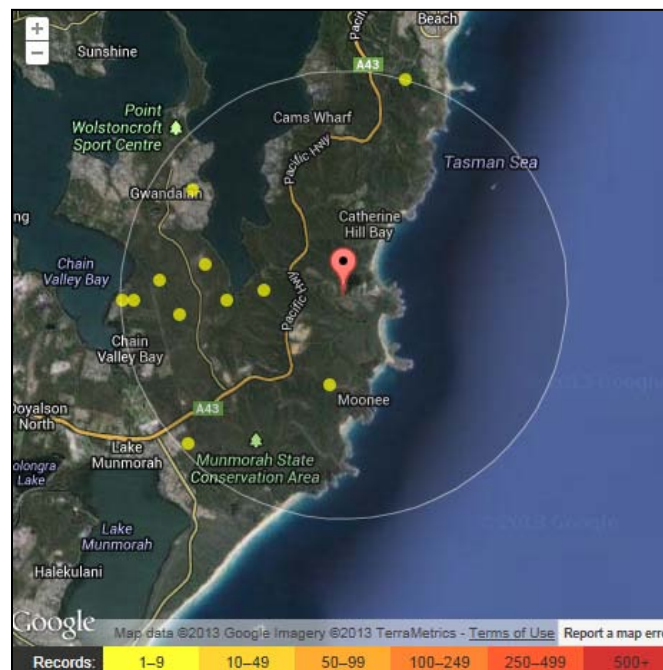


Figure 57 - The Atlas of Living Australia records of the Squirrel Glider (Source: ALA 2013)

Suitable foraging habitat exists in the area with *Acacia* and *Eucalypt* forests present. Denning habitats are also present with tree hollows apparent. The Atlas of Living Australia database recorded the species 15 times within 5km of the site, with the majority of the records found in Crangan Bay (figure 57). The NSW office of Environment and Heritage states that the Squirrel Glider is known to occur in the surrounding area (figure 56).

The species was observed during spotlighting along the NPWS/RFS fire trail during the April site investigations near the Cranagan Bay State Conservation Area.

The future development is unlikely to significantly impact the Squirrel Glider as no hollow bearing trees are to be removed through the development of the WWTP. In addition the vegetation is committed for removal under the approved residential estate and does not represent a significant removal of forage area.

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

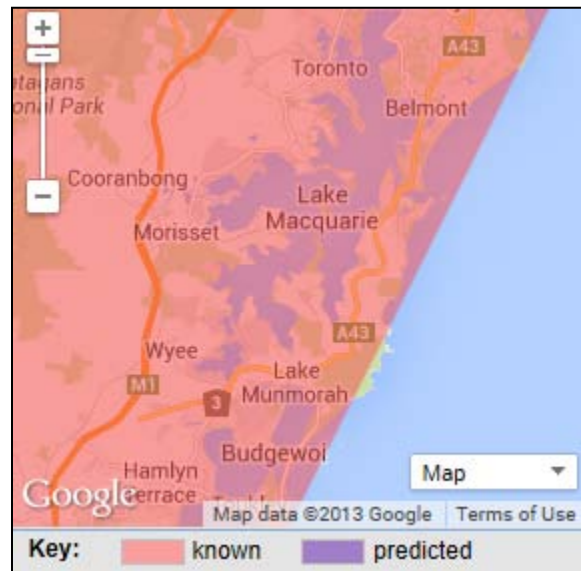


Figure 58 - Distribution range of *Pteropus poliocephalus* (source: OEH 2013n)

Description

The Grey-headed Flying-fox is the largest Australian bat, with a head and body length of 23 - 29 cm. It has dark grey fur on the body, lighter grey fur on the head and a russet collar encircling the neck. The wing membranes are black and the wingspan can be up to 1 m. It can be distinguished from other flying-foxes by the leg fur, which extends to the ankle (OEH 2013n).

Distribution

Grey-headed Flying-foxes are generally found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria. In times of natural resource shortages, they may be found in unusual locations (OEH 2013n).

Habitat and Ecology

It is found in tropical moist forest, open forest, closed and open woodlands, Melaleuca swamps, Banksia woodlands, mangroves, and commercial fruit plantations. It also occurs in urban areas where suitable foraging and roosting habitat are available (Lunney *et al.* 2008)

Roost sites are typically located near water, such as lakes, rivers or the coast (van der Ree *et al.* 2005). Roost vegetation includes rainforest patches, stands of *Melaleuca*, mangroves and riparian vegetation (Nelson 1965), but colonies also use highly modified vegetation in urban and suburban areas (van der Ree *et al.* 2005).

Diet

The Grey-headed Flying-Fox has a diverse native diet, which it supplements with introduced plants (Parry-Jones and Augee 1991). Nectar and pollen from the flowers of eucalypts (genera *Eucalyptus*, *Corymbia* and *Angophora*), melaleucas and banksias are the primary food for the species (Duncan *et al.* 1999). Like other species of Australian flying-fox, the Grey-headed Flying-fox will take cultivated fruits (Hall and Richards 2000).

Comments

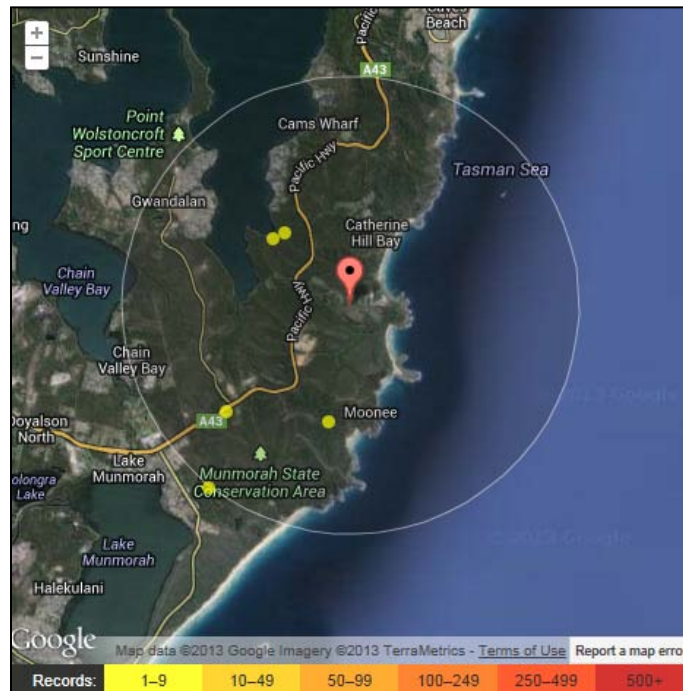


Figure 59 - The Atlas of Living Australia records of the Grey-headed Flying-fox (Source: ALA 2013)

Suitable foraging habitat exists with flowering Eucalypts, Banksias and Melaleuca present. Suitable camp/roosting sites nearby were identified within the drainage lines by (Wildthing 2004a). The Atlas of Living Australia recorded the species five times within 5km of the site (figure 59); however surveys by (Wildthing 2003b) and (Wildthing 2004a) did not record the species.

The NSW office of Environment and Heritage illustrates that the species is known to occur in the area (figure 58). The future development is unlikely to significantly impact the Grey-headed Flying-fox due to its small area in comparison to surrounding reserves and parks with similar habitats.

The species was observed during the April survey period spotlighting along Kananagra Drive proximate to the access road to the Lake Macquarie State recreation Area at Cangan Bay. A small number eight (8) were observed in flight in a north eastern direction.

The WWTP provides forage resources for the species, however the removal of 1.45ha of vegetation for this development, will not significantly affect this species.

***Mormopterus norfolkensis* (Eastern Freetail-bat) RECORDED**

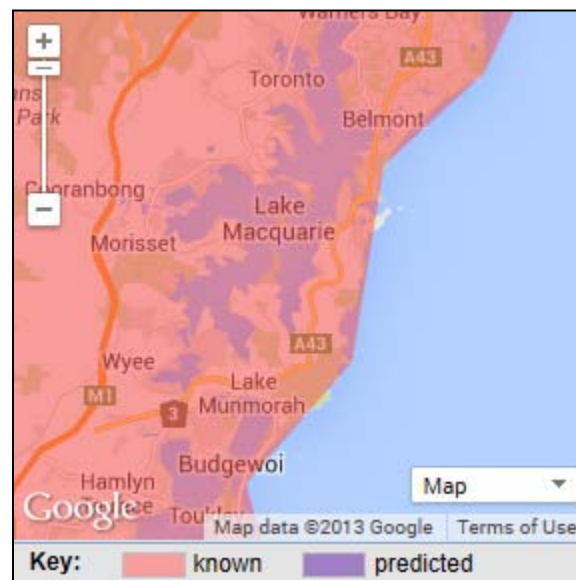


Figure 60 - Distribution range of *Mormopterus norfolkensis* (source: OEH 2013o)

Description

The Eastern Freetail-bat has dark brown to reddish brown fur on the back and is slightly paler below. Like other freetail-bats it has a long (3 - 4 cm) bare tail protruding from the tail

membrane. Freetail-bats are also known as mastiff-bats, having hairless faces with wrinkled lips and triangular ears. They weigh up to 10 grams (OEH 2013o).

Distribution

This species is endemic to Australia, where it ranges from south-eastern Queensland through eastern New South Wales. The type specimen is supposedly from Norfolk Island, but it has never been recorded since (Richards and Pennay 2008).

Habitat and Ecology

This species has been recorded from dry eucalypt forest and over rocky rivers in rainforest and wet sclerophyll forest habitats (Richards and Pennay 2008). Roosts mainly in tree hollows but will also roost under bark or in man-made structures (OEH 2013o).

Diet

The Eastern Freetail-bat's diet is poorly studied, however it's believed to be an insectivorous (OEH 2013o).

Comments

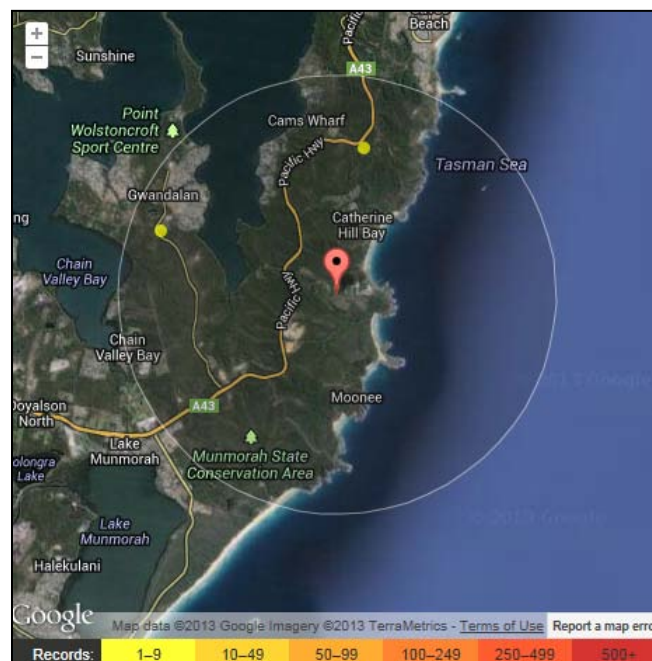


Figure 61 - The Atlas of Living Australia records of the Eastern Freetail-bat (Source: ALA 2013)

The extensive conservation system and eucalypt forests provide a large forage resource for the Freetail-bat. The abundance of tree hollows noted along the route of the NPWS/RFS fire trails also would infer suitable roost sites. The Atlas of Living Australia recorded the species twice within 5km of the site, once in 2001 and the other in 2005 (figure 61). The NSW office of Environment and Heritage states that the Eastern Freetail-bat is known to occur in the surrounding areas (figure 60).

The species was recorded by Anabat at the Kanangra Drive Reservoir site during the April surveying event, but was not recorded at the WWTP site.

The WWTP is unlikely to significantly impact the species due to the small scale of the site in comparison to the nearby Wallarah National Park and Munmorah State Conservation Area with similar habitat. The minor vegetation removal associated with the works of the WWTP is unlikely to affect the species occurrence.

***Miniopterus australis* (Little Bentwing-bat) RECORDED**

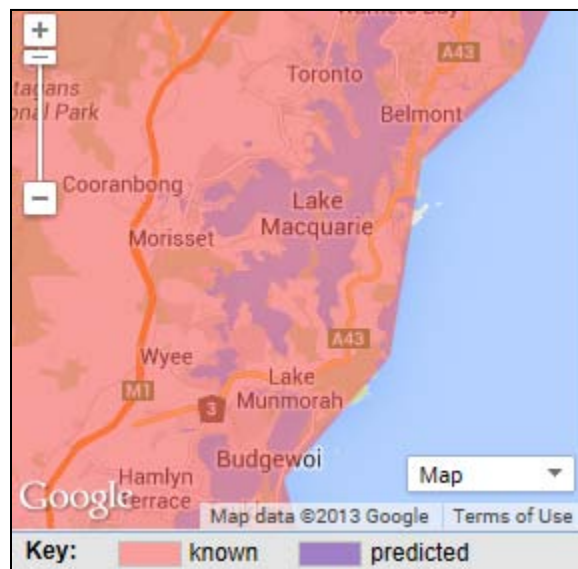


Figure 62 - Distribution range of *Miniopterus australis* (source: OEH 2013p)

Description

Little Bentwing-bats are small dark chocolate brown insectivorous bats with a body length of about 45 mm. The tip of the wing is formed by a particularly long joint of the third finger, folded back and bent under the wing while the bat is at rest. The fur is long and thick, especially over the crown and around the neck, and is slightly lighter in colour on the belly. They exhibit distinctly short muzzles, and have short, rounded roughly triangular shaped ears (OEH 2013p).

Distribution

The Little Bentwing-bat is found on the east coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW (OEH 2013p).

Habitat and Ecology

Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, *Melaleuca* swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas (OEH 2013j). This species roosts in colonies in caves and tunnels, and may also be found roosting in tree holes (Rosell-Amball *et al.* 2008).

Diet

It forages for insects in rainforest, *Meleleuca* swamps and dry sclerophyll forests (Rosell-Amball *et al.* 2008).

Comments

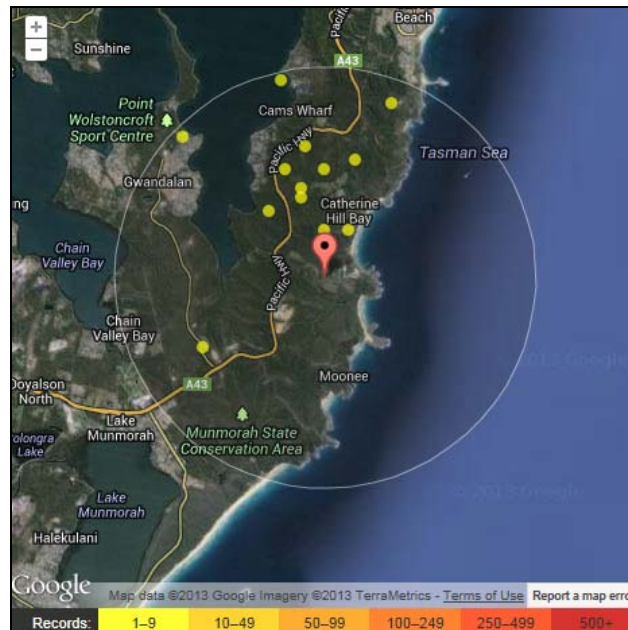


Figure 63 - The Atlas of Living Australia records of the Little Bentwing-bat (Source: ALA 2013)

Suitable foraging habitat is present with eucalypt forests, banksia scrubs and dry sclerophyll forests present in the area. The species predominantly roosts in caves and tunnels which are absent from the site, however they are known to also nest in tree holes which frequent the area.

The Little Bentwing-bat is known to occur in the area with previous surveys by (Wildthing 2003a) and (Wildthing 2003b) both recording the species. The Atlas of Living Australia recorded the species 13 times within 5km of the site, with the majority of the records occurring north of the site in Wallarah National Park (figure 63). The NSW office of Environment and Heritage states that the Little Bentwing-bat is known to occur in the area (figure 62).

The species was recorded during the April survey event at the Waste water treatment Plant Site.

Whilst the specie has been recorded foraging around the site, the development should not impact the Little Bentwing-bat significantly due to the small scale of vegetation removal compared to surrounding reserves and parks which they are known to also forage. In addition it has been previously considered that the larger clearing associated with the residential development does not have a significant impact on the species.

***Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat) RECORDED**

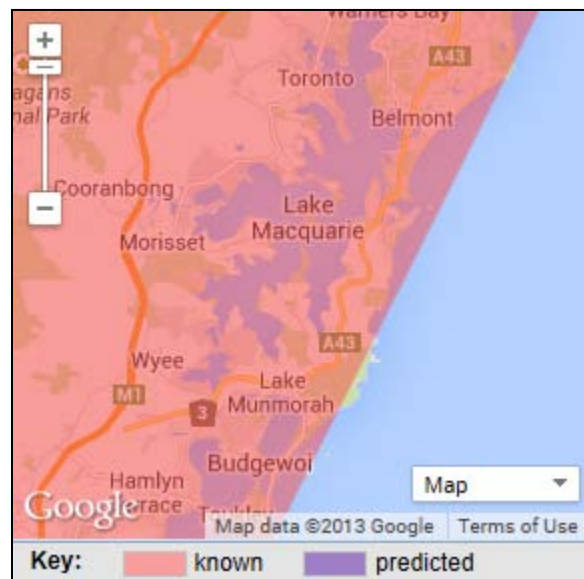


Figure 64 - Distribution range of *Miniopterus schreibersii oceanensis* (source: OEH 2013q)

Description

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

up to 20 grams, has a head and body length of about 6 cm and a wingspan of 30 - 35 cm (OEH 2013q).

Distribution

Eastern Bentwing-bats occur along the east and north-west coasts of Australia (OEH 2013q).

Habitat and Ecology

Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures (OEH 2013q). They hunt in forested areas, catching moths and other flying insects above the tree tops (OEH 2013q).

Diet

It feeds mainly on moths, and occasionally on flies and other insects (Hutson *et al.* 2008).

Comments

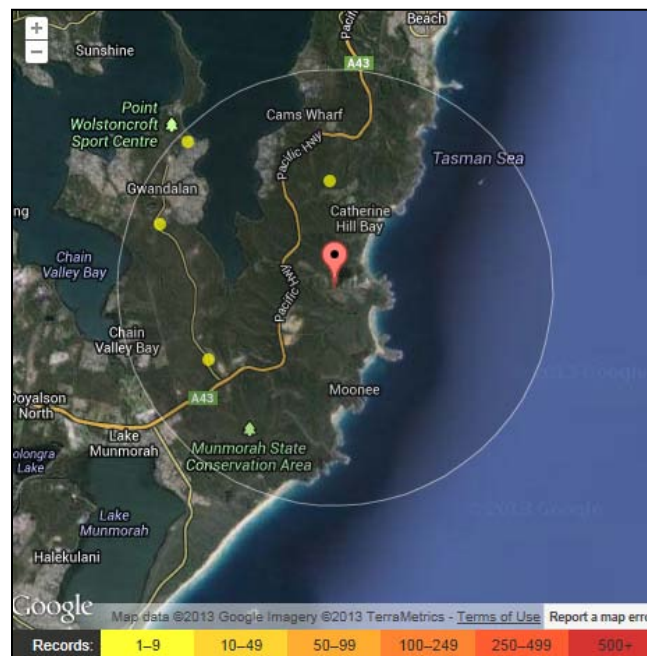


Figure 65 - The Atlas of Living Australia records of the Eastern Bentwing-bat (Source: ALA 2013)

The Eastern Bentwing-bat is known to use the area for foraging with surveys by (Wildthing 2003b) and (Wildthing 2004a) both recording the species. Suitable roosting habitat is absent with the lack of caves, tunnels and buildings on site. The Atlas of Living Australia recorded the

species four times within 5km of the development site (figure 65). The NSW office of Environment and Heritage also notes that the species is known to occur in the area (figure 64).

This species was recorded via ANABAT at the Kanangra Drive and Montefiore recording sites during the April surveying event.

The WWTP will likely modify a small portion of the Eastern Bentwing-bat's foraging range although it is unlikely to cause a significant impact due to the larger foraging opportunities in the surrounding parks and reserves.

***Myotis macropus* (Southern Myotis)**

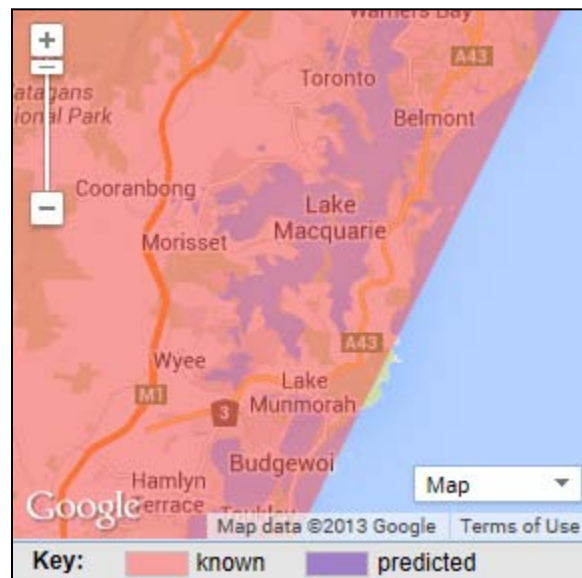


Figure 66 - Distribution range of *Myotis macropus* (source: OEH 2013r)

Description

This species is now most often referred to as *Myotis macropus* or the Southern Myotis, but has previously been called the Large-footed Myotis (*M. adversus*). It has disproportionately large feet; more than 8 mm long, with widely-spaced toes which are distinctly hairy and with long, curved claws. It has dark-grey to reddish brown fur above and is paler below. It weighs up to 15 grams and has a wingspan of about 28 cm (OEH 2013r).

Distribution

This species occurs in Australia and may be found along the coast from Victoria to south-east Queensland, and near Nildottie on the River Murray in South Australia (Reardon and Thomson 2008).

Habitat and Ecology

This species is generally associated with wetland habitat ranging from estuaries to forest streams, large lakes, and reservoirs (Richards *et al.* 2008). It roosts in caves, tunnels and mines, tree hollows, under bridges and in similar habitats (Richards *et al.* 2008).

Diet

It forages over streams and pools catching insects and small fish by raking their feet across the water surface (OEH 2013r).

Comments

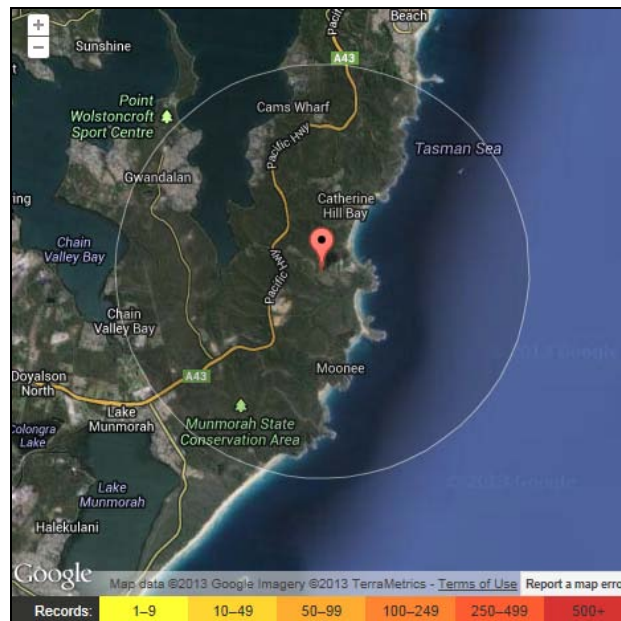


Figure 67 - The Atlas of Living Australia records of the Southern Myotis (Source: ALA 2013)

The WWTPN provides marginal habitat for the the Southern Myotis in association with Coastal Sand Mahogany–Paperbark Swamp Forest. Potential roosting habitat is present with tree hollows available. The NSW office of Environment and Heritage states that the Southern Myotis occurs in the surrounding areas (figure 66), the Atlas of Living Australia has yet to record the species within 5km of the study site (figure 67).

It is highly unlikely that the future development will significantly impact the species due to the low abundance of foraging and roosting habitat available within the development footprint.

***Scoteanax rueppellii* (Greater Broad-nosed Bat)**

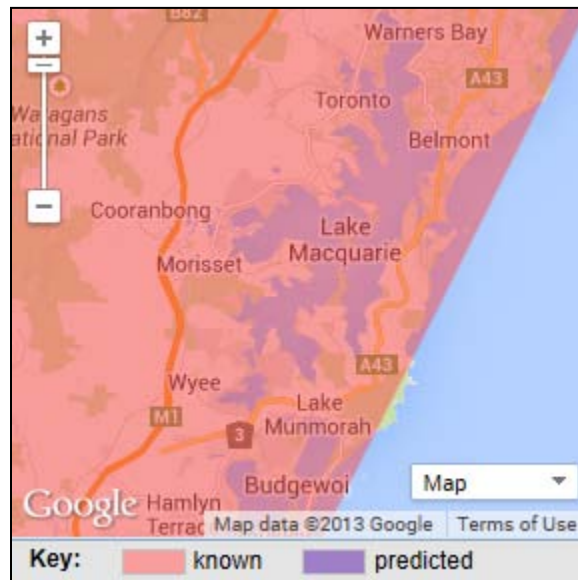


Figure 68 - Distribution range of *Scoteanax rueppellii* (source: OEH 2013s)

Description

The Greater Broad-nosed Bat is a large powerful bat, up to 95 mm long, with a broad head and a short square muzzle. It is dark reddish-brown to mid-brown above and slightly paler below. It is distinguished from other broad-nosed bats by its greater size. While similar to the Eastern False Pipistrelle *Falsistrellus tasmaniensis*, it differs by having only two (not four) upper incisors (OEH 2013s).

Distribution

The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however does not occur at altitudes above 500 m (OEH 2013s).

Habitat and Ecology

This species is found in tropical moist forest, dry and wet sclerophyll woodland, and eucalypt forest. Its roosting habits are poorly known, but it has been found roosting in tree hollows, crevices, and under bark (Lunney and Pennay 2008).

Diet

Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species (OEH 2013s).

Comments

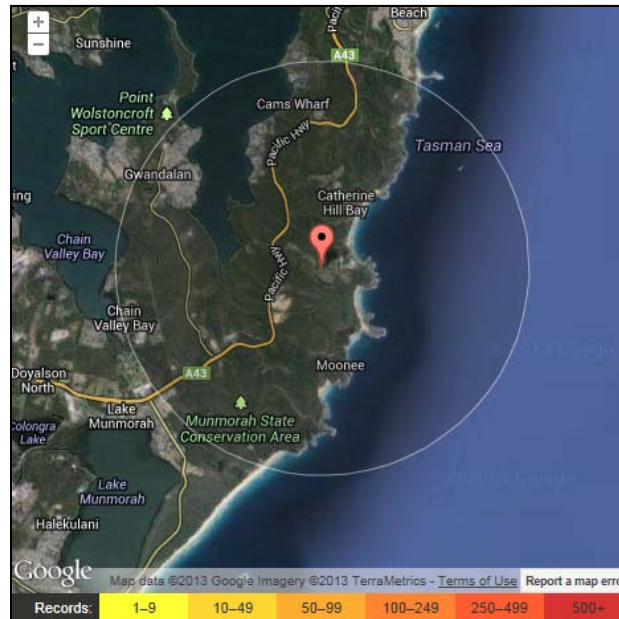


Figure 69 - The Atlas of Living Australia records of the Greater Broad-nosed Bat (Source: ALA 2013)

Potential foraging habitat is known to occur in the area with the presence of dry sclerophyll woodlands, and eucalypt forests. Potential roosting habitat is also available with the presence of tree hollows. The species has however yet to be recorded within 5km of the site (figure 69) even though the NSW office of Environment and Heritage illustrates that it's known to occur in the surrounding areas (figure 68).

The WWTP is unlikely to significantly impact the Greater Broad-nosed Bat within minimal vegetation comparative to the larger conservation reserve being removed.

***Pomatostomus temporalis temporalis* (Grey-crowned Babbler (eastern subspecies))**

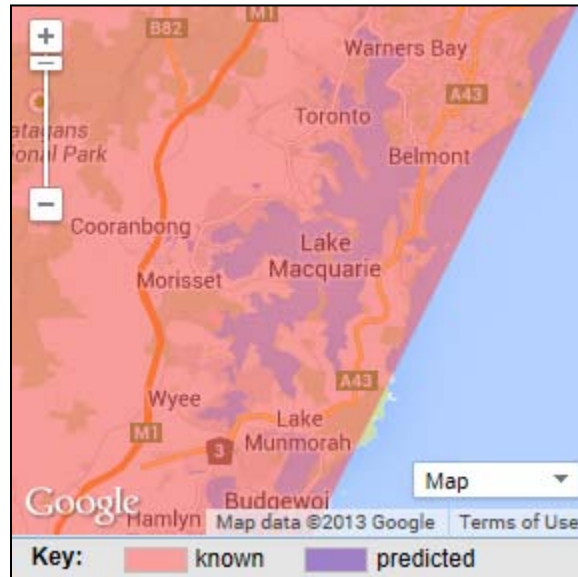


Figure 70 - Distribution range of *Pomatostomus temporalis temporalis* (source: OEH 2013t)

Description

The Grey-crowned Babbler is the largest of the four Australian babblers, reaching to 30 cm long. Its distinctive bill is scimitar-shaped, long and heavy. The broad white eyebrow and a pale grey crown-stripe are other distinguishing characters.

A dark band passes from the bill through the eye, separating the pale throat and brow to giving a 'masked' look. It has dark greyish-brown upperparts and is paler brown on the underparts, grading to a whitish throat. It is distinctive in flight, showing white tips to the tail feathers, and orange-buff patches in the broad, rounded wings. Young birds have dark brown eyes, with the iris becoming paler with age, reaching a yellow colour by about three years (OEH 2013t).

Distribution

In NSW, the eastern sub-species occur on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Balranald. It also occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW. It may be extinct in the southern, central and New England tablelands (OEH 2013t).

Habitat and Ecology

Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains (OEH 2013t). Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts (OEH 2013t)

Diet

It feeds on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses (OEH 2013t).

Comments

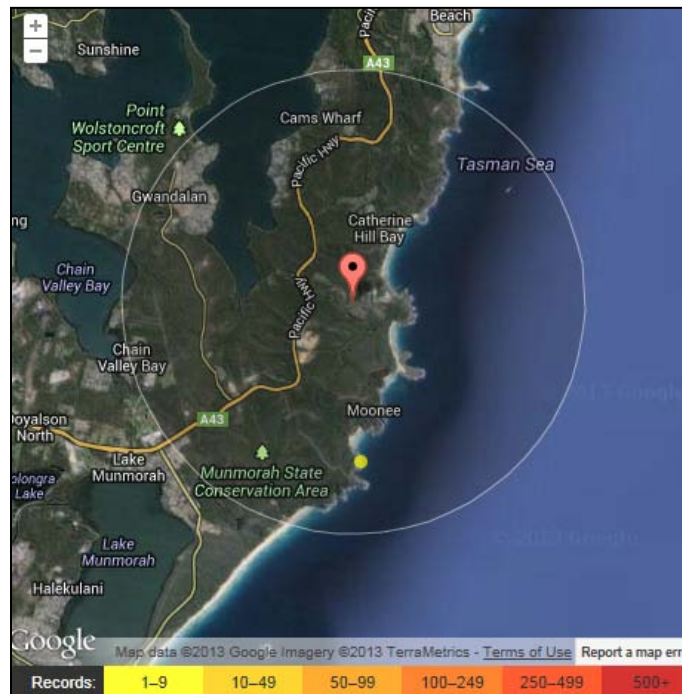


Figure 71 - The Atlas of Living Australia records of the Grey-crowned Babbler (Source: ALA 2013)

Potential foraging habitat is present with the abundance of eucalypts and other woodland trees and hollows in the area. The Atlas of Living Australia recorded the species only once within 5km of the site (figure 71).

This single occurrence was recorded in 1986 which may raise the question of its existence in the local area currently. The NSW Office of Environment and Heritage does however state that the species is still known to occur in the area (figure 70).

Should the Grey-crowned Babbler still occur in the local area, the minor vegetation removal and occurrence of larger similar habitat types in the nearby parks and reserves means that the species should not be significantly affected by the development.

***Ixobrychus flavicollis* (Black Bittern)**

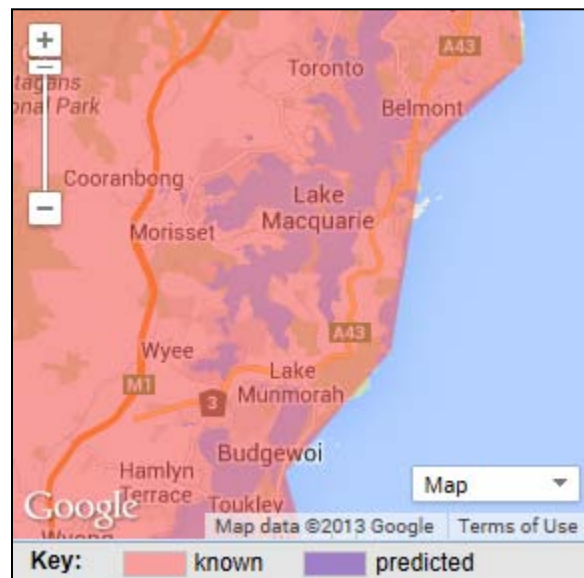


Figure 72 - Distribution range of *Ixobrychus flavicollis* (source: OEH 2013u)

Description

The Black Bittern is a heron, dark grey to black in colour, with buff streaks on the throat and a characteristic yellow streak on the sides of the head and down the neck. The female is paler than the male, with a more yellow wash on the underparts. The species has a characteristic booming call that is mainly heard during the breeding season, at day or night. The colour alone readily distinguishes it from the other two much paler bittern species (OEH 2013u).

Distribution

The Black Bittern has a wide distribution, from the southern NSW north to Cape York and along the entire northern coast to the Kimberley region. The species also occurs in the south-western corner of Western Australia (Marchant and Higgins 1990). In NSW, records of the species are scattered along the east coast. Individuals are rarely recorded south of Sydney and inland (Marchant and Higgins 1990).

Habitat and Ecology

The Black Bittern inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation (Marchant and Higgins 1990). Where permanent water is present, this species may occur in flooded grassland, forest, woodland, rainforest and mangroves (Marchant and Higgins 1990). During the day, the Black Bittern roosts in trees or on the ground amongst dense reeds (Marchant and Higgins 1990). Nests may be located on a branch overhanging water and consists of a bed of sticks and reeds on a base of larger sticks (Marchant and Higgins 1990).

Diet

The Black Bittern forages on reptiles, fish and invertebrates, including dragonflies, shrimps and crayfish (Barker and Vestjens 1989).

Comments

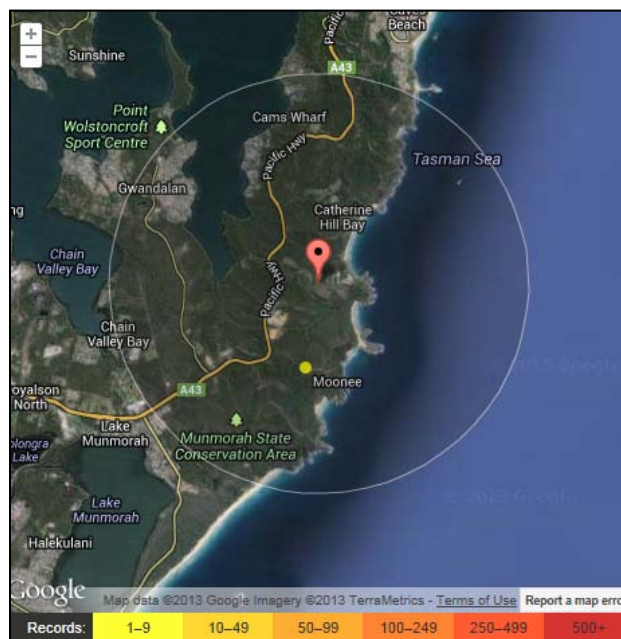


Figure 73 - The Atlas of Living Australia records of the Black Bittern (Source: ALA 2013)

The site is not considered favoured / preferred habitat for the species. The Atlas of Living Australia database recorded the Black Bittern only once (figure 73) back in 1984. With the only record of the species in the area occurring nearly 30 years ago.

The NSW office of Environment and Heritage illustrates that the species does still exist in the area (figure 72). The future development will unlikely significantly impact the Black Bittern due to the lack of foraging and nesting habitat available on site. Areas surrounding the site such as Lake Macquarie and Lake Munmorah are much more suited to the Black Bittern compared to the development site.

As illustrated above a number of scheduled species are likely to be recorded in the location of the development, however the proposal is unlikely to result in significant habitat modification for any of the species.

5.6.2 SCHEDULED SPECIES SUMMARY

As illustrated above, a number of scheduled species are likely to be recorded in the location of the development, however the proposal is unlikely to result in significant habitat modification for any of the species.

5.7 CRITICAL HABITAT

Critical habitats in the NSW which are listed under the *Threatened Species Conservation Act 1995* include:

- Bomaderry zieria (*Zieria baeuerlenii*) within the Bomaderry bushland;
- Eastern Suburbs Banksia Scrub Endangered Ecological Community;
- Wollemia nobilis (the Wollemi pine);
- Gould's Petrel;
- Little penguin population in Sydney's North Harbour; and
- Mitchell's Rainforest Snail in Stotts Island Nature Reserve

The proposed development is unlikely to impact upon any of these declared critical habitats.

5.8 FAUNA CORRIDORS/LINKAGES

Wildlife corridors can be defined as 'retained and/or restored systems of (linear) habitat which, at a minimum enhance connectivity of wildlife populations and may help them overcome the main consequences of habitat fragmentation' (Wilson & Lindenmayer, 1995).

Corridors can assist ecological functioning at a variety of spatial and temporal scales from daily foraging movements of individuals, to broadscale genetic gradients across biogeographical regions (Parsons Brinkerhoff, 2005).

Corridors serve a number of different functions in terms of biodiversity conservation including:

- providing increased foraging area for wide-ranging species
- providing cover for movement between habitat patches, particularly for cover dependent species and species with poor dispersal ability and enhancing the movement of animals through sub-optimal habitats
- reducing genetic isolation by maintaining continuity between sub-populations in a metapopulation and thereby preventing and /or reversing localised extinction
- facilitating access to a mix of habitats and successional stages to those species which require them for different activities (for example, foraging or breeding)
- providing refuge from disturbances such as fire
- providing habitat in itself (Wilson, A. & Lindenmayer 1995; Lindenmayer, 1994; Bennett, 1999).

How species use the corridor network will depend largely on the home and activity ranges of the species, their habitat requirements and the ecological characteristics of the corridor. For example, some large or mobile species may make direct movements through the corridor network, moving from one patch of habitat to another. These direct movements may be on the scale of a foraging expedition or a migration (Bennett 1990b). Other species may have movements by single individuals punctuated by pauses in the corridor, which can last anything from a small foraging or resting bout to weeks and even months.

If the corridor contains sufficient resources to maintain a population, then continuity through the corridor may be through gene flow through the resident population (Bennett 1990b; Wilson, A. & Lindenmayer 1995).

For example a mobile species with a large home range (i.e. koala) may regularly traverse a corridor to move between favoured feeding grounds or in attempt to access mates, whereas a species with a comparably minor home range (i.e. antechinus) may spend its entire life within a portion of the same corridor.

It is important that the site features many corridors due to it being located between the Wallarah National Park and Munmorah State Conservation Area.

Catherine Hill Bay is abundant with corridors which connects highly mobile fauna species to different vegetation communities in the area (figure 74). It is noted that the WWTP site is identified as a potential rehabilitation corridor, however the area has been approved for clearing and development associated with the residential development. Due to the abundance

of corridors and the minimal clearing required, 1.45ha for the development, it is unlikely that the proposal will significantly affect species distribution or act as a barrier to movement .

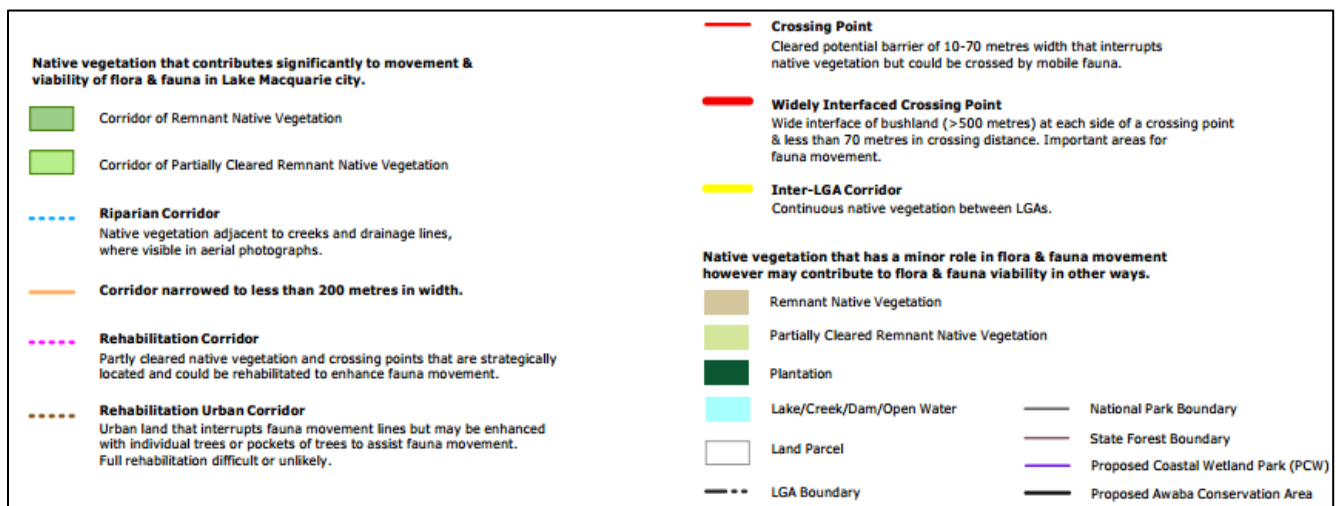
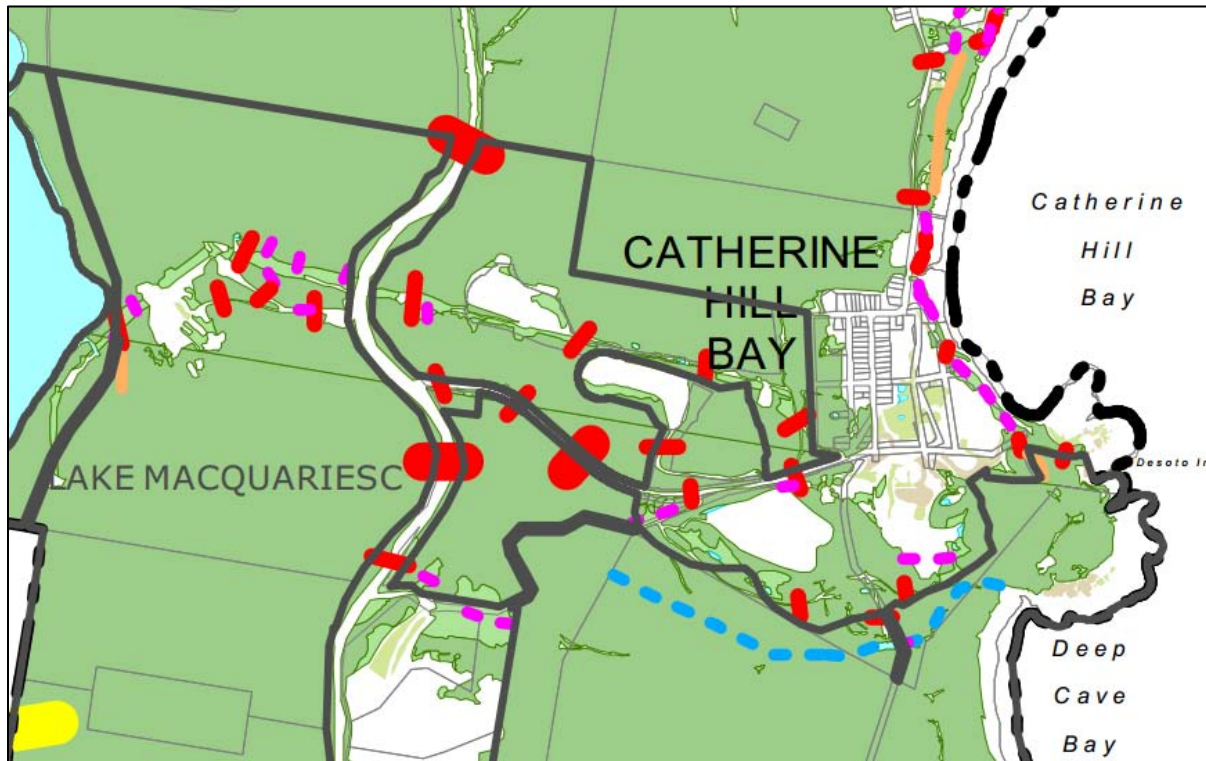


Figure 74 - Catherine Hill Bay Native Vegetation and Corridors (LMCC 2011)

6.0 STATUTORY CONSIDERATIONS – THE 7-PART TEST OF SIGNIFICANCE

Further to the provisions of Schedules 1 and 2 of the *Threatened Species Conservation Act 1995*, Section 5A of the *Environmental Planning and Assessment Act 1979* (the '7-Part Test') is applied to assess any potentially adverse impacts of the site-proposal on threatened species, populations and/or communities occurring within the site or surrounding locality.

The Assessment of Significance is not a 'pass/fail' test or technique based on a scoring system. Instead, the outcome of each factor needs to be considered as to whether effects are likely and whether they are significant (NPWS 1996a). It is further noted that a positive finding in respect of one or more factors of the 7-part test of significance does not necessarily lead to the conclusion that an SIS is then required (Talbot in Gales Holdings Pty Ltd v Tweed Shire Council [2006] NSWLEC 212). Rather it allows consideration as to whether a particular effect may be present or occur as a result of the development and whether that effect is likely to be significant.

The 7-Part Test is applied to scheduled flora, fauna, populations and communities (where applicable) to assess potentially adverse impacts of the proposal on threatened species, populations or communities identified on or likely to utilise the site based on available habitat components, geography and local environmental conditions.

Note that threatened species, populations and/or communities have been excluded from this assessment where:

- No direct observations of threatened species, populations or communities were made on the site during survey works;
- No previous sightings of threatened species, populations or communities within a 10-kilometre radius of the site have been registered within the NPWS database and scheduled under the *Threatened Species Conservation Act 1995*; and
- An abundance of primary habitat requirements for said species are not located on or within the study area of the proposal (refer previous sections)
- Potential habitat (feeding, roosting, nesting or refuge) will not be or will be minimally affected by the proposal (refer previous sections)

As such it is considered that, of the scheduled species, populations and/or communities described previously within this report, the following eight species of threatened fauna were recorded in the study area or are considered likely occurrences within the area based upon available habitat components and have the potential to be significantly affected through development of the site.

As outlined the proposal results in minor clearing of Coastal Narrabeen Woodland, Coastal Headland Complex, And Narrabeen Wallaraha Sheltered Grassy Forest mapped communities. This clearing is principally associated with the construction of the Waste water Treatment Plant at Montefiore Street.

We note this area has been approved for clearing in association with the approved residential estate on the land which has been subject to additional detailed investigation over a number of years.

Whilst the proposal does involve minor clearing through the installation of the WWTP, we note the vegetation to be removed does not constitute an EEC and the site vegetation is not unique to the site or display features which are uniquely dependent of scheduled species for forage or roosting/den.

All areas of the proposal as noted were significantly affected by the recent bushfires with the ground layer and understorey largely being removed. Regeneration from fire is a natural process for the Australian vegetation however the impact of the fires on flora and fauna was evident for surveying in November 2013.

Regardless the seven part test has been undertaken for the following;

- *Petaurus norfolcensis* - Squirrel Glider
- *Pteropus poliocephalus* - Grey Headed Flying Fox
- *Mormopterus norfolkensis* - Eastern Freetail-bat
- *Miniopterus australis* - Little Bentwing-bat
- *Miniopterus schreibersii oceanensis* - Eastern Bentwing-bat

No seven part test is considered necessary for Endangered Ecological Communities (EEC's), or Endangered Populations given the proposal will not affect these. A seven part test has not been performed for the two scheduled flora species recorded on site as their removal through the approved residential estate has been permitted and management plans produced for these.

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

MEGACHIROPTERANS (GREY-HEADED FLYING-FOX)

Local Population

As the Grey-headed Flying Fox is wide ranging in the region, it is considered that it is not genetically isolated on the subject site and would form part of a population within the wider region. This species was observed in flight and is likely to be found across the conservation network in the immediate area where abundant forage resources are found.

Stages of lifecycle potentially affected by development

Habitat Preference	Roosting/Breeding
<p>The Grey-headed Flying-fox inhabits subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps (Eby, 1995). Urban gardens and cultivated fruit crops also provide habitat for this species (NSW NPWS 1999c). Grey-headed Flying-foxes forage on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca, Banksia (Eby, 2000) and fruits of rainforest trees and vines (NSW NPWS 1999c). During periods when native food is limited, Grey-headed Flying-foxes disperse from colonial roosts, often foraging in cultivated gardens and fruit crops (NSW NPWS 1999c). This species is a canopy-feeding frugivore, blossom-eater and nectarivore of rainforests, open forests, woodlands, Melaleuca swamps and Banksia woodlands. As such, it plays an important ecosystem function</p>	<p>This species roosts in large aggregations or camps in close proximity (20 km or less) to a regular food source, often in stands of riparian rainforest, Paperbark or Casuarina forest (Eby, 1995). Camps provide resting habitat, sites of social interactions and refuge for animals during significant phases of their annual cycle, such as birth, lactation and conception (Parry-Jones and Augee 1992, 2001).</p> <p>“Roosting habitat critical to survival:</p> <p>Grey-headed Flying-foxes roost in large aggregations in the exposed branches of canopy trees (Ratcliffe 1931, Nelson 1965a, Parry-Jones and Augee 1992). The locations of camps are generally stable through time, and several sites have documented histories that exceed 100 years (Lunney and Moon 1997).</p> <p>On the basis of current knowledge, roosting habitat that meets at least one of the following criteria can be explicitly identified as habitat critical to survival, or essential habitat, for Greyheaded Flying-foxes. Roosting habitat that:</p> <ol style="list-style-type: none"> 1. is used as a camp either continuously or seasonally in > 50% of years 2. has been used as a camp at least once in 10 years (beginning in 1995) and is known to have contained > 10 000 individuals, unless such habitat has been used only as a temporary refuge, and the use has been of limited duration (i.e. in the order of days rather than weeks or months)

by providing a means of seed dispersal and pollination for many indigenous tree species (Eby 1996; Pallin 2000).	3. has been used as a camp at least once in 10 years (beginning in 1995) and is known to have contained > 2 500 individuals, including reproductive females during the final stages of pregnancy, during lactation, or during the period of conception (i.e. September to May) (in DECCW, 2009)
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Potential foraging resources (flowering and fruiting trees) are abundant within the study area and locality with a large conservation network based on and around the Wallarah Peninsula and broader Lake Macquarie. Additional extensive forests contained within private freehold properties are also found in the locality. No Grey Headed Flying Fox camps are known from within proximity to the study area and the proposal results in only a minor removal of potential forage area.

It is considered unlikely that Grey Headed Flying Fox populations will be significantly impacted upon.

MICROCHIROPTERANS

As the discussed micro-bat species are considered to be wide ranging in the region, it is considered that they are not genetically isolated on the subject site and form part of populations within the wider region.

Little Bentwing Bat, Eastern Freetail Bat, Eastern Bentwing

These species were recorded via anabat detection foraging over the roadway and adjacent eucalypt woodland within and external to the site.

Species	Habitat Preference	Roosting/Breeding
Little Bentwing Bat	This species utilises well-timbered habitats including rainforest, <i>Melaleuca</i> swamps and dry sclerophyll forests where it feeds on insects within the canopy.	DECC (2005) note the following particulars with regard to the little bentwing bat: <ul style="list-style-type: none"> • Maternity colonies form in spring. Males and juveniles disperse in summer. • Only five nursery sites /maternity colonies are known in Australia. • Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, <i>Melaleuca</i> swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. • Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines,

		<p>stormwater drains, culverts, bridges and sometimes buildings during the day</p> <ul style="list-style-type: none"> • They often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters. • In NSW the largest maternity colony is in close association with a large maternity colony of Common Bentwing-bats (<i>M. schreibersii</i>) and appears to depend on the large colony to provide the high temperatures needed to rear its young.
Eastern Freetail Bat	<p>This species has been recorded in dry eucalypt forest and coastal woodlands but individuals have been captured in riparian zones in rainforest and wet sclerophyll forest and mangrove forests east of the Great Dividing Range (Allison and Hoyer, 1995; DEC, 2005). An extensive study near Coffs Harbour found it to be more active on the upper slopes where flyways are large than along creeklines (Hoyer, Law and Allison in Van Dyck and Strahan, 2008)</p> <p>The species forages upon insects above the forest canopy or at forest edges (Allison, 1983).</p>	<p>It is known to roost in tree hollow, particularly in hollow spouts, but occasionally found in buildings (Gilmore and Parnaby, 1994; Allison and Hoyer, 1995; DEC, 2005).</p>
Eastern Bentwing Bat	<p>Utilises a broad range of habits including</p> <p>wet and dry sclerophyll forest, open</p> <p>woodland, paperbark forests, rainforests</p>	<p>Has been found to roost within caves, tunnels, stormwater culverts or disused mining areas (Strahan eds, 2002; DEH, 2005).</p>

	and open grasslands (North & Pasic, 2005) where they forage upon insects.	
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A review of existing habitats indicates that the site provides potential habitat (Eucalypt Open Forest/Woodland) for the Little Bentwing Bat and Eastern Freetail Bat. However, it is likely that all bats would utilize the area as a flyway between canopy trees.

As all three species are wide ranging and the proposal will result in only a minor modification of potential foraging habitat, it is considered unlikely that a significant impact to any of species will result.

A review of the above species indicates that tree cavities and caves/crevices are necessary for roosting/breeding. In addition to providing shelter, maternity places and retreats for hibernation, roosts are also important places for social interactions among bats. The availability of suitable roosts is therefore critical for forest bat survival (Herr, 1998). Within the study area it is considered that cave/mine potential breeding sites are absent although hollow bearing trees are abundant in the locality. The project is therefore unlikely to impact upon any micro-bat roosting sites.

Likelihood of Local Extinction

Reviewing the above, it is considered unlikely that the proposal will disrupt the lifecycle of the local populations of the discussed micro-bats to the point that they are at risk of extinction.

SQUIRREL GLIDER

As discussed above the Squirrel Glider was observed off site proximate to the NPWS/RFS fire trail during inspections associated with the existing pipeline near Crangan Bay. NSW Scientific community note 'The Squirrel Glider is distributed from north Queensland to western Victoria. Its core range is in north-east NSW and south-east Queensland (Quin et al. 1996), but it is generally rare and patchy in NSW (Kavanagh 2004).

The Squirrel Glider requires hollow-bearing, floriferous eucalypt open forests and woodlands with a Banksia or Acacia shrub layer, that provide den sites in tree cavities and a good winter supply of nectar. Large trees with abundant hollows are critical elements (Holland et al. 2007; Crane et al. 2008). Preferred hollows are those with a large cavity that can house multiple gliders in a large nest, yet with a small entrance that protects the group from predators like goannas.'

The proposal results in a minor reduction in potential forage area and this does not represent a significant removal of available habitat in the context of the broader conservation network in the locality. Also no large hollow bearing trees are to be removed and clearing does not represent a new barrier to movement.

Likelihood of Local Extinction

Reviewing the above, it is considered unlikely that the proposal will not disrupt the lifecycle of the local population to the point that it is at risk of extinction.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

N/A

No endangered fauna populations listed under Part 2 Schedule 1 of the Threatened Species Conservation Act 1995 are located on or within the proximity of the site. As such, the proposed activity is unlikely to disrupt the lifecycle of any species constituting an endangered population or the viability of such a population. The endangered populations currently listed include the following:

- Tusked Frog population in the Nandewar and New England Tablelands Bioregions
- Emu population in the New South Wales North Coast Bioregion and Port Stephens local government area
- Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai Local Government Areas
- Glossy Black-Cockatoo, Riverina population
- Little Penguin in the Manly Point Area (being the area on and near the shoreline from Cannae Point generally northward to the point near the intersection of Stuart Street and Oyama Cove Avenue, and extending 100 metres offshore from that shoreline)
- White-browed Treecreeper population in Carrathool local government area south of the Lachlan River and Griffith local government area
- Broad-toothed Rat at Barrington Tops in the local government areas of Gloucester, Scone and Dungog
- Long-nosed Bandicoot, North Head
- Cie in the Wagga Wagga Local Government Area
- Squirrel Glider on Barrenjoey Peninsula, north of Bushrangers Hill

- Koala, Hawks Nest and Tea Gardens population
- Koala in the Pittwater Local Government Area
- Long-nosed Potoroo, Cobaki Lakes and Tweed Heads West population

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

- (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

DEC (2007) notes the following with regard to EECs:

Ecological communities are usually defined by two major components – the geographical distribution and the species composition which influences the physical structure and ecological function of the ecological community. The relative importance of the geographical distribution and the species composition varies according to the specific listed ecological community. Hence this factor provides for consideration of two criteria:

- (i) local occurrence of the ecological community
- (ii) modification of the ecological community's composition.

Interpretation of key terms used in this factor:

Local occurrence: the ecological community that occurs within the study area. However the local occurrence may include adjacent areas if the ecological community on the study area forms part of a larger contiguous area of that ecological community and the movement of individuals and exchange of genetic material across the boundary of the study area can be clearly demonstrated.

Risk of extinction: similar to the meaning set out in factor (a), this is the likelihood that the local occurrence of the ecological community will become extinct either in the short-term or in the long-term as a result of direct or indirect impacts on the ecological community, and includes changes to ecological function.

Composition: both the plant and animal species present, and the physical structure of the ecological community. Note that while many ecological communities are identified primarily by their vascular plant composition, an ecological community consists of all plants and animals as defined under the TSC and FM Acts that occur in that ecological community.

The WWTP does not clear any EEC. The proposed clearing associated with the development is unlikely to have an adverse effect on the extent or substantially and adversely modify the composition of any EECs such that their local occurrence is placed at risk of extinction.

(d) in relation to the habitat of a threatened species, population or ecological community:

- (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Habitat for a given threatened species, community or population is considered to be an area containing similar known (documented) habitat preferences for that species within the species' geographic distribution.

In assessing whether a significant area of the habitat of a threatened species, population or ecological community is to be modified or removed the following should be considered:

- The geographic range of the threatened species, population or ecological community and its known or documented occurrence within the region and locality;
- The relative scale and value of the habitat within the region and locality;
- The importance of the habitat (i.e. relationship to life cycle, reproductive success etc)

DEC (2005) indicates that a “quantitative and qualitative approach to assessing the extent to which habitat is likely to be removed or modified/degraded should consist of the following steps:

- an assessment of the amount of habitat of the threatened species, population or ecological community that occurs within the locality;
- an assessment of the amount of habitat of the threatened species, population or ecological community that occurs within the study area;
- an estimation of the area and quality that the habitat of the study area represents in relation to the local distribution of that habitat;
- An estimation of the area and quality of the habitat of the study area which is to be removed or modified by the proposed development or activity;

- a calculation of the amount of the habitat of the region that will be removed or modified by the proposed development, activity or action or indirectly by longer term impacts from the proposed development such as increased predation weed invasion, salinity etc;
- An estimation of the area and quality of the habitat of the region that will be removed or modified by the proposed development, activity or action; and
- an assessment of the ecological integrity of the habitat to be affected and of the habitat which will remain"

As discussed within this report it is considered that the site and study area represents potential and recorded habitat for the threatened species subject to this 7-part test. The site will result in minor vegetation removal associated with the Waste Water Treatment Plant Site at Montefiore Street and a section of associated pipeline. These components of the development occur within areas previously assessed as part of the approved residential development.

Vegetation from the footprint of the WWTP provides minor forage areas to the scheduled mega / micro bats and Squirrel Gliderch represented in the broader conservation reserve network and adjoining forested lands. Clearing associated with this aspect is unlikely to affect the distribution of Squirrel Glider.

This minor clearing, approximately 1.45ha, is unlikely to affect the identified species.

Reviewing the above, it is considered that the proposed WWTP will not result in the removal or modification of a significant area of habitat for endangered ecological communities or the recorded or potentially occurring threatened species.

In assessing the potential for habitats of threatened species, populations or ecological communities to become fragmented or isolated to such an extent that the long-term survival of the said species, population or community is at risk, the following is to be considered:

- 'Interconnecting or proximate areas of habitat' (which may be at risk of being fragmented or isolated from other habitat areas) are considered to be two or more habitat areas where currently an individual can move between the two. Such areas could become 'isolated' in the event that the development negates future potential movement of individuals between the two habitats. This could occur through the clearance of habitat, creation of physical impediments (i.e. roads, fences) or potential impacts to behaviour (fauna) which may restrict future movements.
- For threatened species, in reviewing whether isolation may occur, consideration must be given to the movement values of the site and surrounds for particular species, the mobility of threatened species, connectivity of habitats within and external to the site and the degree to which the proposal may significantly disrupt these patterns.

- Consideration should be given to the dispersal and genetic exchange mechanisms of individual species and whether the isolation of currently interconnecting or proximate areas of habitat for threatened species, communities or populations will adversely affect the maintenance of gene flow and the ability to sustain viable populations (DEC, 2005).

As discussed it is considered that the works are of a minor nature in the context of the broader local and regional terrestrial and aquatic corridors of the Wallarha Peninsula. The removal of vegetation for the WWTP is consistent of the previously approved clearing footprint. This clearing does not result in the surrounding existing open forest/woodland remnant being fragmented into two smaller remnants.

Additionally, it is considered that the proposal will not introduce a new terrestrial fauna dispersal barrier or intensify an existing barrier as the works proposed.

The existing corridor value of the locality is therefore unlikely to be reduced by the WWTPN.

Reviewing the above, it is considered that project will not result in a significant area of habitat for a threatened species, population or ecological community to become isolated from currently interconnecting or proximate areas of habitat for threatened species, populations or ecological communities. Further the proposal is unlikely to adversely impact upon or alienate movement corridors or limit dispersal options for any threatened species.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

N/A. To date the only 'Critical Habitat Areas' within the state declared pursuant to the Threatened Species Conservation Act 1995 are the Mitchell's Rainforest Snail Habitat of Stott's Island NR and Little Penguin Population habitat in Sydney's North Harbour (NPWS, 2005). The WWTP is unlikely to affect 'critical habitat' areas.

The construction access is also considered unlikely to affect nominated 'critical habitat' areas which are pending determination by the Scientific Committee

- Bomaderry zieria within the Bomaderry bushland
- Eastern Suburbs Banksia Scrub Endangered Ecological Community
- Wollemia nobilis (the Wollemi pine)

(sourced online at <http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Critical+habitat+protection+by+doctype>)

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

Section 69(1) of the TSC Act requires that a public authority implement actions for which they are responsible and “must not make decisions that are inconsistent with the provisions in a recovery plan”. In this regard it is considered important that the proposed development does not conflict with the objectives or actions listed within the recovery plan(s) for recorded or potentially occurring threatened species, populations or communities (as discussed within this report). Recovery plans associated with such threatened species or communities as discussed in this report include:

- Grey-headed Flying Fox (National) Recovery Plan

It is noted that under the EP&A Act, it is the responsibility of the consent or determining authority to form a view as to whether a proposed development or activity is likely to significantly affect threatened species, communities, populations or their habitat. This is achieved by undertaking an Assessment of Significance under Section 5A of the EP&A Act. In this regard, an assessment of significance has been conducted for the WWTP proposal which concludes that a species impact statement is not required. It is further concluded within this report that the proposal is unlikely to have a significant impact on recorded or potentially occurring threatened species, communities and their associated habitat.

As such, it is considered that the proposal is not in conflict with the objectives or actions of the listed recovery plans.

“Any process can be listed as a key threatening process (KTP) under schedule 3 of the NSW Threatened Species Conservation Act 1995 (TSC Act), provided the process and its nomination meet the specific requirements and criteria established under the Act. A threat abatement plan or TAP is a statutory document prepared in accordance with the TSC Act, for a KTP listed under the Act. The TAP’s principle aim is to reduce, abate or ameliorate the threat posed by the KTP to threatened species and ecological communities, or those species which may become threatened as a result of the KTP (DEC, 2004: vii). Existing TAPs include:

- Invasion of native plant communities by bitou bush/boneseed (2004)
- Predation by the red fox (2001)
- Predation by *Gambusia holbrooki* (plague minnow) (2003)

The red fox was recorded on the Scout cameras. The proposal is unlikely to exacerbate the impacts of the red fox on native wildlife and as such is not considered to be in conflict with the objectives or actions of the TAP.

As such, it is considered that the proposal is not in conflict with the objectives or actions of the listed threat abatement plans.

(g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The Threatened Species Conservation Act 1995 defines a 'threatening process' as 'a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities.' Accordingly Key Threatening Processes are nominated within Schedule 3 of the Act and include the following (online @ http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/home_threats.aspx):

Table 14 – Key Threatening Table

THREATENING PROCESS	COMMENT
Alteration of habitat following subsidence due to longwall mining	Not applicable
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	Not applicable
Anthropogenic climate change	Not applicable
Bushrock removal	Not applicable
Clearing of native vegetation	<p>The proposal will involve clearing of some native vegetation (including clearing of one or more strata within a stand of native vegetation). The NSW Scientific Committee notes in their final determination that ‘clearing of native vegetation’ is recognised as a major factor contributing to the loss of biological diversity and includes impacts such as the following:</p> <ul style="list-style-type: none"> • Destruction of habitat results in loss of local populations of individual species • Fragmentation • Expansion of dryland salinity • Riparian zone degradation • Increased greenhouse gas emissions • Increased habitat for invasive species • Loss of leaf litter layer • Loss or disruption of ecological function • Changes to soil biota (NSW Scientific Committee, 2001) <p>The area to be cleared is located in Stage 5 of the approved residential estate which has previously been identified and approved for clearing. It is considered that the level of clearing proposed, 1.45ha, is unlikely to significantly impact upon the viability of threatened fauna species and habitat values available within the site and surrounding locality.</p>
Competition and grazing by the feral European rabbit (<i>Oryctolagus cuniculus</i>)	Not applicable
Competition and habitat degradation by feral goats (<i>Capra hircus</i>)	Not applicable
Competition from feral honey bees (<i>Apis mellifera</i>)	Not applicable
Death or injury to marine species following capture in shark control programs on ocean beaches	Not applicable
Entanglement in or ingestion of anthropogenic debris in marine and estuarine	Not applicable

THREATENING PROCESS	COMMENT
environments	
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners	Not applicable
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	Not applicable
Herbivory and environmental degradation caused by feral deer	Not applicable
Importation of red imported fire ants (<i>Solenopsis invicta</i>)	Not applicable
Infection by psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations	Not applicable
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	Not applicable
Infection of native plants by <i>Phytophthora cinnamomi</i>	Not applicable
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	Not applicable
Introduction of the large earth bumblebee (<i>Bombus terrestris</i>)	Not applicable
Invasion and establishment of exotic vines and scramblers	Exotic scramblers should be removed in association with the proposed works where they occur within the works zone.
Invasion and establishment of Scotch broom (<i>Cytisus scoparius</i>)	Not applicable
Invasion and establishment of the cane toad (<i>Bufo marinus</i>)	Not applicable
Invasion of native plant communities by African Olive <i>Olea europaea</i> L. subsp. <i>cuspidata</i>	Not applicable
Invasion, establishment and spread of <i>Lantana camara</i>	Lantana is present in the locality. The species should be removed in association with the proposed works where it occurs within the works zone. The recent fires have affected all site vegetation.
Invasion of native plant communities by <i>Chrysanthemoides monilifera</i> (bitou bush and boneseed)	Not applicable
Invasion of native plant communities by exotic perennial grasses	Not applicable
Invasion of the yellow crazy ant (<i>Anoplolepis gracilipes</i> (Fr. Smith)) into NSW	Not applicable
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	Not applicable
Loss of hollow-bearing trees	Not applicable
Loss or degradation (or both) of sites used for hill-topping by butterflies	Not applicable
Predation and hybridisation of feral dogs (<i>Canis lupus familiaris</i>)	Not applicable
Predation by the European red fox (<i>Vulpes vulpes</i>)	Not applicable

THREATENING PROCESS	COMMENT
Predation by the feral cat (<i>Felis catus</i>)	Not applicable
Predation by <i>Gambusia holbrooki</i> Girard, 1859 (plague minnow or mosquito fish)	Not applicable
Predation by the ship rat (<i>Rattus rattus</i>) on Lord Howe Island	Not applicable
Predation, habitat degradation, competition and disease transmission by feral pigs (<i>Sus scrofa</i>)	Not applicable
Removal of dead wood and dead trees	Not applicable

6.1 SEPP 14 COASTAL WETLAND ASSESSMENT

SEPP 14 Coastal Wetlands aims to protect and preserve coastal wetlands. Under SEPP 14, a person must not clear land, construct a levee, drain land or fill land which is covered by the Policy except with the consent of the local council and the concurrence (agreement) of the Director-General of Planning. Works to restore SEPP 14 wetlands must not be carried out except with the consent of the local council and the concurrence (agreement) of the Director of Planning.

Furthermore, in respect of land to which the SEPP 14 policy applies, a person must not carry out restoration works except with the consent of the council and the concurrence of the Director.

Figure 75 illustrates that there are no SEPP 14 Wetland sites located on or adjacent to the WWTP. The proposal should not affect these wetland areas or be in conflict with the SEPP 14 policy.

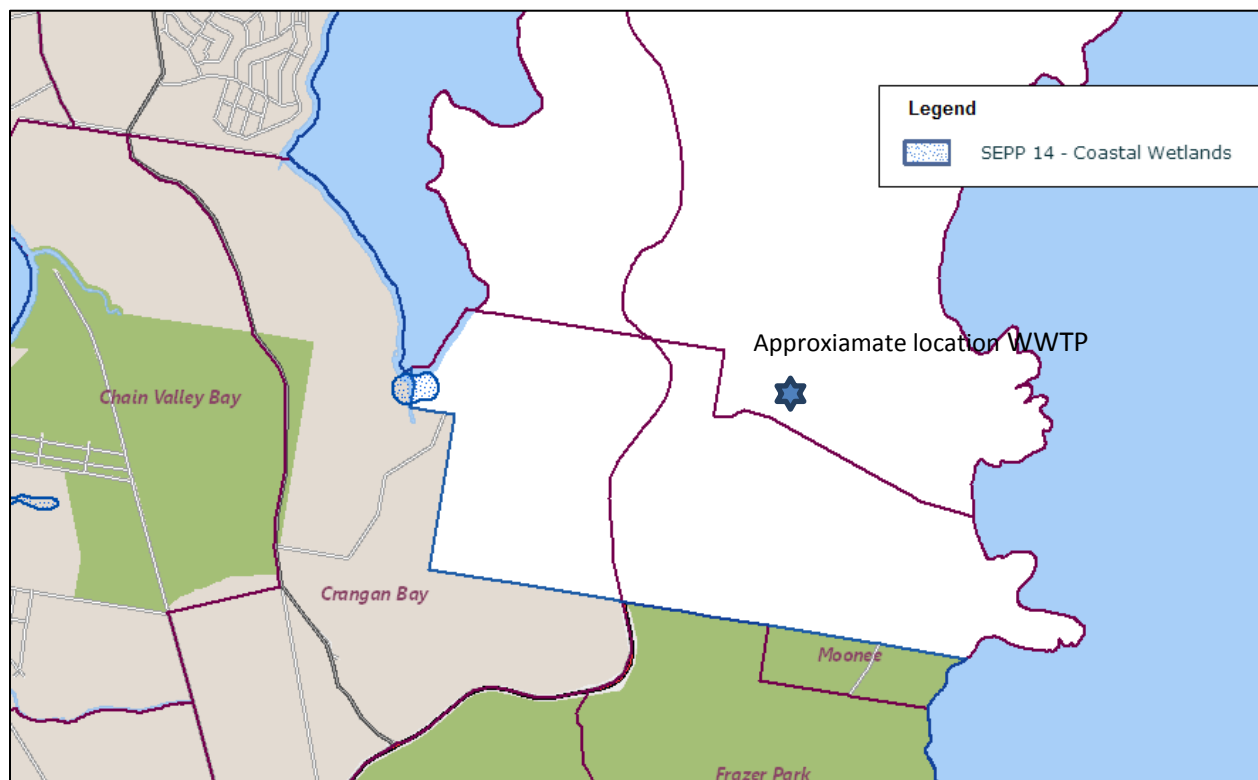


Figure 75- SEPP14 Coastal Wetland in the CHB area (Source: WSC 2013)

6.2 SEPP 26 LITTORAL RAINFORESTS ASSESSMENT

SEPP 26 aims to provide a mechanism for the consideration of applications for development that is likely to damage or destroy littoral rainforest areas with a view to the preservation of those areas in their natural state.

There are no Littoral Rainforests located within the CHB development sites (figure 78).

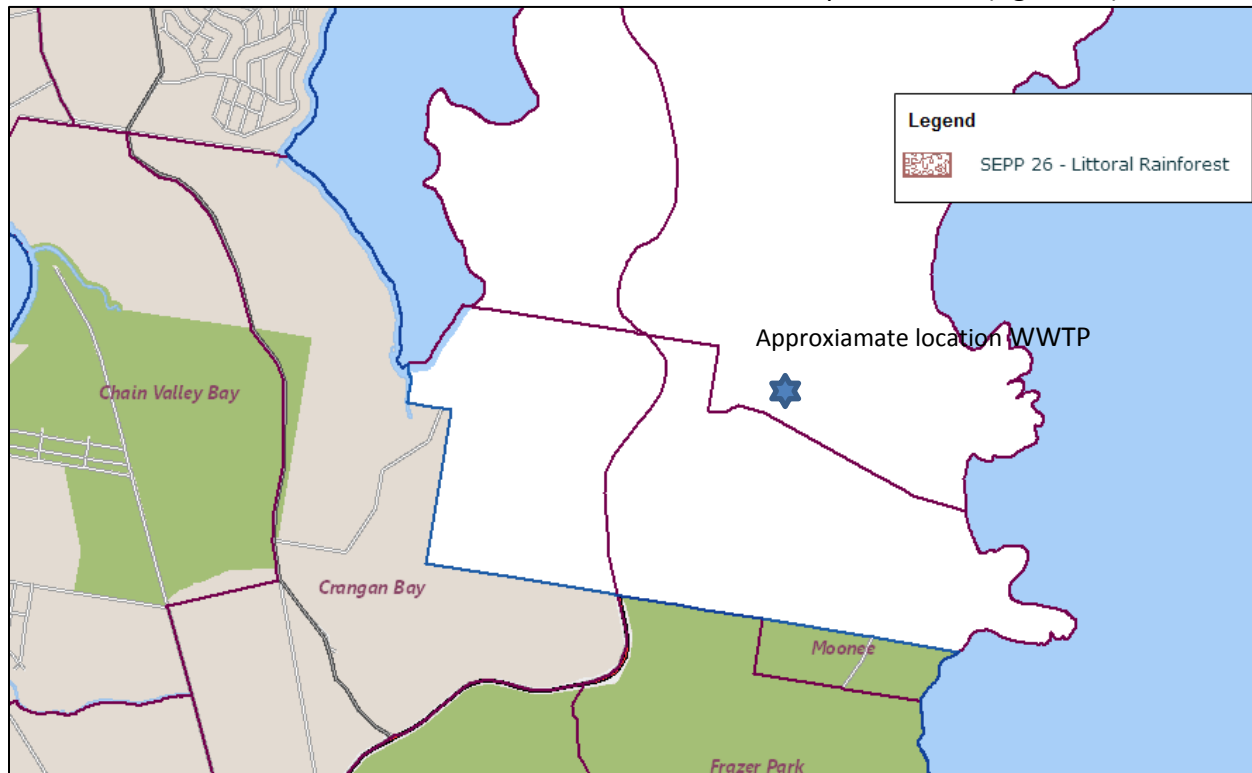


Figure 76 - SEPP 26 Littorial Rainforest in the CHB area (Source: WSC 2013)

6.3 SEPP 44 KOALA HABITAT ASSESSMENTS

Resources enacted the *State Environmental Planning Policy No. 44: Koala Habitat Protection*. This Policy 'aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline.'

In association with development applications and in areas where the policy applies a number of criteria are to be addressed to determine levels of assessment and to govern management considerations. The steps are as follows:

1. Does the Policy Apply?

Is the land greater than 1ha in size and located within one of the Local Government areas listed within Schedule 1 of SEPP 44?

Yes. The land is >1HA in area and located within the Lake Macquarie Local Government area.

2. Is the land potential koala habitat?

The SEPP defines 'potential koala habitat' as 'areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.' The trees within Schedule 2 are tabulated below:

Table 15 - Koala Feed Tree Species

Scientific Name	Common Name
Eucalyptus tereticornis	Forest red gum
Eucalyptus microcorys	Tallowwood
Eucalyptus punctata	Grey Gum
Eucalyptus viminalis	Ribbon or manna gum
Eucalyptus camaldulensis	River red gum
Eucalyptus haemastoma	Broad leaved scribbly gum
Eucalyptus signata	Scribbly gum
Eucalyptus albens	White box
Eucalyptus populnea	Bimble box or poplar box
Eucalyptus robusta	Swamp mahogany

RPS HSO (2010) states that there is Eucalyptus punctate, Eucalyptus haemastoma, Eucalyptus signata, and Eucalyptus robusta located in vegetation communities within the site. These were observed as part of these investigations within the site and adjacent to it.

3. Is the land core koala habitat?

The SEPP defines 'core koala habitat' means 'an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.'

According to RPS HSO (2010), no evidence of Koalas was observed within the CHB Development Lands during previous fauna surveys which included scat searches and spotlighting. There has however been Koalas recorded in the nearby offset areas identified

above in Section 5 and (Atlas of NSW Wildlife Data). It is contended that the land is not core koala habitat as defined.

4. *Is there a requirement to prepare a Plan of Management for land containing core koala habitat?*

No. It is considered that the site does not contain core Koala habitat as described.

6.4 SEPP 71 COASTAL PROTECTION ASSESSMENT

This Policy aims:

- (a) to protect and manage the natural, cultural, recreational and economic attributes of the New South Wales coast, and
- (b) to protect and improve existing public access to and along coastal foreshores to the extent that this is compatible with the natural attributes of the coastal foreshore, and
- (c) to ensure that new opportunities for public access to and along coastal foreshores are identified and realised to the extent that this is compatible with the natural attributes of the coastal foreshore, and
- (d) to protect and preserve Aboriginal cultural heritage, and Aboriginal places, values, customs, beliefs and traditional knowledge, and
- (e) to ensure that the visual amenity of the coast is protected, and
- (f) to protect and preserve beach environments and beach amenity, and
- (g) to protect and preserve native coastal vegetation, and
- (h) to protect and preserve the marine environment of New South Wales, and
- (i) to protect and preserve rock platforms, and
- (j) to manage the coastal zone in accordance with the principles of ecologically sustainable development (within the meaning of [section 6 \(2\)](#) of the [Protection of the Environment Administration Act 1991](#)), and
- (k) to ensure that the type, bulk, scale and size of development is appropriate for the location and protects and improves the natural scenic quality of the surrounding area, and
- (l) to encourage a strategic approach to coastal management.

This Policy:

- (a) requires certain development applications to carry out development in sensitive coastal locations to be referred to the Director-General for comment; and

(b) identifies master plan requirements for certain development in the coastal zone.

The site is subject to the provisions of State Environmental Planning Policy 71- Coastal Protection (SEPP 71) as the site is situated within the Coastal Zone identified under the Coastal Protection Act 1979 (figure 77). The matters for consideration in determining a proposed development or the preparation of a draft LEP are identified under Clauses 8 and 14 – 16 of the SEPP.

The site of the proposed Waste Water Treatment Plant and proportion of new pipeline is situated within Stage 5 and 6 of the approved residential estate. We note the site obtained Project Approval (MP 10/0204) by the NSW Planning for 554 dwellings across 72 hectares on the site of the former Moonee Colliery. The proposal is subject to additional approvals regulating its use and as such is largely not relevant to the flora and fauna investigations undertaken in this report.

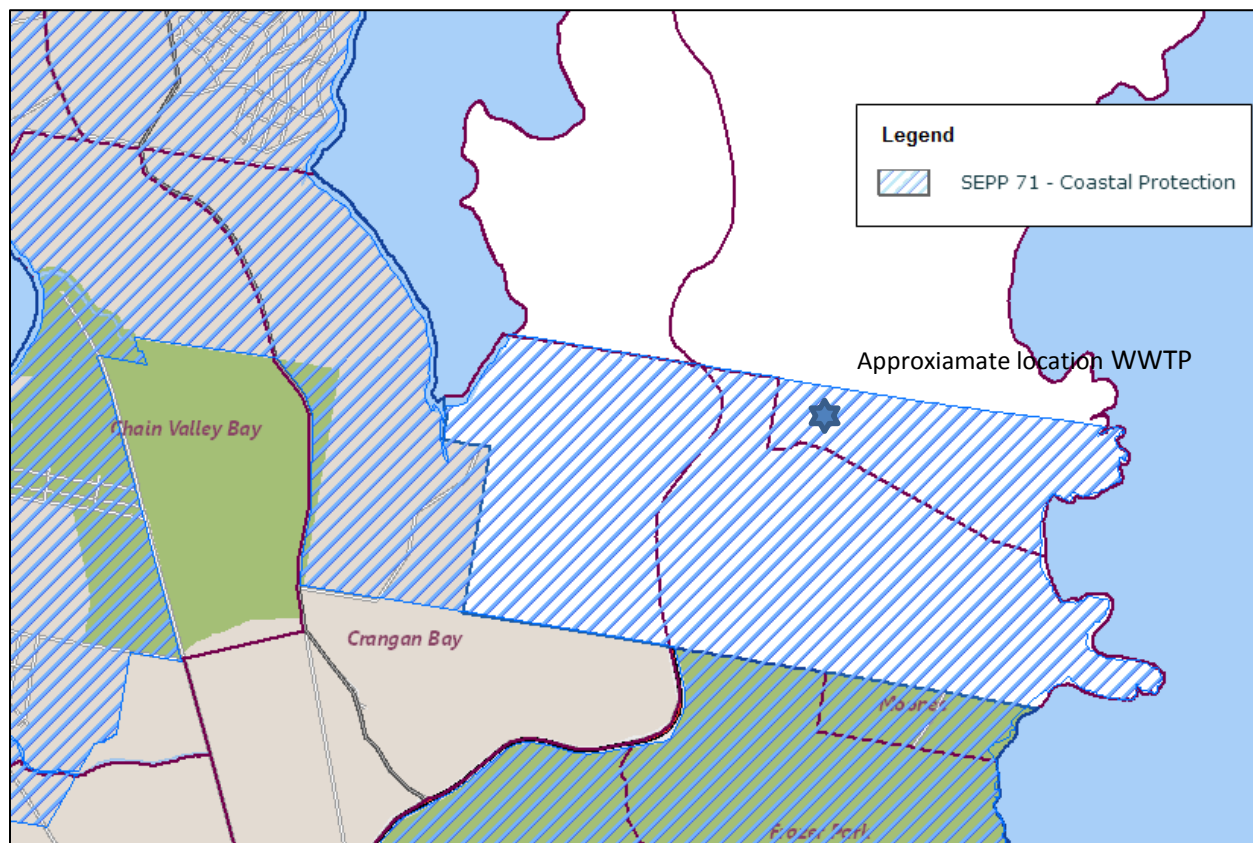


Figure 77 - SEPP 71 Coastal Protection in the CHB area (Source: WSC 2013)

6.4.1 SEPP 71 SENSITIVE COASTAL LOCATION

"sensitive coastal location" means any of the following:

- (a) land within 100m above mean high water mark of the sea, a bay or an estuary,
- (b) a coastal lake,
- (c) a declared Ramsar wetland within the meaning of the [Environment Protection and Biodiversity Conservation Act 1999](#) of the Commonwealth,
- (d) a declared World Heritage property within the meaning of the [Environment Protection and Biodiversity Conservation Act 1999](#) of the Commonwealth,
- (e) land declared as an aquatic reserve under the [Fisheries Management Act 1994](#) ,
- (f) land declared as a marine park under the [Marine Parks Act 1997](#) ,
- (g) land within 100m of any of the following:
- (h) the water's edge of a coastal lake,
- (i) (ii) land to which paragraph (c), (d), (e) or (f) applies,
- (j) (iii) land reserved or dedicated under the [National Parks and Wildlife Act 1974](#) ,
- (k) (iv) land to which *State Environmental Planning Policy No 14-Coastal Wetlands* applies,
- (l) residential land (within the meaning of *State Environmental Planning Policy No 26-Littoral Rainforests*) that is within a distance of 100m from the outer edge of the heavy black line on the series of maps held in the Department of Planning and marked " *State Environmental Planning Policy No 26-Littoral Rainforests (Amendment No 2)* " .

Figure 78, below identifies the site is proximate to Sensitive Coastal Locations under SEPP 71.

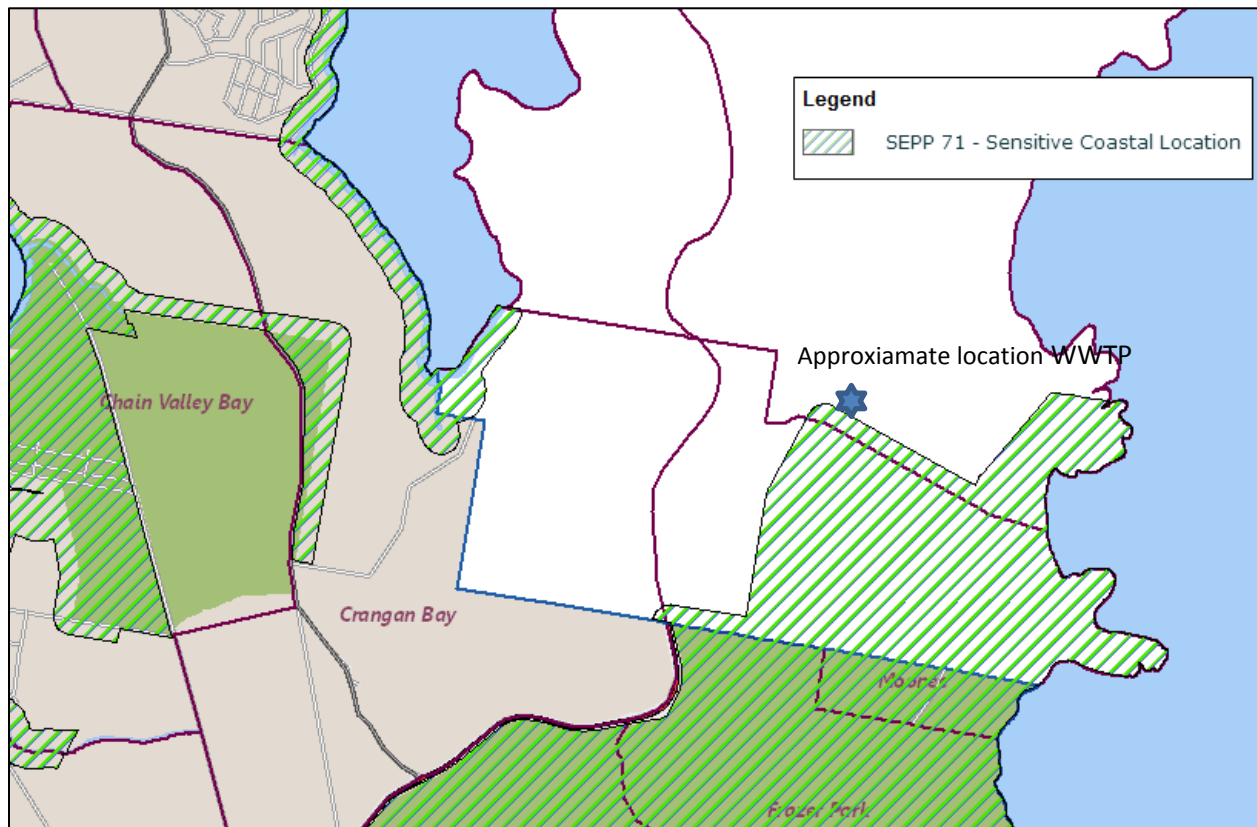


Figure 78 - SEPP 71 Sensitive Coastal Protection in the CHB area (Source: WSC 2013)

As outlined, the Waste Water Treatment Plant Site is located within the footprint of the approved Catherine Hill Bay development. Boundary for the SEPP proximate to the site is reflective of the Mummorah SCA boundary which adjoins the WWTP to the east. Site is not within a Sensitive Coastal Location.

7.0 SITE IMPACTS

In determining the nature and magnitude of an impact, DECC (2007) notes that it is important to consider matters such as:

- pre-construction, construction and occupation/maintenance phases
- all on-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones
- all direct and indirect impacts
- the frequency and duration of each known or likely impact/action
- the total impact which can be attributed to that action over the entire geographic area affected, and over time
- the sensitivity of the receiving environment
- the degree of confidence with which the impacts of the action are known and understood.

Pre-construction, construction and occupation/maintenance phases:

It is anticipated that the initial clearing and construction works will occur over a short period (6 weeks) with use continuing for at least 50 years. The design of the works in accordance with accepted design standards will be such that the use will be permanent.

On-site and off-site impacts, including location, installation, operation and maintenance of auxiliary infrastructure and fire management zones:

It is anticipated that the impacts of the proposal, removal of 1.45ha of vegetation and landform modification of the area will be confined to the site. Construction management plans will be implemented to mitigate potential secondary offsite impacts (i.e. deterioration of water quality, downstream sedimentation, dust transport offsite etc).

A Vegetation Management Plan is provided in Attachment 6 to address clearing activities. We note separate management plans for the scheduled flora identified as occurring on site exists, and has been approved for clearing and earthworks for the site. These would also be implemented with these works.

All direct and indirect impacts:

The direct impacts of the proposal will be the immediate removal of approximately 1.45ha of vegetation. Temporary impacts will be associated with additional noise generation during construction.

It is relevant to also note in respect to the potential impacts identified by Office of Environment and Heritage on the proposal the WWTPN is;

- a. Subject to significant environmental management measures and licensing requirements as required by the NSW EPA. In this regard, the plant will represent a state of the art fully enclosed plant that is designed to be fail safe in respect of leakages (resulting in downstream and groundwater impacts). Much of these measures are outlined in the current application for operator's license submitted by Solo Water with NSW IPART;
- b. The system is designed to ensure that in the event of any leakage in the plant, that bunding of the site area and emergency conveyance systems divert all leakage back to storage tanks for further treatment;
- c. The system relies entirely upon controlled irrigation that is connected to Soil Moisture probes and on site weather monitoring stations that ensure that no irrigation occurs in wet weather events and all irrigation has been determined on conservative wet weather modelling;
- d. The system is designed to alert, by telemetry, the operators of any movement of the system outside tolerations designed to ensure the safety of the system;
- e. The system includes the construction of a 10ML storage to cater for all wet weather events. Such storage is fully PE lined to restrict leakage; and
- f. All treatment tanks are below ground, concrete encased and the site will be to a volume in excess of that within the treatment tanks.

The above matters are and will be addressed in detail within the current IPART Operators Licence application (refer to the following link:

http://www.ipart.nsw.gov.au/Home/Industries/Water/Private_Sector_Licensing_WICA/Catherine_Hill_Bay_Water_Utility_Pty_Ltd) and also within a detailed Review of Environmental Factors being currently prepared.

The frequency and duration of each known or likely impact/action:

It is anticipated that the initial clearing and construction of the construction access will occur over a short period (6 weeks) and the works will remain in place permanently.

The total impact which can be attributed to that action over the entire geographic area affected, and over time:

The total impact will be the modification of the existing environment within the new components to the proposed WWTPN. Secondary or indirect impacts to flora and fauna are related to minor upgrades and or maintenance works. These impacts are anticipated to be permanent.

The sensitivity of the receiving environment:

The proposal occurs within and adjacent to areas of conservation significance. The proposal is however contained to areas previously disturbed, recreational reserves and or vegetated areas designated and approved for development involving the removal of vegetation in areas the subject of the WWTPN.

The degree of confidence with which the impacts of the action are known and understood

The process of clearing works is very common practice and their impacts are well known and understood. As such the impacts of this project are considered to have been assessed with confidence.

7.1 SIGNIFICANCE OF IMPACTS TO THREATENED SPECIES AND/OR COMMUNITIES

DEC (2005 & 2007) outline assessments relating to the significance of impacts of actions to threatened species, communities and populations. DEC (2005) notes that evaluation of impacts should involve not only the magnitude and extent of impacts, but also the significance of the impacts as related to the conservation importance of the habitat, individuals and populations likely to be affected.

Impacts are considered more significant if:

- Areas of high conservation value are affected.
- Individual animals and/or plants and/or subpopulations that are likely to be affected by a proposal play an important role in maintaining the long-term viability of the species, population or ecological community.
- Habitat features that are likely to be affected by a proposal play an important role in maintaining the long-term viability of the species, population or ecological community.
- The impacts are likely to be long-term in duration.

- The impacts are likely to be permanent and irreversible.

A number of threatened species have been found (or are considered potential occurrences) within the locality and individuals of these species may be impacted through the removal of vegetation or disturbance to habitat.

As noted above the recent fires may affect the distribution and abundance of the recorded flora species. The management plans for translocation of the species approved through the clearing associated with the residential estate are proposed to be utilised for this development.

Impacts to vegetation from the fires, also affects the abundance and distribution of scheduled fauna. The reports, whilst acknowledging the impact of these fires, assess the sites in the context of the whole of the surveying period and results so that catastrophic events such as the fire do not skew results findings or comments. The reviews conducted for the proposed removal of 1.45ha of native vegetation identify that no significant impact to scheduled flora and fauna would arise from the proposal.

Significance assessments for these threatened species have been undertaken in Section 6. The significance assessments indicate that the proposed action is unlikely to have a significant impact on any EECs, endangered populations, critical habitats, threatened plants or threatened animals (as summarized below).

Table 16 - Summary of Species for Which Significance Tests Were Undertaken

TYPE	TSC ACT	LIKELY TO BE SIGNIFICANTLY AFFECTED BY PROPOSED ACTION?
Endangered Ecological Community		
N/A	N/A	N/A
Threatened Animals		
Eastern Freetail Bat	V	No
Grey Headed Flying Fox	V	No
Little Bentwing Bat	V	No
Eastern Bentwing-bat	V	No
Squirrel Glider	V	No
Threatened Plants		
N/A	N/A	N/A
Black Eyed Susan*	V	No
Leafless Tongue Orchid*	E	No
Critical Habitats		
N/A	N/A	N/A
Endangered Populations		
N/A	N/A	N/A

* No new individuals observed within site. Species identified prior to works commencing to be removed in accordance with approved Management Plan for prior site development / clearing works.

Although the potential impacts of the proposed action on threatened biodiversity are not considered significant (as summarized above and discussed in detail within Section 6), mitigation measures are proposed to manage potential impacts (refer Section 8).

7.2 IMPACTS TO FAUNA HABITAT

The proposal will involve the clearing of areas of the site to deliver the WWTP as presented in Attachment 2. These areas currently support a fauna assemblage typical to eucalypt forests/woodlands including potential habitat for several threatened species. Specific discussions regarding each major faunal class have been previously provided in Section 4 of this report. Typical impacts associated with vegetation clearing on fauna habitat include:

- Overall loss of standing biomass and reduction in flora species abundance/diversity
- Mortality as a result of construction activities (removal/disturbance of nests, hollows, burrows and general habitat)
- Loss of habitat complexity from the clearance zones including loss of potential foraging and nesting/roosting resources
- Increased potential from 'edge effects' to retained remnants (on or offsite)
- Disturbance of species behaviour (i.e. some species are less tolerant to human presence or a higher level of human activity and may abandon currently utilized habitats)
- Reduction of potential fauna movement linkages throughout the overall landscape
- Alteration to the fauna assemblage (some species tolerant to modified habitats (i.e. rats, minors, crows etc) may dominant the newly created niches and displace species from adjacent vegetated remnants)

In this instance it is considered that the proposal represents only a minor loss of potential resources from the larger habitat system and conservation reserve network.

None of the trees to be removed were noted to bear hollows and as such loss of potential breeding/roosting sites for hollow dependent arboreal mammals, microchiropteran bats and avifauna is unlikely to be occasioned. It is also considered that a significant increase in 'edge effects' (and potential associated behavioral alteration through the establishment of a new edge) is unlikely to occur as the works will occur within an existing area of minor fragmentation (i.e. the roadway / trails) or within an area approved for development.

Taking into account the minor extent of habitat to be cleared in the context of the surrounding expansive habitats, associated with the private forested land and conservation reserves of the Wallarah Peninsula, it is considered unlikely that a significant impact to the localities fauna habitat and associated assemblage will be occasioned.

7.3 FAUNA MORTALITY/INJURY

Any level of vegetation clearing, construction or earthworks modification undertaken has the potential to kill or injure fauna species. Whilst potential does exist for dispersal of numerous species (particularly avifauna) to retained habitats offsite, less dispersive species or species not tolerant to a surrounding human interface may become trapped within the construction zone during earthworks.

7.4 HABITAT FRAGMENTATION, BARRIER EFFECTS AND EDGE EFFECTS

Habitat fragmentation is considered to be the division of a single area of habitat into two or more smaller habitats separated by a new habitat type in the area between the remaining fragments (PB, 2007). Often the dividing habitat is anthropogenic (i.e. crop, roadway, residential development etc) which limits continued interaction and movement of individuals between the new patches to varying degrees (i.e. birds may be still able to move between patches). Additionally the dividing habitat tends to favour a different assemblage of animals typically described as generalist and/or aggressive (i.e. crows, noisy minors, black rat). This is particularly relevant to urban development where domestic and feral species (cats, foxes, dogs) are favoured by the new habitat to the exclusion of native species.

The resultant habitat fragments or patches are also impacted as a result of a reduction in patch size, reduction in the 'interior' area and creation or expansion of the habitat 'edge.' Edge areas also typically favour aggressive and generalist species particularly in relation to exotic flora. Dominance of exotic flora or weeds can threatened the integrity of the 'interior' habitat thus expanding the edge further. Weed dominance also typically simplifies the structural and floristic diversity to the exclusion of numerous 'niches' and the fauna that occupy such spaces.

Many wildlife studies have shown how the relative abundance of fauna species changes with habitat fragment size (e.g. Ambuel and Temple 1983; Lynch and Whigham 1984; Robinson *et al.* 1997) with some species showing a greater abundance in smaller remnants, while others decrease or even disappear from remnants due to habitat fragmentation (Berry, 2001).

"Species can be grouped according to their response to edges. 'Edge' species are those that increase in abundance at habitat edges. Typically, these are habitat generalist or open-country species, and often they are species also found in greater numbers in small habitat remnants. In

contrast, 'interior' species decrease in abundance or are absent from habitat edges; these are typically specialists, have large home ranges, inhabit large forest areas, and are rare or absent from small habitat remnants (Ambuel and Temple 1983; Ford *et al.* 1995; Canady 1997; Luck *et al.* 1999). For example, Catterall *et al.* (1991) found that in forest-suburb boundaries in Brisbane, forest-interior birds were typically smaller and insectivorous, while forest-edge species were usually larger and fed on open ground" (Berry, 2001: 240).

Some of the above and more commonly discussed impacts are summarized below:

Barrier effects "result when severed habitat connections restrict the movement of species (Yahner 1988). Barrier effects can result from relatively small-scale anthropogenic disjunction of habitat and may preclude dispersal or migration and disrupt population processes (e.g. Mansergh and Scotts 1989). The distance over which such effects operate may vary among species. For example, many bird species may be able to readily cross discontinuities in suitable habitat by using small remnants as stepping stones (e.g. Date *et al.* 1991). In contrast, forest-dependent mammals may be reluctant to cross relatively small areas of open habitat (e.g. Burnett 1992)" (Goldingah & Whelan, 1997:24-25)

Genetic isolation may occur when individuals from a previously connected population can no longer interbreed due to the creation of fragments and barrier effects. Such isolation can result in problems associated with inbreeding (and associated loss of genetic diversity and risk of disease, mutation, population crash), divergence and genetic drift.

"Edge effects may occur when a new boundary is established within an existing habitat, producing a change in the remaining habitat (Harris 1984). Abiotic and biotic factors may be responsible for an edge effect (Murcia 1995). Abiotic factors include changes in microclimate such as altered temperature regimes, increased light levels and greater wind speeds (e.g. Scougall *et al.* 1993). Changes in the nutrient status of the soil surrounding an edge may occur when remnant habitat occurs adjacent to agricultural land. Biotic factors include changes in the abundance of animals and plants. These may occur in response to the abiotic factors or because particular species are favoured by the close association of two different habitat types. Edges may promote access by predators to existing habitat, particularly those that favour boundaries between open and remnant habitat (Harris 1988). This may increase the vulnerability of species and lead to a decline in their abundance near the edge (Yahner 1988; Marini *et al.* 1995)" (Goldingah & Whelan, 1997:24)

As discussed in Section 5 above it is considered that the works are of a minor nature in the context of the regional terrestrial corridors. The removal of 1.45ha of vegetation within approved development footprint and minimisation of the construction footprint will ensure

that the existing open forest/woodland remnant will not be fragmented into two smaller remnants.

Additionally, it is considered that the proposal will not introduce a new terrestrial fauna dispersal barrier or intensify an existing barrier. The existing corridor value of the locality is therefore unlikely to be reduced by the road rectification proposal.

7.5 ESTABLISHMENT OF WEEDS

Modification (i.e. clearing, earthworks, creation of new batters) may increase the germination and establishment of exotic floral species if inappropriately managed or an inappropriate planting mix is installed. It is widely accepted that an increase in weed abundance is detrimental to the existing viability of any bushland remnant and has an impact upon flora and fauna assemblages alike.

The degradation of currently utilised habitat as a result of weed invasion and associated poor native species recruitment may reduce the potential use of the habitat by previously occurring fauna. For example weed invasion may reduce potential fauna movement (i.e. thick lantana, blackberry, prickly pear, morning glory). Thickets of herbaceous and woody weeds within the lower strata of a forest may also reduce native recruitment of preferred foraging species or habitat types. Associated tree dieback will also reduce the potential forage base of a forest as well as altering the canopy cover and changing the microclimate of the forest floor. This can lead to the prevalence of weed invasion which, as discussed, can hamper fauna movement and reduce recruitment potential of native trees.

As discussed in this report, weeds are prevalent in several areas, mostly on the fringes. In this regard it is considered suitable that such weeds are treated to reduce further spread and only native species are utilised in stabilisation and revegetation works.

7.6 CHANGES TO WATER QUALITY

The construction phase of the proposal has the potential to impact upon downstream water quality through the generation of pollutants (particularly sediment loads during storm events). Increases in sedimentation and turbidity of proximate waterways may smother benthic fauna and associated habitats as well as increasing levels of nutrients and other toxicants attached to sediment within runoff. In addition to stormwater related runoff impacts accidental spillage/leakage of road construction materials, fuels, lubricants and oils from construction equipment may occur resulting in downstream aquatic impacts.

8.0 MEASURES TO AVOID AND MINIMISE ECOLOGICAL IMPACTS

8.1 PROTECTION & AVOIDANCE

The majority of this area has been previously modified or approved for modification i.e clearing and the new pipeline is to be positioned to avoid impacts to retained vegetation.

As discussed in this report, the proposed works are considered unlikely to significantly impact upon any threatened flora/fauna species or endangered ecological communities occurring elsewhere within the locality.

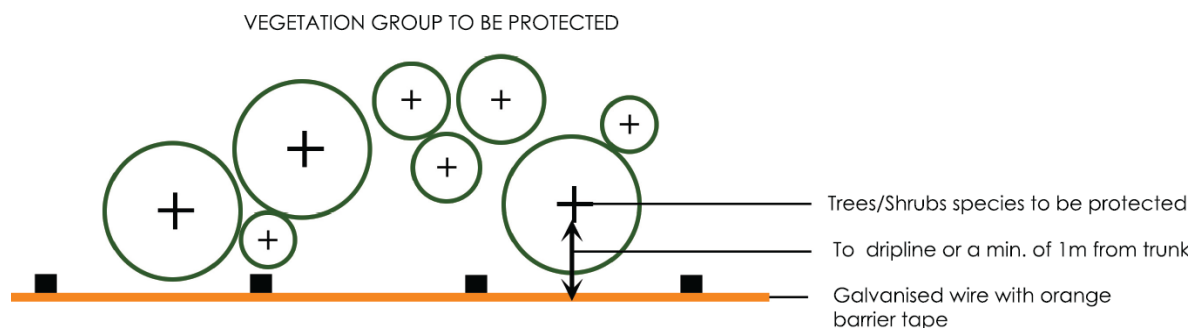
In association with this terrestrial flora and fauna assessment the design has been reviewed and the following important design issues appropriately included with regard to ecological issues:

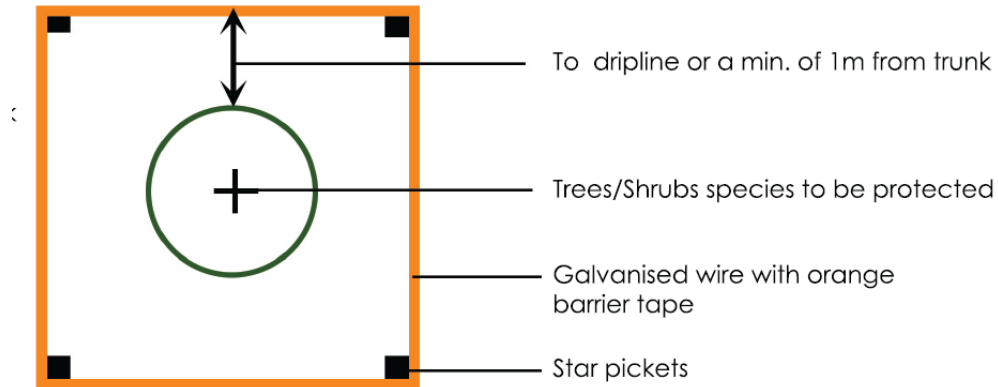
8.2 MITIGATION MEASURES

The following measures are proposed to mitigate impacts associated with the temporary construction access:

8.2.1 IMPACT OF VEGETATION AND HABITAT CLEARING

Disturbance to areas of native and exotic vegetation as described in this report will be unavoidable to deliver WWTP as proposed. To ensure that clearing impacts do not occur outside of the designated construction zone it will be necessary to clearly identify and mark the boundaries the works zones onsite prior to construction. Such boundaries are to be protected via high visibility fencing, sediment fencing and/or signage identifying that no construction activities (including temporary storage, stockpiling, vehicle movement etc) are permitted beyond.





INDIVIDUAL TREE TO BE PROTECTED



Figure 79 - Examples of Vegetation Protection Fencing

Additionally where works are required amongst retained vegetation (i.e. for cut off/table drains) machinery and equipment will approach from the the existing roadway to minimise damage to habitat. Similarly the following activities should not be conducted in areas of habitat retention:

- Storage and mixing of materials;
- Vehicle parking or maneuvering;

- Liquids disposal;
- Machinery repairs or refuelling;
- Site office and/or shed erection;
- Lighting of fires;
- Rubble, soil or debris stockpiling; and
- Excavation.

Within the designated development/construction zone identification of areas to be cleared are to be pre-assessed by an experienced ecologist/wildlife spotter/catcher. This pre-assessment shall allow for an inventory of fauna habitat components (i.e. birds nests, loose rocks providing reptile refuge, ground logs etc) to be undertaken prior to felling and construction works. A wildlife spotter catcher is to be utilized during all phases of clearing of the site to ensure safe dispersal and relocation of native fauna.

Cleared vegetation is to be disposed of/recycled in accordance with accepted measures including:

- All felled trunks from large trees and existing large logs within the clearance zone are to be moved into adjacent areas where they will provide future fauna habitat
- All non-suitable timber is sheered and mulched for reuse within the site by contractors. Mulch produced onsite must be appropriately treated and composted for use in revegetation areas
- Reduction of wastes are maximised by doing large scale felling to ensure all removed vegetation is contained and mulched.
- Soils are screened from the mulch piles and utilised for top soil in revegetation works where necessary

Attachment 6 provides a VMP for the site works. It is acknowledged separate scheduled flora management plans exist and these are also to be implemented.

8.2.2 WEED MANAGEMENT

It is recommended that treatment of weeds within the site be undertaken.

Control techniques will vary depending upon the species being targeted and its location. In areas of low significance (i.e. weed thickets external to bushland or drainage lines etc) broad scale application of herbicide or mechanical removal will be appropriate. Within the proximity

to areas of native floral species dominance more selective removal techniques (i.e. cut stump, stem application, hand removal etc) and spot application of a non-residual herbicide (i.e. roundup bioactive) would be necessary.

PHYTOPHTHORA PROTOCOL

Phytophthora is a microscopic soil borne organism which causes environmental damage in natural ecosystems including root rot of a wide variety of native plant species. Where there is a risk of *Phytophthora*, contractors/landscapers must follow hygiene related processes with equipment prior to entering the rehabilitation zone including:

- Cleaning off all dirt from boots on arrival and departure from site;
- Disinfect boots with mentholated spirits;
- Scrub boot with stiff brush and follow similar principle for tools
- Use of Mentholated spirits in spray bottle for secateurs, loppers, knives, etc.
- Plants identified to be infected by *Phytophthora* should be treated with a fungicide containing potassium phosphonate in accordance with best practice guidelines

MYRTLE RUST PROTOCOL

Myrtle Rust (*Uredo rangelii*) is a newly described fungus that is closely related to the [Eucalyptus/Guava rusts](#). It infects leaves of susceptible plants producing spore-filled lesions on young actively growing leaves, shoots, flower buds and fruits. Leaves may become buckled or twisted and may die as a result of infection. In association with revegetation on site all nursery stock introduced to the property must come only from plant nurseries following the hygiene protocols as set out within the Nursery Industry Myrtle Rust Management Plan-2011 for the prevention of spread of this fungus.

In addition to the above protocols a general weed propagule protocol should also be applied whereby vehicles and machinery is checked for vegetative material (particularly in tyres or chassis) prior to entry to the site. An exit inspection should also be undertaken to ensure material is not removed from the site to an external bushland location.

8.2.3 PEST ANIMAL MANAGEMENT

No specific pest animal management initiatives are recommended in association with the project as the works are unlikely to increase the current abundance or extent of the likely occurring pest animals (feral cat, wild dog) within the locality.

8.2.4 MANAGEMENT OF CONSTRUCTION PHASE WATER QUALITY IMPACTS

Management protocols shall be developed for the construction phases of the project to minimise potential for offsite water quality deterioration. Such protocols shall include sediment/erosion control devices to ensure all stormwater is treated to appropriate standards prior to discharge to the downstream receiving environments of Lake Macquarie or the Pacific Ocean. It should also identify measures relating to storage and repair of vehicles, machinery, refuelling, equipment and chemicals including protocols for bunding and emergency clean-up procedures.

8.3 ENHANCEMENT MEASURES

Limited post construction habitat enhancement and revegetation potential exists due to the nature of the proposal. Such would be limited to management of existing weeds and ensuring revegetation works on batters incorporates native floral species.

9.0 SUMMARY & CONCLUSIONS

Planit Consulting have been engaged by Solo Water to undertake a flora and fauna assessment for a proposed Waste Water Treatment Plant Network. The WWTPN is to service an approved residential development at Catherine Hill Bay. The WWTPN comprises 3 elements and this report addresses the Water Watere treatment Plant (WWTP).

The proposed WWTP is approximately 1.45ha is area and is located within the footprint of the approved residential estate.

The assessment has included the following:

- Desktop review of previous available ecological surveys within the locality and several databases regarding species and vegetation community occurrence;
- Survey, ground truthing and mapping of vegetation communities and determining conservation status reflective of reference reports and onsite condition;
- Targeted survey for threatened flora species within the site footprint;
- Survey for faunal species including assessments of the site's habitat value for threatened species over a number of seasons;
- Providing a flora and fauna site assessment report identifying constraints, impacts and mitigation methods for proposed activities;
- Addressing statutory requirements including Section 5A of the Environmental Planning and Assessment Act and SEPP 44-Koala Habitat Protection

The proposal will require removal of 1.45ha vegetation for the WWTP. The clearance zone includes 4 separate veegtaion communities with the Narrabeen Doyalson Coastal Woodland being the dominate community. Site investigations did not idenitify any habitat/hollow bearing trees within the proposed clearance zone. Two scheduled flora species have been recorded from within the development footprint. A managment plan for there removal in association with the clearing for the approved residential development will be implemented for works associated with the WWTP.

As discussed within this report the removal of the vegetation is not considered to be a significant impact to the terrestrial flora, communities and corridors in the locality.

The fauna survey conducted over 3 separate trapping investigation periods of the WWTPN area resulted in the recording of 68 species of bird, 13 reptiles, 7 amphibians and 31 mammals (or evidence of their previous presence). Of these species five (Little Bentwing Bat, Eastern Freetail Bat, Eastern Bentwing-bat Grey Headed Flying Fox, Squirrel Glider) are listed as vulnerable within the *Threatened Species Conservation Act 1995*.

A Section 5A of the *Environmental Planning and Assessment Act 1979* (the '7-Part Test of Significance') was conducted for the five recorded species. The assessment concludes that the impacts of the proposed development are unlikely to threaten the viability of any local populations of the nominated species. A species impact is therefore not required.

A SEPP 44 assessment was also conducted which concludes that the site does not contain core koala habitat. A Koala Management Plan is therefore not required.

Whilst the proposal is considered unlikely to significantly affect native flora, fauna or associated habitat it will result in the minor loss of local habitat for native species through tree removal/vegetation removal. In this regard recommendations have been included in this report regarding the management of works to minimize disruption to native fauna, minimize damage to retained vegetation and local weed management and better revegetation to compensate for minor habitat losses.

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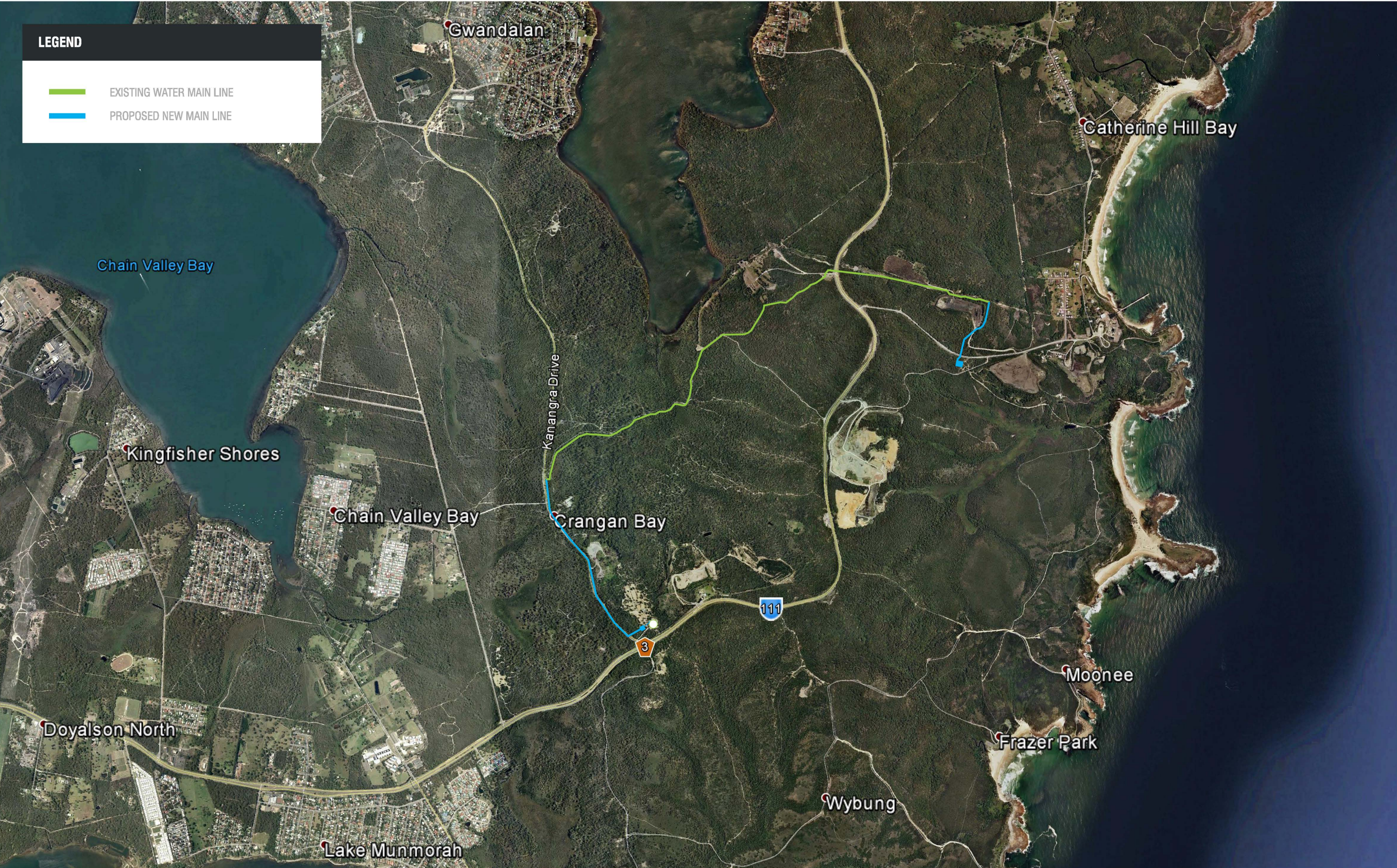
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ATTACHMENT 1

Locality Plan



SOLO WATER CATHERINE HILL BAY WATER UTILITY

PIPELINE LOCALITY PLAN

DRAWN: ZP
DATE: 12/13
REV: 00

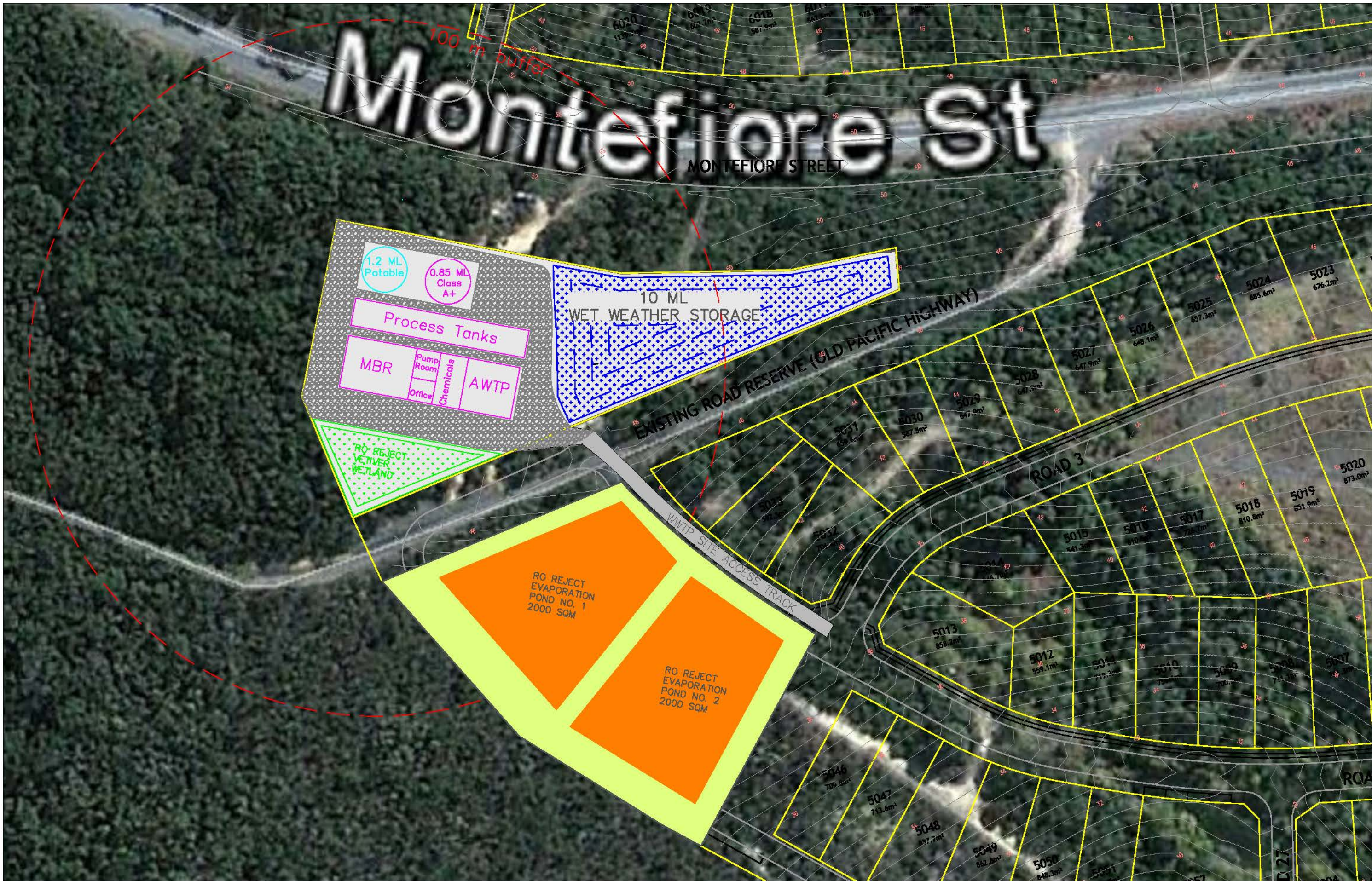
SCALE: NTS
CHECKED: BS
DRAW NO.: CHB_LOCALPLN_01

Level 1 2247 Gold Coast Hwy
Nobby Beach
PO Box 206 Nobby Beach QLD 4218
Telephone: 07 5526 1500
Fax: 07 5526 1502
admin@planitconsulting.com.au



ATTACHMENT 2

Layout Plans



ISSUE	DATE	ISSUE DETAILS
C	10/7/13	ADJUSTED RO REJECT POND & ADDED WWTP SITE ACCESS TRACK
B	15/8/13	ADJUSTED RO REJECT POND
A	30/3/13	WWTP LAYOUT FOR IPART APPLICATION

harvest
water management consultants pty ltd

184 Rivergum Drive
Burpengary, Qld 4505
0488 427 878
office@harvestwmc.com.au
www.harvestwmc.com.au
ABN: 54140 844 047

CLIENT
SOLO WATER – CATHERINE HILL BAY WATER UTILITY

PROJECT
**CATHERINE HILL BAY
RESIDENTIAL SUBDIVISION
ROSE GROUP**



LOCATION
**MONTEFIORE ROAD
CATHERINE HILL BAY
NSW**

DESIGN
BY
BRADLEY IRWIN NPES (10837) OPEN NPES
Environmental Engineer

DATE
2013

PROJECT TITLE
WASTEWATER TREATMENT PLANT SITE LAYOUT

SCALE
1:1000 at A3

DATE TYPE
CONCEPT ONLY NOT
FOR CONSTRUCTION

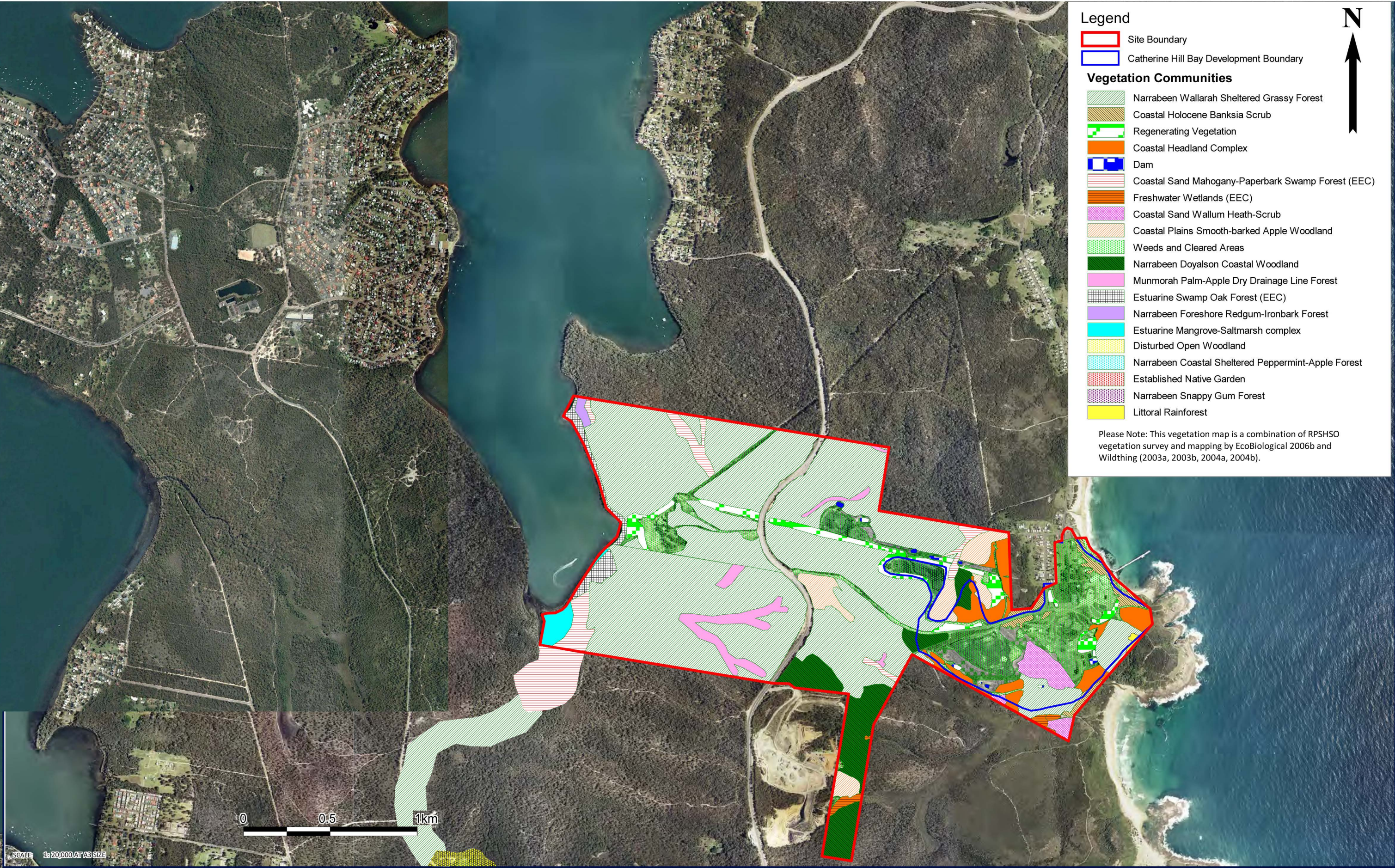
PROJECT NO.
H10052

DWG NO.
P10

SCALE
C

ATTACHMENT 3

Vegetation Mapping



SOLO WATER CATHERINE HILL BAY WATER UTILITY
VEGETATION MAPPING

DRAWN: ZP
DATE: 12/13
REV: 00

SCALE: NTS
CHECKED: BS
DRAW NO.: CHB_VEG_01

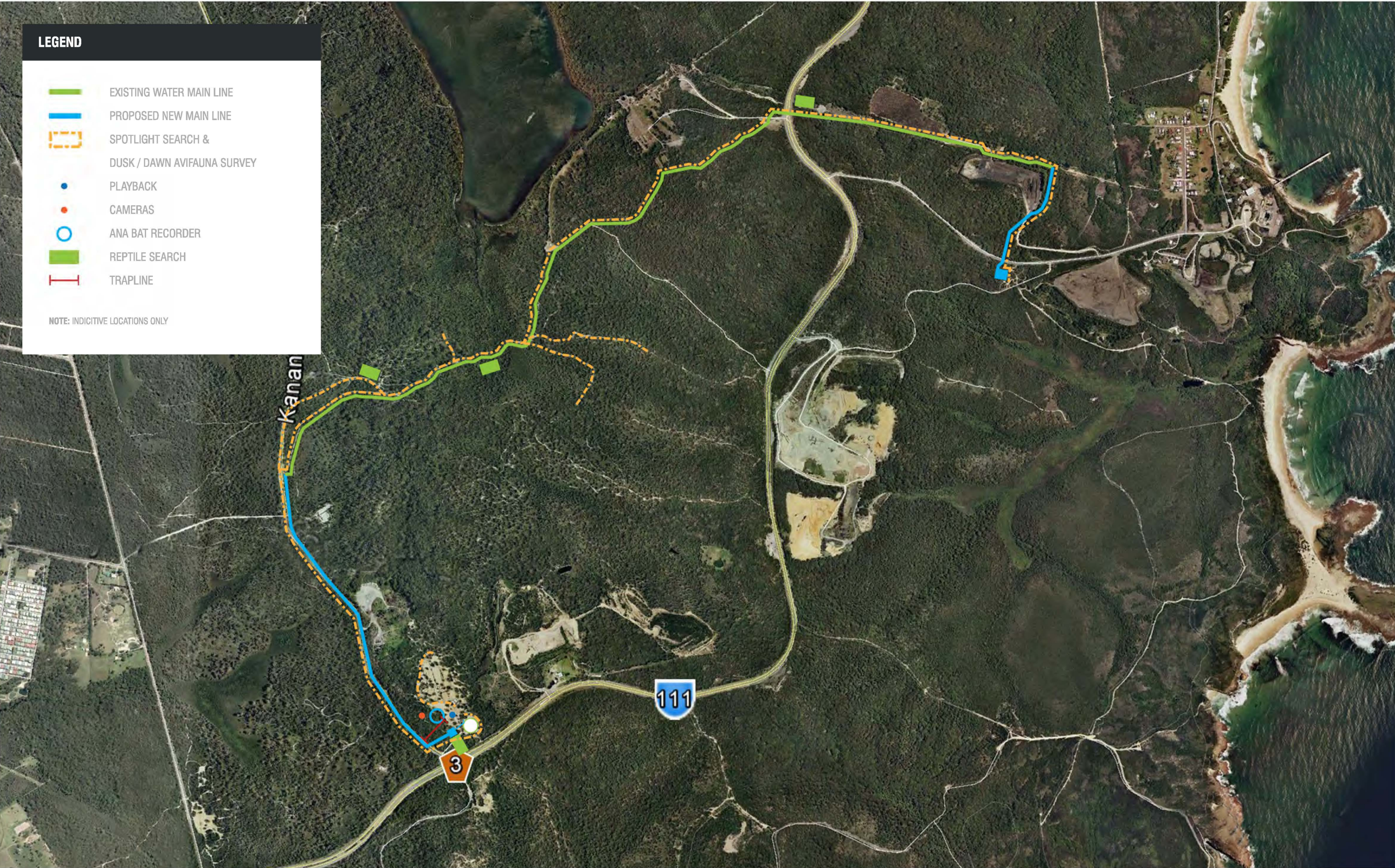
Level 1 2247 Gold Coast Hwy
Nobby Beach
PO Box 206 Nobby Beach QLD 4218

Telephone: 07 5526 1500
Fax: 07 5526 1502
admin@planitconsulting.com.au



ATTACHMENT 4

Fauna Survey Technique and Location Maps



SOLO WATER CATHERINE HILL BAY WATER UTILITY

FAUNA SURVEY TECHNIQUE LOCATIONS - OVERALL

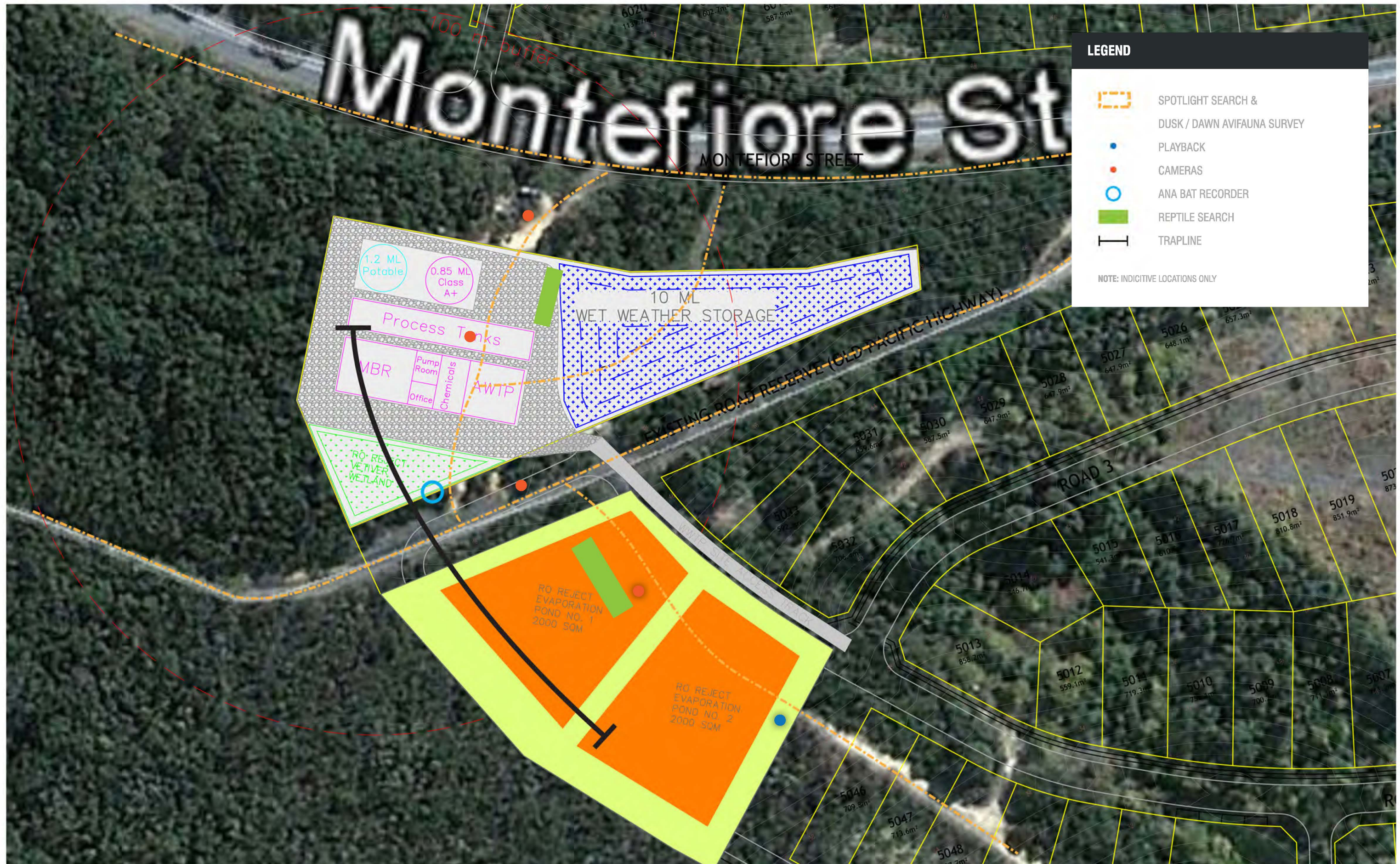
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REV: 00

SCALE: NTS
CHECKED: BS
DRAW NO.: CHB_FAUNA_01

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Nobby Beach
PO Box 206 Nobby Beach QLD 4218

Telephone: 07 5526 1500
Fax: 07 5526 1502
admin@planitconsulting.com.au





SOLO WATER CATHERINE HILL BAY WATER UTILITY

FAUNA SURVEY TECHNIQUE LOCATIONS - TREATMENT PLANT

DRAWN: ZP
DATE: 12/13
REV: 00

SCALE: NTS
CHECKED: BS
DRAW NO.: CHB_FAUNA_02

Level 1 2247 Gold Coast Hwy
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PO Box 206 Nobby Beach QLD 4218

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ATTACHMENT 5

NSW BioNet Search Area Results



Environment
& Heritage



the website for the Atlas of NSW Wildlife

- [HOME](#)
- [ATLAS SEARCH](#)
- [VIS FLORA SURVEY](#)

You are here: [Home](#) > Atlas search results

Search results

Which species or group?

☒ All entities ☐ Animals ☐ Plants ☐ Fungi ☐ Communities ☐ Threats ☐ Endangered populations

Search for a species or group of species (e.g. birds)

Search for term

Enter at least 3 le

Term selected:

[Submit](#)

[Submit](#)

[Submit](#)

[Download records](#)

[Save species list](#)

[View map](#)














Search criteria: Public Report of all Valid Records of Threatened (listed on TSC Act 1995) Entities in selected area [North: -33.1 West: 151.56 East: 151.66 South: -33.2] returned a total of 1,000 records of 48 species.
Report generated on 7/11/2013 11:21 AM.

Displaying 1-48 of 48 species below

To **map records for individual species**, select up to 5 species then click "view map".
To **map all records**, click on "view map" (without selecting any species first).



	Common name	Scientific name	Map [Clear all]	NSW status	Comm. status	No. of records	
Animalia Amphibia Myobatrachidae	Wallum Froglet	Crinia tinnula		V,P		33	
Hylidae	Green and Golden Bell Frog	Litoria aurea		E1,P	V	1	
Reptilia Cheloniidae	Loggerhead Turtle	Caretta caretta		E1,P	E	1	
	Green Turtle	Chelonia mydas		V,P	V	9	
Aves Columbidae	Rose-crowned Fruit-Dove	Ptilinopus regina		V,P		1	
Diomedei dae	Black-browed Albatross	Thalassarche melanophris		V,P	V	1	
Procellari dae	Southern Giant Petrel	Macronectes giganteus		E1,P	E	2	
	Little Shearwater	Puffinus assimilis		V,P		1	
Ardeidae	Black Bittern	Ixobrychus flavicollis		V,P		1	
Accipitrid ae	Eastern Osprey	^Pandion cristatus		V,P,3		5	
Haematop odidae	Sooty Oystercatcher	Haematopus fuliginosus		V,P		8	
	Pied Oystercatcher	Haematopus longirostris		E1,P		1	
Charadriid ae	Lesser Sand-plover	Charadrius mongolus		V,P	C,J,K	1	
Laridae	Little Tern	Sternula albifrons		E1,P	C,J,K	1	
Cacatuida e	Glossy Black-Cockatoo	^Calyptorhynchus lathami		V,P,2		13	
Psittacida e	Little Lorikeet	Glossopsitta pusilla		V,P		5	
	Swift Parrot	^Lathamus discolor		E1,P,3	E	5	
Strigidae	Powerful Owl	^Ninox strenua		V,P,3		19	
Tytonidae	Masked Owl	^Tyto novaehollandiae		V,P,3		6	
Meliphagi dae	White-fronted Chat	Epthianura albifrons		V,P		1	

Pomatostomidae	Grey-crowned Babbler (eastern subspecies)	Pomatostomus temporalis temporalis		V,P		1	
Neosittidae	Varied Sittella	Daphoenositta chrysoptera		V,P		4	
Mammalia Dasyuridae	Spotted-tailed Quoll	Dasyurus maculatus		V,P	E	1	
Phascolarctidae	Koala	Phascolarctos cinereus		V,P	V	7	
Burramyidae	Eastern Pygmy-possum	Cercartetus nanus		V,P		1	
Petauridae	Squirrel Glider	Petaurus norfolcensis		V,P		18	
Pteropodidae	Grey-headed Flying-fox	Pteropus poliocephalus		V,P	V	10	
Molossidae	Eastern Freetail-bat	Mormopterus norfolkensis		V,P		3	
Vespertilionidae	Little Bentwing-bat	Miniopterus australis		V,P		19	
	Eastern Bentwing-bat	Miniopterus schreibersii oceanensis		V,P		7	
	Southern Myotis	Myotis macropus		V,P		3	
	Greater Broad-nosed Bat	Scoteanax rueppellii		V,P		2	
Balaenidae	Southern Right Whale	Eubalaena australis		E1,P	E	5	
Balaenopteridae	Humpback Whale	Megaptera novaeangliae		V,P	V	2	
Physeteridae	Sperm Whale	Physeter macrocephalus		V,P		1	
Plantae Flora Asteraceae	Heath Wrinklewort	Rutidosia heterogama		V,P	V	90	
Elaeocarpaceae	Black-eyed Susan	Tetratheca juncea		V,P	V	639	
Fabaceae (Faboideae)	Coast Headland Pea	Pultenaea maritima		V,P		6	
Myrtaceae	Charmhaven Apple	Angophora inopina		V,P	V	18	
	Netted Bottle Brush	Callistemon linearifolius		V,P,3		10	
	Camfield's Stringybark	Eucalyptus camfieldii		V,P	V	3	
		Eucalyptus parramattensis subsp. decadens		V,P	V	3	

	Eucalyptus parramattensis C. Hall. subsp. parramattensis in Wyong and Lake Macquarie local government areas	Eucalyptus parramattensis subsp. parramattensis		E2		1	
	Magenta Lilly Pilly	Syzygium paniculatum		E1,P	V	4	
ae	Orchidaceae Thick Lip Spider Orchid	^Caladenia tessellata		E1,P,2	V	4	
	Leafless Tongue Orchid	^Cryptostylis hunteriana		V,P,2	V	4	
	Rough Doubletail	^Diuris praecox		V,P,2	V	17	
	Variable Midge Orchid	^Genoplesium insignis		E1,P,2		2	

Close

Commonwealth status

C Listed on China Australia Migratory Bird Agreement

CD Conservation Dependent (Commonwealth EPBC Act 1999)

CE Critically Endangered (Commonwealth EPBC Act 1999)

E Endangered (Commonwealth EPBC Act 1999)

J Listed on Japan Australia Migratory Bird Agreement

K Listed on Republic of Korea Australia Migratory Bird Agreement

KTP Key Threatening Process (Commonwealth EPBC Act 1999)

V Vulnerable (Commonwealth EPBC Act 1999)

X Extinct (Commonwealth EPBC Act 1999)

XW Extinct in the Wild (Commonwealth EPBC Act 1999)

Close

Save species list

DISCLAIMER

By clicking on the button you accept that data in the Atlas come from a number of different sources and are only indicative; the data cannot be considered a comprehensive inventory and may contain errors and omissions.

Download now ▼

Submit

Submit

Submit

Close

Mapping help

To map records for individual species, select up to 5 species then click "view map". Clicking on "view map", without first making any species selection, will return a map of all records without distinguishing species (although you can use the "identify" mapping tool to query individual records). Please note that there is a mapping limit of 200,000 records.

Trouble shooting

When you click "view map", a new screen should open and display your map. The most common mapping issues are:

- **Nothing happens** when you click 'View map':
 - The usual reason is that **pop-ups are blocked**. See your browser's Help menu for information on how to turn your pop-up blocker off.
 - With some computer set-ups, the mapping browser may not be given priority and you will need to click on it yourself in order to see the map.
 - Try holding down control (ctrl) and clicking 'View map'.
- **An inactive grey or white screen** appears when you click 'View map':
 - The commonest reason is that Adobe Flash is not installed, or your version of Flash is out of date. The latest version of Adobe Flash can be downloaded at <http://get.adobe.com/flashplayer/>. If this doesn't resolve the problem, you can try:
 - closing the map and clicking 'View map' again;
 - deleting all cookies and browsing history and then re-running your search. See your browser's Help menu for information on how to clear your internet history and cookies.

If you are still encountering problems, please send an email to Atlas@environment.nsw.gov.au outlining the problem, your search parameters, and details of your operating system and browser.

Submit

Submit

Submit

Submit

Submit

Submit

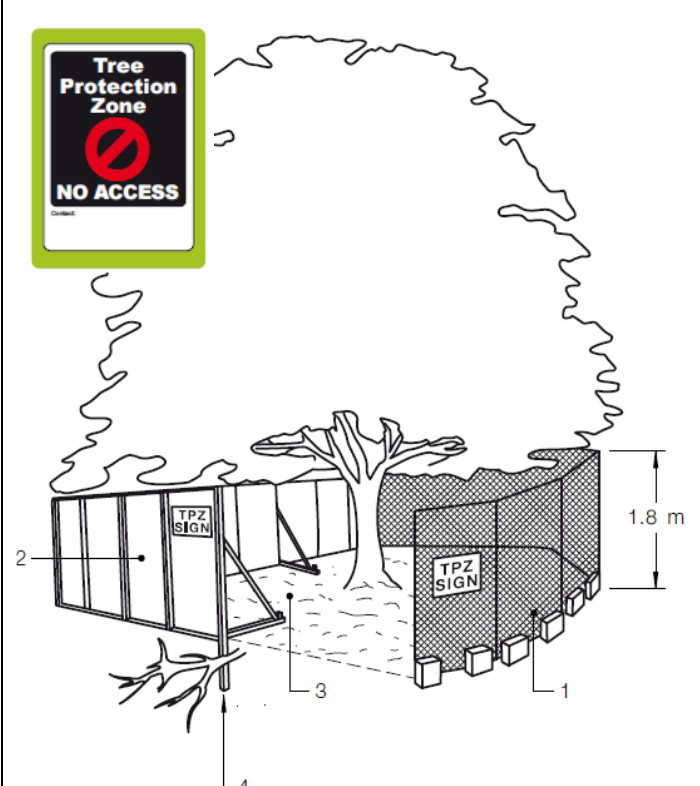


ATTACHMENT 6

Vegetation Management Plan

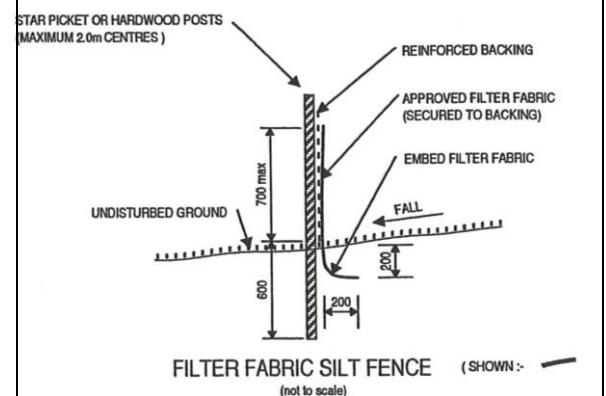
This Vegetation Management Plan (VMP) has been prepared for both the clearing of development envelope and the retention and protection of identified trees located within 'vegetation retention zones' where earthworks are not required to facilitate construction / pipe installation /batters and/or civil infrastructure. The VMP is to be used as a tool during the construction of the development, identifying tasks to be undertaken, the timing of such works and responsible parties for the supervision/implementation of vegetation removal/retention on the site.

Areas where vegetation is proposed to be removed to facilitate earthworks and civil works is displayed within Attachment 2 with the relevant engineering plans to be further developed and appended to this document. This plan identifies appropriate vegetation protection methods also addresses the necessary removal of vegetation as described above. Strict implementation of the following methodologies is necessary to ensure vegetation not approved for removal is not damaged during construction works.

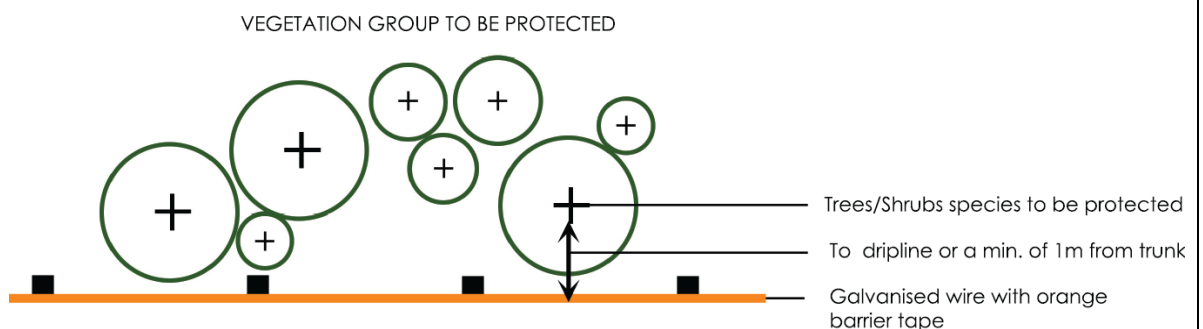
Element	Vegetation Management
Objectives	<ul style="list-style-type: none"> To remove protected vegetation located within the identified clearing zones (Attachment 2) To retain and protect native trees external to the identified clearing zones To address and minimise potential fauna mortality associated with tree clearing as part of the construction process. To reduce impacts from dust and erosion associated with tree-clearing and construction works.
Action	<ul style="list-style-type: none"> Tree-retention zones are to be clearly delineated on-site to ensure that all areas affected by this VMP are readily identifiable. Vegetation to be retained onsite must be tagged/marked/delineated prior to commencement of tree clearing for easy identification (do not use permanent paints or similar) i.e. trees and copses of less mature vegetation/small trees will be retained within designated areas are to be clearly fenced according to the Australian Standard 4970 Protection of trees on development sites, similar to the below: <div data-bbox="316 1160 1505 1957">  <p>LEGEND:</p> <p>1 Chain wire mesh panels with shade cloth (if required) attached, held in place with concrete feet.</p> <p>2 Alternative plywood or wooden paling fence panels. This fencing material also prevents building materials or soil entering the Tree Protection Zone (TPZ).</p> <p>3 Mulch installation across surface of TPZ (at the discretion of the project arborist). No excavation, construction activity, grade changes, surface treatment or storage of materials of any kind is permitted within the TPZ.</p> <p>4 Bracing is permissible within the TPZ. Installation of supports should avoid damaging roots.</p> </div>
Action	

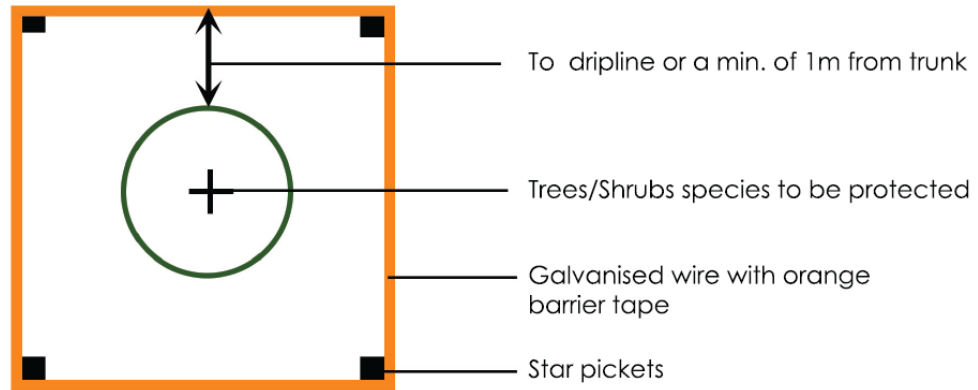


- During construction areas with batters adjacent to vegetation retention zones (including stormwater basins) are also to incorporate sedimentation fencing:



- Vegetation where the drip line of a tree or group of trees (including saplings and regrowth) is located >5m from the extent of earthworks may be fenced using orange construction barrier tape.





INDIVIDUAL TREE TO BE PROTECTED



- The existing trees to be retained will be managed during construction activities and through the establishment and maintenance periods in accordance with the approved Vegetation Management plan and Australian Standard AS 4970 Protection of trees on development sites to avoid any of the following:
 - Structural damage to the tree including root damage;
 - Compaction of the root plate including parking of any vehicles;
 - Filling of soil within the tree protection zone (tpz) and/or drip zone; and
 - Storage of any building materials within the drip zone;
 - Long-term harm to the health of the tree.
- The project superintendent must adequately protect from damage any vegetation on private and/or public property which is not designated for removal in association with this development.
- Hygiene management is to be applied to all stages of the development (pre-construction, construction and occupation). This requires that prior to entering the construction site all tools, equipment, vehicles and all landscape materials (including but not limited to, soils, mulch, gravel and potted or ex-ground plants) are to be cleaned free of Nut Grass propagules *Cyperus esculentus* and *Cyperus rotundus*.

Action

- Any existing Nut Grass present on site is fully controlled and shows no signs of active growth prior to the acceptance by Council of the commencement of the 'On Maintenance' period.
- All landscape materials including but not limited to soils, mulch, gravel, potted or ex-ground plants, pavers, timber etc. to be used in landscape treatments on this site are to be free of 'Fire Ants' and Fire Ant eggs.
- All landscape material being sourced from areas currently identified as potential Fire Ant risk areas must be checked by a suitably qualified professional and certified that:
 - No risk of transportation of Fire Ants exists; and
 - That all materials are free from Fire Ant contamination.
- All contractors working on the site are to be informed of all provisions specified under this VMP.
- All 'vegetation retention zones' are to be appropriately protected by sediment erosion controls and detail is to be reflected within future operational works development applications and within/on any revised sediment and erosion control plans submitted to council for approval.
- Cleared vegetation is to be disposed of in accordance with accepted measures including:
 - All felled trees are sorted for millable timber. Millable timber is sold for use as usable timber/fencing etc.
 - All non suitable timber is sheered and mulched for reuse within the site by contractors. Mulch produced onsite must be appropriately treated and composted for a minimum period of 6 weeks prior to use in revegetation areas or other areas of public open space.
 - Reduction of wastes are maximised by doing large scale felling to ensure all removed vegetation is contained and mulched.
 - Soils are screened from the mulch piles and utilised for top soil.
- Remaining debris not disposed of in either of the above methods is to be removed off-site by the owner to an approved green-waste disposal facility.
- To be removed hollow-bearing trees are to be dismantled by a QPWS-recognised fauna spotter-catcher and limbs dispersed within retained vegetation zones
- The following activities are not permitted within the drip zones of trees to be retained (i.e. trees not designated for removal):
 - Storage and mixing of materials;
 - Vehicle parking or manoeuvring;
 - Liquids disposal;
 - Machinery repairs or refuelling;
 - Site office and/or shed erection;
 - Lighting of fires;
 - Rubble, soil or debris stockpiling; and
 - Excavation.
- If root/crown damage (or other significant disturbance) to retained trees occurs/is required during approved clearing/construction works on the site, works are to cease and treatment by a suitably qualified Arborist (i.e. root truncations, crown thinning) is to be implemented.
- Any retained trees with deadwood overhanging road reserve or public open space that may constitute a hazard to members of the public as determined by a qualified Arborist will be pruned in accordance with AS 4373 - 1996 Pruning of Amenity Trees.
- A fauna spotter-catcher is to ensure safe dispersal of fauna into areas of retained vegetation during clearing works
- Effective sediment and erosion control devices are to be identified and provided at in association with clearing and construction works.
- Site access locations will be located external to vegetation retention zones.

Performance Indicators	<ul style="list-style-type: none">Tree-clearing activities are restricted to identified areas.Construction fencing and sediment/erosion control devices are installed and maintained at all times in accordance with an approved erosion/sediment control planA fauna spotter catcher is present during all clearing works and all encountered fauna are safely dispersed with no injury sustained. All works to proceed in accordance with a pre-clearing fauna assessment and management plan.Retained vegetation is to demonstrate healthy conditions:<table><tr><th>Grade</th><th>Condition</th><th>Descriptor</th></tr><tr><td>1</td><td>Healthy</td><td>Leaves green, no abnormal leaf loss</td></tr><tr><td>2</td><td>Fair</td><td>Leaves green, some yellowing of leaves, but <20% of canopy affected</td></tr><tr><td>3</td><td>Poor</td><td>Many leaves yellow or brown, substantial reduction in canopy extent since last measurement</td></tr><tr><td>4</td><td>Dead</td><td>Leaves brown or absent, little of the canopy remaining</td></tr></table>	Grade	Condition	Descriptor	1	Healthy	Leaves green, no abnormal leaf loss	2	Fair	Leaves green, some yellowing of leaves, but <20% of canopy affected	3	Poor	Many leaves yellow or brown, substantial reduction in canopy extent since last measurement	4	Dead	Leaves brown or absent, little of the canopy remaining
Grade	Condition	Descriptor														
1	Healthy	Leaves green, no abnormal leaf loss														
2	Fair	Leaves green, some yellowing of leaves, but <20% of canopy affected														
3	Poor	Many leaves yellow or brown, substantial reduction in canopy extent since last measurement														
4	Dead	Leaves brown or absent, little of the canopy remaining														
Frequency/Deadline	<ul style="list-style-type: none">Identification of retained vegetation prior to commencement of clearing works.Construction/tree protection fencing is to be installed prior to commencement of any site works.Implement tree clearing works upon receipt of tree clearing approval - completion within 12 months.QPWS-recognised fauna spotter-catcher to be present on-site prior to and during all vegetation-clearing works.All sediment/erosion control devices installed prior to construction works commencing															
Person Responsible	<ul style="list-style-type: none">The Project Superintendent is responsible for informing all contractors, sub-contractors, consultants and government authorities working on the site of the provisions of this VMP.A fauna spotter-catcher is to be contracted for fauna capture/relocation as necessary.A suitably qualified Arborist is responsible for assessing and implementing any remediation works to damaged vegetation retained within protection zones areas if/where required.A suitably qualified consultant is responsible for installing and monitoring erosion and sediment control devices.															
Reporting and Reviewing	<ul style="list-style-type: none">The project superintendent is responsible for reporting to Council where actions specified in this VMP are not undertaken and/or compromised.The project superintendent is responsible for commissioning all consultants necessary for implementing this VMP (i.e. clearing contractors, arborist, wildlife spotter catchers etc).A licenced Wildlife Spotter Catcher is responsible for all fauna capture/dispersal worksThe owner/project superintendent is responsible for the implementation of this VMPIf damage or tree works is required to ensure the protection of adjacent vegetation, landowners consent may be required. Furthermore, if the land in which tree works are required is owned by the State, the applicant is to apply to Office of Environment and Heritage for approval prior to Council granting the clearing.															
Corrective	<ul style="list-style-type: none">If vegetation not identified for removal is disturbed during clearing or building works, the need for supplementary rehabilitation works is to be negotiated between the project superintendent															

Action	<p>and Lake Macquarie City Council.</p> <ul style="list-style-type: none"> • If retained trees show signs of ill health (i.e. poor or dead), likely causes are to be determined, methods of mitigating such effects are to be identified in consultation with a suitably qualified Arborist and Council officers, and mitigation measures to improve growth conditions are to be put in place. • All works required at the interface of the 'vegetation retention zone' and earthworks where any encroachment is necessary into the drip zone of a retained tree shall incorporate preventative and remedial actions according to the Australian Standard AS 4970 Protection of Trees on development sites. These include: <ul style="list-style-type: none"> ○ Arborist must be present on site during tree civil earthworks at the interface of retained vegetation. ○ The area lost to this encroachment should be compensated for elsewhere and contiguous with the TPZ ○ If approved batters are encroaching a TPZ than sediment fencing is required at the interface ○ Where roots within the TPZ are exposed by excavation, temporary root protection should be installed to prevent them drying out. This may include mulch, jute mesh or hessian sheeting as multiple layers over exposed roots and excavated soil profile, extending to the full depth of the root zone. Root protection sheeting should be pegged in place and kept moist during the period that the root zone is exposed ○ If the grade is to be raised the material should be coarser or more porous than the underlying material. Depth and compaction should be minimized ○ Where the project arborist identifies roots to be pruned within or at the outer edge of the TPZ, they should be pruned with a final cut to undamaged wood. Pruning cuts should be made with sharp tools such as secateurs, pruners, handsaws or chainsaws. Pruning wounds should not be treated with dressings or paints. It is not acceptable for roots within the TPZ to be 'pruned' with machinery such as backhoes or excavators. ○ If root zones are overlapping the opinion of a suitably qualified Arborist shall be sought regarding as to what remedial action is required • Where a tree shows signs of any loss in structural integrity or a potentially unsafe condition, then in the opinion of a suitably qualified Arborist and Council officers the tree shall be either stabilised or removed to avoid any future danger/risk. • Where sediment and erosion control structures fail, likely causes are to be identified and additional measures installed.
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