Narrabeen Lagoon Multi Use Trail – Stage 3: Review of Environmental Factors

DRAFT REPORT

Prepared for Thompson Berrill Landscape Design for Northern Beaches Council

14 November 2017

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1 Introduction

1.1 Background

This Review of Environmental Factors (REF) assesses the potential environmental impacts of the proposed Stage 3 trail works along the Narrabeen Lagoon Multi-Use Trail (NLMUT) in Narrabeen, NSW (study area). The environmental assessment of the proposed works has been undertaken in accordance with Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and Clause 228 of the *Environmental Planning and Assessment Regulation 2000* (EP&A Reg). The REF has been prepared by Biosis Pty Ltd on behalf of Thompson Berrill Landscape Design Pty Ltd and Northern Beaches Council.

1.2 Existing and surrounding environment

The proposed Stage 3 trail works are located on the banks of Narrabeen Lagoon, which is situated between Bilarong Reserve to the east and Deep Creek Reserve to the west (Figure 1). Narrabeen Lagoon is located within the Northern Beaches Council local government area. The Warringah and Pittwater Councils established a continuous link around Narrabeen Lagoon through the construction of a multi-use trail. Northern Beaches Council is now proposing to provide a safer route for all trail users and to improve recreational assets for the public, and protect biodiversity within and adjacent to the lagoon (TBLD 2017).

Land surrounding the study area consists mostly of foreshore and bushland reserves to the north, south and west of Wakehust Parkway and the NLMUT. Residential development exists beyond the bushland reserves. The study area has been subject to minor disturbances including the construction of the existing trail, as well as the construction of drainage associated with Wakehurst Parkway to the north of the study area.

The terrestrial vegetation within the study area comprises Estuarine Swamp Oak Forest, which is equivalent to the Swamp Oak Floodplain Forest endangered ecological community listed under the *Biodiversity Conservation Act 2016* (BC Act) (Biosis 2017a). There is a loose transition from the Swamp Oak Floodplain Forest through Saltmarsh to fringing Reed Swamp communities. There are scattered seagrass patches offshore from the study area foreshore with many of the patches smothered by algae. There is also a very large area of seagrass wrack (accumulations of sloughed off seagrass blades and other organic debris) overlaying the inshore shallows and in most cases smothering the seabed (MPR 2017).The study area also supports approximately 0.21 hectares of vegetation providing suitable habitat for a range of fauna (Biosis 2017a). Plates 1and 2 provide an example of the surrounding environment of the Stage 3 section of the NLMUT.

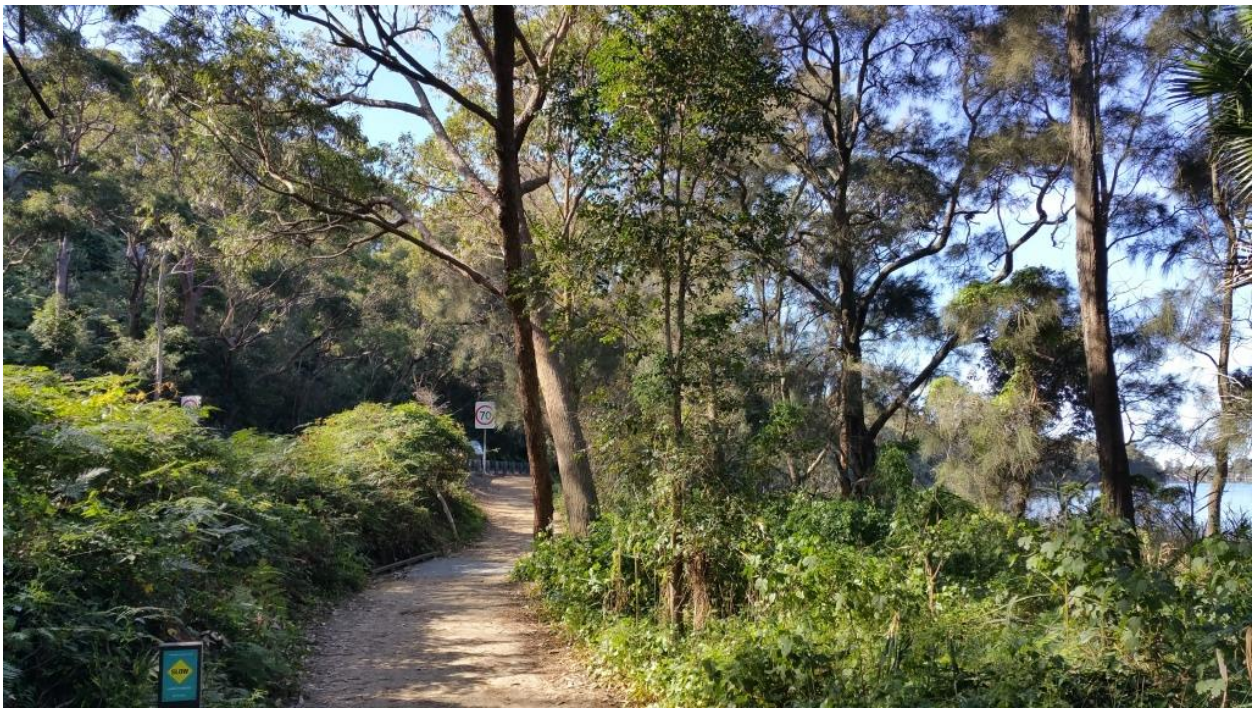
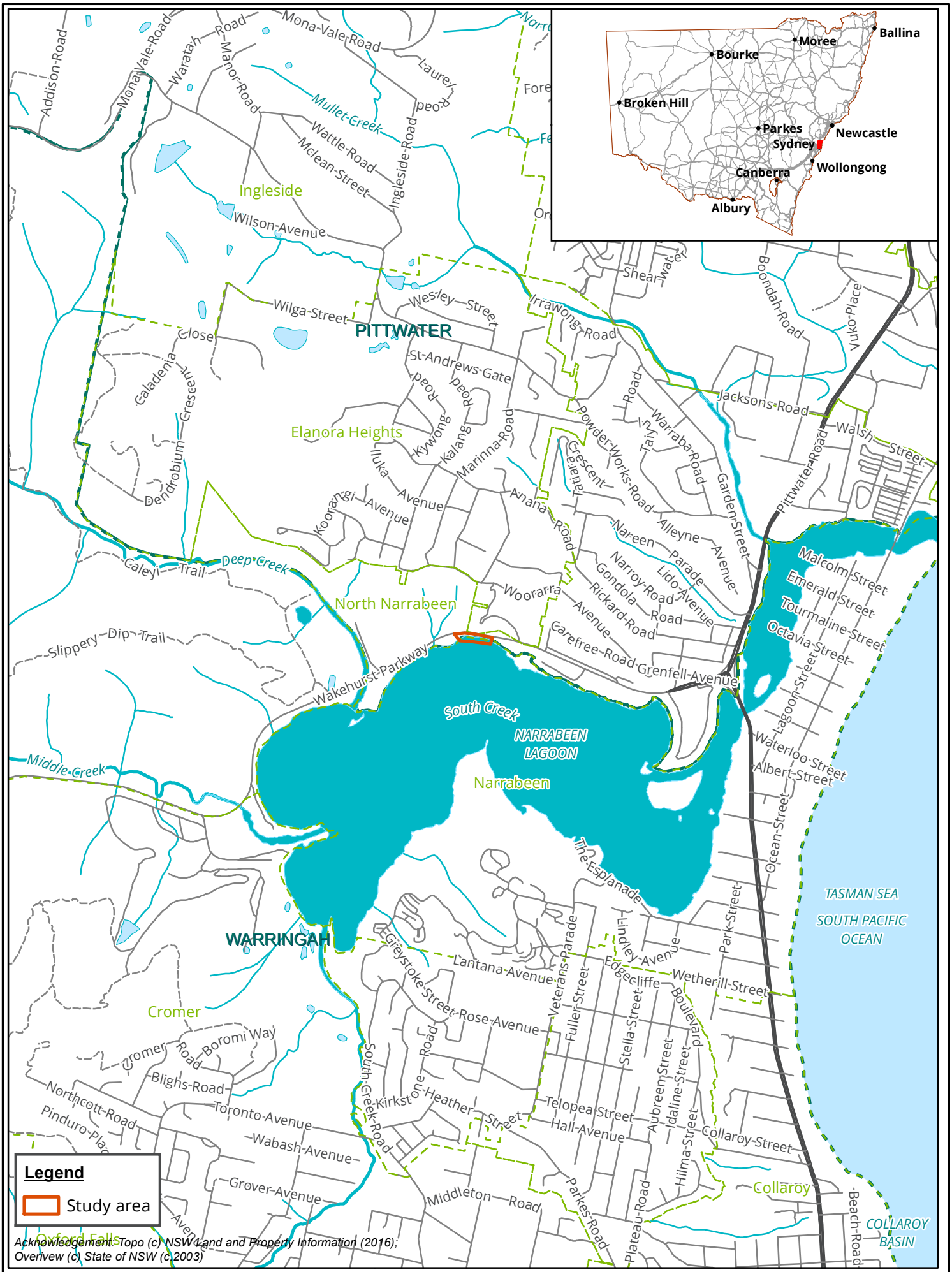


Plate 1 **Photo of western most extent of Stage 3 section of NLMUT looking towards eastern end of proposed alignment over the lagoon**

Plate 2 **Photo of typical riparian area on the edge of Narrabeen Lagoon, photo taken at eastern end of Stage 3 section of NLMUT, looking west**



Acknowledgement: Topo (c) NSW Land and Property Information (2016); Overivew (c) State of NSW (c.2003)

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Figure 1: Location of the study area in a regional context

Matter: 25499
Date: 25 October 2017,
Checked by: JAC, Drawn by: LH, Last edited by: lharley
Location:P:\25400s\25499\Mapping\

0 250 500 750 1,000
Metres

N

Scale 1:25,000 @ A4, GDA 1994 NSW Lambert

2 Proposal and scope of works

2.1 Proposal description

Northern Beaches Council is proposing to improve the safety of a small section (approximately 180 metres) of the NLMUT (proposed works). This section is located between Bilarong Reserve and the Deep Creek Bridge and either side of the monument rocks adjacent to Wakehurst Parkway (Figure 2). The proposed works will result in a re-alignment and new section of the NLMUT, and a boardwalk over a small section of the lagoon. The design will further enhance an appreciation of the lagoon to improve safety and further encourage a wide range of users to safely enjoy the recreational and environmental aspects of the Narrabeen Lagoon area (TBLD 2017a).

2.2 Proposal need

The usage of the NLMUT has increased in recent years. In 2015, council identified the requirement to upgrade the Stage 3 section of the Narrabeen Lagoon trail following numerous requests from the public (TBLD 2017a). Approximately 180 metres of the NLMUT presents an unsafe risk to users as:

- The trail is unacceptably narrow (1.5 metres rather than the 2.5 metres required for shared trails).
- There is also no offset to the adjacent steel vehicle barrier which presents a collision risk to cyclists and does not meet the minimum 1.3 metre barrier requirements.
- The trail in this location is directly adjacent to Wakehurst Parkway, which is an arterial road with high volumes of traffic.
- There is a steep drop on the lagoon side of the trail, with no protective barrier.
- It does not meet Australian Standards for shared use trails.

The construction of Stage 3 NLMUT would resolve a short, unsafe section of the 8.5 kilometre trail (TBLD 2017a).

2.3 Alternative options

TBLD, in conjunction with Northern Beaches Council, undertook detailed site investigations and analyses to assess the physical, functional, environmental and visual qualities of the study area. Results and recommendations from the aquatic ecology assessment (MPR 2017) and Preliminary Construction Methodology were also used to inform the feasibility and concept design process. Two options were considered in a feasibility report for the project (TBLD 2017a):

- Option 1: Upgrade existing trail
- Option 2: Lagoon boardwalk (preferred)

A third option that was not explored in the feasibility report is to do nothing.

Option 1: Upgrade existing trail

To comply with Australian Standards and Australian Guidelines, the existing trail would need to be widened by approximately 2 metres to the south of the lagoon. To achieve the ideal trail width, construction of a retaining wall (approximately 1.75 metres high) would be required along the entire southern edge of the trail.

A 1.3 metre high barrier would also be required along the southern edge, and a minimum 0.5 – 1 metre offset would be required for the new 1.3 metre barrier along the northern edge. This would involve substantial vegetation removal and environmental impacts such as increased erosion and sedimentation, as well as disturbance to the existing bank and fauna habitat. Construction of a widened trail in this location would also present significant challenges regarding the two memorial rocks, traffic management and stormwater management. Although this option would result in minimal direct disturbance to the lagoon bed and aquatic vegetation, this option is not preferred due to the extensive potential associated environmental impacts (TBLD 2017a).

Option 2: Lagoon boardwalk (preferred)

The proposed overwater boardwalk would be 2.5 metres internal width in-line with the existing NLMUT and would meet all relevant Australian Standards and Guidelines regarding barrier design and safety. The boardwalk would be aligned to avoid all mapped seagrass beds and the approach alignment would be micro-sited to minimise vegetation removal. The proposed boardwalk would be constructed with timber piles (driven from a low impact barge), timber subfloor, open mesh FRP deck, and painted steel barriers. The boardwalk connects with the existing trail to the west and east with raised earthen approach ramps that would be retained with sandstone retaining walls. Although construction will require strict environmental controls, this option will not require the removal of any endangered ecological community or significant impact on seagrass beds. It will provide a safe boardwalk for trail users and remove the risk of falls and traffic accidents/incidents associated with the existing alignment (TBLD 2017a).

Option 3: Do nothing

This option was not discussed in the feasibility study (TBLD 2017a) as it is not a viable option. The condition of the existing trail through this 180 metre section currently presents an unacceptable risk to the public.

2.4 Construction activities

Innovative and best practice construction methodologies have been selected for the construction of the NLMUT to minimise potential environmental impacts. Proposed construction methodology is described in the Narrabeen Lagoon Multi Use Trail Stage 3 Preliminary Construction Methodology (TBLD 2017b). Environmental mitigation measures for these construction activities is discussed further in Section 4.2.

Legend

- Study area
- Proposed works footprint
- Existing trail

Figure 2: Detailed aerial of the study area

0 6 12 18 24 30

Metres
Scale: 1:700 @ A3
Coordinate System: GDA 1994 NSW Lambert

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Matter: 25499
Date: 25 October 2017,
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Location:P:\25400s\25499\Mapping
25499_ADD_F2_StudyArea

3 Legislative context

The EP&A Act provides for the creation of State Environmental Planning Policies (SEPPs) and Local Environmental Plans (LEPs). Collectively they are referred to as Environmental Planning Instruments (EPIs) and can be used to determine if an activity is permissible. SEPPs deal with issues significant to the State and people of NSW. They establish a range of policies that apply to all or part of areas across NSW. SEPPs are higher order plans that override any provision within a LEP. Under the *State Environmental Planning Policy (infrastructure) 2007* (Infrastructure SEPP) a number of exemptions apply for development without consent and exempt development. The relevant designation under the Infrastructure SEPP is provided in the table below. Although the proposed works are designated exempt development under the Infrastructure SEPP, Section 111 of the EP&A Act states that a determining authority in its consideration of an activity has a duty to consider all matters affecting or likely to affect the environment by reason of that activity. These matters are considered in the next section.

Table 1 Approval pathway and legislative requirements

Legislative considerations	Requirements
Infrastructure SEPP designation	Part 3, Division 12 Parks and other public reserves Clause 66 Exempt development (1) Development for any of the following purposes is exempt development if it is carried out by or on behalf of a public authority in connection with a public reserve or on land referred to in clause 65 (1), and if it complies with clause 20: (a) construction, maintenance and repair of: (i) walking tracks, boardwalks and raised walking paths, ramps, minor pedestrian bridges, stairways, gates, seats, barbecues, shelters and shade structures (ii) viewing platforms with an area not exceeding 100m2 Part 2, Division 4 Exempt development Clause 20 General requirements for exempt development (1) This clause applies to any development that this Policy provides is exempt development. (2) To be exempt development, the development: (a) must meet the relevant deemed-to-satisfy provisions of the Building Code of Australia, or if there are no such relevant provisions, must be structurally adequate, and (b) must not, if it relates to an existing building: (i) cause the building to contravene the Building Code of Australia, or (ii) compromise the fire safety of the building or affect access to any fire exit, and (c) must be carried out in accordance with all relevant requirements of the Blue Book, and (d) must not be designated development, and (e) if it is likely to affect a State or local heritage item or a heritage conservation area, must involve no more than minimal impact on the heritage significance of the item or area, and (f) must be installed in accordance with the manufacturer's specifications, if applicable, and (g) must not involve the removal or pruning of a tree or other vegetation that requires a permit or development consent for removal or pruning, unless that removal or pruning is undertaken in accordance with a permit or development consent.

	Division 25 Waterway or foreshore management activities Clause 129 Development permitted without consent (1) Despite clause 129A, development for the purpose of waterway or foreshore management activities may be carried out by or on behalf of a public authority without consent on any land. (2) In this clause, a reference to development for the purpose of waterway or foreshore management activities includes a reference to development for any of the following purposes if the development is in connection with waterway or foreshore management activities: (d) Environmental management works.
Land zoning	The proposed works are located on land zoned SP2 – Infrastructure, W1 – Natural Waterways and E2 – Environmental Conservation under the *Pittwater Local Environmental Plan 2014* and *Warringah Local Environmental Plan 2011*. The proposed works are not inconsistent with the objectives of the zoning.
Applicable Environmental Planning Instruments (EPIs)	The following SEPPs are relevant to the proposed works and have been considered in the preparation of this REF: *State Environmental Planning Policy (Infrastructure) 2007* *State Environmental Planning Policy No 19 – Bushland in Urban Areas* *Warringah Local Environmental Plan 2011* *Warringah Development Control Plan 2011* *Pittwater Local Environmental Plan 2014* No inconsistencies with these EPIs have been identified.
Approvals required under environmental legislation	*Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act): • Proposed works are not likely to impact on any matters of national environmental significance. *Biodiversity Conservation Act 2016* (BC Act): • No threatened species, communities or their habitat will be significantly impacted. *Fisheries Management Act 1994* (FM Act): • No permits required due to no dredging or significant impacts to threatened species or their habitat. EP&A Act: • As per Section 5AA, consideration has been given to the provisions of Part 7 of the BC Act and Part 7A of the FM Act that relate to the operation of the EP&A Act in connection with the terrestrial and aquatic environment. The proposed works are not likely to have a significant impact on the environment. No further assessment is required. Infrastructure SEPP: • The proposed works are exempt development under Clause 66. *National Parks and Wildlife Act 1974*: • No registered Aboriginal sites or places were identified in the study area. *Biosecurity Act 2015*: • The Biosecurity Act was enacted to provide for the identification, classification and control of all biosecurity threats within NSW. These threats include priority exotic flora species which have been identified per Local Land Services (LLS) region. The proposed works are located in the Greater Sydney LLS region. Three priority weed species were identified in the ecological assessment. Control methods are discussed

	in the Biodiversity Management Plan (Biosis 2017b). *Water Management Act 2000*: • A public authority does not need to obtain a controlled activity approval for any controlled activities that it carries out in, on or under waterfront land. *Heritage Act 1977*: • The study area does not contain any heritage listed items.
Offset requirements	No offsets are required, however a Biodiversity Management Plan (Biosis 2017b) has been developed to facilitate rehabilitation and revegetation of the site. This can be found in the Appendix.
Stakeholder and consultation requirements	Part 2 Division 1 Clause 16 of the Infrastructure SEPP requires that a public authority or a person acting on behalf of a public authority must not carry out development comprising a fixed or floating structure in or over navigable waters unless the authority or person has given written notice of the intention to carry out the development to Roads and Maritime Services (RMS), and taken into consideration any response to the notice that is received from RMS within 21 days after the notice is given.

4 Environmental assessment and mitigation

4.1 Environmental impact assessment

4.1.1 Consideration of threatened species

According to Section 5AA of the EP&A Act, consideration must be given to the provisions of Part 7 of the BC Act and Part 7A of the FM Act that relate to the operation of the EP&A Act in connection with the terrestrial and aquatic environment. Under Part 7 of the BC Act, development or an activity is likely to significantly affect threatened species or ecological communities, or their habitats according to the test in Section 7.3 or if it is carried out in a declared area of outstanding biodiversity value.

No threatened flora species were detected during the Flora and Fauna Assessment undertaken by Biosis (2017a). This assessment also determined that there is a low likelihood of impact on any threatened fauna species that may utilise the study area. The construction and operation of the boardwalk is not likely to place the seagrass beds in the lagoon at risk, and there are unlikely to be any cumulative risks for aquatic birds that use the seagrass beds and riparian shallows for feeding and shelter. As the proposal does not include dredging or reclamation and as it is considered that the potential seagrass loss is insignificant, it is concluded that the project is not likely to require a permit under the FM Act (MPR 2017). Marine Pollution Research (2017) concluded that construction can be achieved with minimal risk to the adjacent riparian and aquatic habitats and communities provided suitable measures are implemented and specified in a project Construction Environmental Management Plan that includes the aquatic ecology management options specified in their report. The following therefore addresses the test in Section 7.3 for only the listed endangered ecological community Swamp Oak Floodplain Forest (SOFF) recorded in the study area.

Swamp Oak Floodplain Forest EEC

The SOFF is typically associated with grey-black clay loams and sandy loams on coastal floodplains of NSW. The community generally occurs below 20 metres elevation and structurally varies from open forests to low woodlands, scrubs or reedlands with scattered trees. The dominant canopy species is Swamp Oak *Casuarina glauca* with Lilly Pilly *Acmena smithii, Glochidion* spp. and *Melaleuca* spp. occasionally occurring as subordinate species. Generally, tree diversity decreases with latitude. The understorey is characterised by vines and a continuous groundcover of forbs, sedges, grasses and leaf litter with a sparse shrub cover. Generally, the composition of the ground stratum depends on salinity levels in the groundwater. The extent of the SOFF prior to European settlement is unknown however it is predicted that the remaining area today represents less than 30% of its original range.

The study area currently supports 0.21 hectares of SOFF. The proposed works will require the removal of 0.02 hectares of this community. The community as a whole was in moderate condition with moderate species diversity within the canopy and understorey. Recruitment of exotic species was apparent in the shrub strata with Lantana recorded (Biosis 2017a).

A number of measures have been included in this report to reduce potential impacts to surrounding vegetation and to assist in the long-term survival for this EEC.

The following is to be taken into account for the purposes of determining whether the proposed tree removal works are likely to significantly affect the Swamp Oak Floodplain Forest EEC within the study area:

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

N/A: SOFF is not a threatened species.

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

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

The SOFF is known to occur in the North Coast, Sydney Basin and South East Corner bioregions. The SOFF in the study area is therefore not at the limit of known occurrence of the EEC. The proposed works will require the removal of 0.02 hectares of SOFF from the eastern and western portions of the study area. This represents 9.1% of its extent within the study area and only 0.05% of its extent within the local area. The removal of 0.02 hectares of SOFF from the study area is not 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.

The SOFF within the study area is in moderate condition as it had been affected by disturbances such as weed invasion, fragmentation and edge effects resulting from previous land uses. Clearance of a very small area of SOFF from the study area as a result of the proposed works is unlikely to further degrade the composition of SOFF or result in any increasing in edge effects or invasion of exotic species. It is therefore considered that the proposed works will not place the EEC at further risk of extinction.

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

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

SMCMA mapping (OEH, 2016) indicates that approximately 42.22 hectares of SOFF occurs within a 5 kilometre radius of the study area. The study area supports 0.21 hectares of SOFF in the study area, which equates to 0.5% of similar habitat types in the local area (5 kilometre radius). Approximately 0.02 hectares of this will be removed which equates to only 0.05% of its occurrence within the local area.

Remnant vegetation within the study area has been historically degraded and isolated by previous land uses. The highest quality vegetation occurs along the south-western boundary, which becomes more edge affected to the east. The study area provides a narrow strip of habitat connectivity between Wakehurst Parkway and the foreshore of Narrabeen Lagoon, linking larger patches of similar vegetation the east and west. Given the existing edge effects and fragmentation occurring within the study area it is not anticipated that the clearing of 1.6 hectares of SOFF for the proposed works will further isolate or fragment this community.

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

The SOFF is not a declared area of outstanding biodiversity value.

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

The proposed works within the study area are likely to result in the operation of two Key Threatening Processes:

- Clearing of native vegetation – approximately 0.02 hectares of SOFF would be cleared within the study area. This represent 9.1% of the occurrence of SOFF within the study area, and only 0.05% of the occurrence of SOFF in the locality. Clearing of native vegetation for the proposed works is not therefore considered likely to result in a significant reduction of SOFF within the study area or in locality.
- Invasion, establishment and spread of Lantana – *Lantana camara* is already established in the more disturbed areas of SOFF in the study area. The clearing of the very small area of vegetation required for the proposed works is not considered likely to result in lantana further invading the patches of existing remnant vegetation.

Conclusion

The removal of the SOFF from within the study area is considered unlikely to result in a significant impact on the local occurrence of the EEC as:

- The 0.02 hectares SOFF to be removed from the study area for the proposed works represents 9.1% of the total occurrence within the study area, and only 0.05% of the total occurrence in the locality.
- The SOFF within the study area forms a narrow corridor connecting larger patches of remnant vegetation to the east and west. The proposed works will require the removal of only a very small portion of the community, with much of the vegetation within the study area to be retained. The proposed works will not therefore result in any further reduction in existing habitat connectivity in the locality.
- Although a number of KTP's have the potential to be triggered by the proposed development, it is unlikely that these will have a significant impact on SOFF.

A Species Impact Statement or Biodiversity Development Assessment Report is therefore not required.

4.1.2 Duty to consider environmental impact

Section 111 of the EP&A Act states that a determining authority in its consideration of an activity has a duty to consider all matters affecting or likely to affect the environment by reason of that activity:

> *111 Duty to consider environmental impact*
>
> *(1) or the purpose of attaining the objects of this Act relating to the protection and enhancement of the environment, a determining authority in its consideration of an activity shall, notwithstanding any other provisions of this Act or the provisions of any other Act or of any instrument made under this or any other Act, examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity.*

Under Section 111 (3) consideration must also be given to the effect of an activity on any wilderness area (within the meaning of the *Wilderness Act 1987*) in the locality in which the activity is intended to be carried on. However, the proposed NLMUT works are not located within any wilderness areas.

This REF has been prepared to address the requirements for environmental assessment under Part 5 of the EP&A Act and all matters likely to affect the environment are presented in Table 3 below. Table 3 also provides measures for avoiding, minimising or mitigating potential impacts on the surrounding environment.

4.1.3 Clause 228 Factors

Clause 228 of the EP&A Regulation lists the factors that must be considered when determining the potential or likely impacts of an activity on the surrounding environment. These are addressed in Table 2.

Table 2 Clause 228 factors for consideration

Clause 228 Factor	REF finding
a) any environmental impact on a community	The proposed works will improve safety for trail users and provide further opportunities for engagement with the environment.
b) any transformation of a locality	The locality will undergo a temporary transformation during construction. The proposed works will result in a boardwalk / trail section with a design that has taken into account the site environmental conditions, access, nearby infrastructure, preferred materials, low key environmentally sympathetic aesthetics and minimal potential impact on the adjacent seagrass beds in the lagoon. Materials and colours have also been selected to ensure the boardwalk has a low visual impact on the surrounding environment.
c) any environmental impact on the ecosystems of the locality	The proposed works will have only minor impacts on the ecosystem of the locality. A flora and fauna assessment (Biosis 2017a) and aquatic ecology assessment (MPR 2017) concluded that the works would not result in a significant impact on the ecosystems of the locality. Environmental impacts on the ecosystem have been avoided or minimised through the development of the mitigation measures in the ecological reports and included in this REF. The following additional measures will be developed prior to commencing construction: • A construction protocol for addressing potential acid sulfate soils in the water column. • An Aquatic Construction Environmental Management Plan (CEMP).
d) any reduction of the aesthetic, recreational, scientific or other environmental quality or value of the locality	The proposed works are likely to improve the aesthetic and recreational values of the locality by improving trail quality and access to Narrabeen Lagoon. The proposed works are not likely to have a significant impact on scientific values or environmental quality such as damage to the lagoon and seagrass beds.

Clause 228 Factor	REF finding
e) any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or any other special value for present or future generations	The proposed works have been designed to avoid impacts to any significant aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social values. For example, the boardwalk and construction have been offset from the memorial rocks to respect their significance to the Aboriginal community. Ecological assessments and Aboriginal and non-Aboriginal assessments have been undertaken for the locality. No significant effects were identified.
f) any impact on the habitat of protected fauna (within the meaning of the National Parks and Wildlife Act 1974)	The proposed works are not likely to result in a significant impact to any threatened species or fauna habitat.
g) any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air	The proposed works are not likely to result in any endangering of any terrestrial or aquatic species (see Biosis 2017a; MPR 2017).
h) any long-term effects on the environment	The proposed construction works are minor and temporary in nature and will not result in any long-term effects on the environment. Mitigation measures included in this REF will avoid and minimise any impacts on the environment.
i) any degradation of the quality of the environment	The proposed works will require the removal of approximately 0.02 hectares of Swamp Oak Floodplain Forest EEC and fauna habitat. An assessment of significance test under Part 7 of the BC Act concluded that this will not significantly impact on the occurrence of this community in the locality. The proposed works has the potential to result in minor environmental impacts such as the introduction and/or spread of weeds during clearing and construction. If the mitigation measures in this REF are implemented, the proposed works are not likely to lead to the degradation of the quality of the environment.
j) any risk to the safety of the environment	If the mitigation measures proposed in this REF are implemented, the proposed works will result in only a minor risk to the safety of the environment.
k) any reduction in the range of beneficial uses of the environment	The proposed works will not result in any reduction of the range of beneficial uses of the environment.
l) any pollution of the environment	If the mitigation measures proposed in this REF are implemented, the proposed works will not result in any pollution to the environment.

Clause 228 Factor	REF finding
m) any environmental problems associated with the disposal of waste	All waste will be secured to avoid pollutants escaping and disposed of at a licenced facility. All green waste resulting from weed removal is to be disposed of at a registered green waste facility.
n) any increased demand on resources (natural or otherwise), that are, or are likely to become, in short supply	The proposed works will not result in any increased demand on resources.
o) any cumulative environmental effect with other existing or likely future activities	The potential impacts associated with construction will be minor and temporary in nature. Any environmental risks associated with the on-going use of the new boardwalk will be the same as for the current trail alignment. The proposed works therefore do not present any additional cumulative environmental effects.
p) any impact on coastal processes and coastal hazards, including those under projected climate change conditions	The proposed works will not impact on coastal processes and coastal hazards.

4.2 Environmental mitigation and safeguards

The proposed works present various risks and impacts on Narrabeen Lagoon, as well as other environmental components such as soils, hydrology, ecology, air quality, and Aboriginal cultural heritage. These are described in Table 3. The mitigation measures and safeguards listed in Table 3 will be implemented prior to, during and following construction to reduce the associated environmental risks.

Table 3 Potential impacts of proposed works, mitigation measures and safeguards

Environmental component	Potential impacts	Mitigation measures and safeguards
Soils and geology	Erosion of exposed surfaces and stockpiles: • Loss of topsoil • Potential pollution of stormwater / runoff into Narrabeen Lagoon • Windblown dust to surrounding environment • Smothering of retained vegetation	• Prepare and implement a sediment and erosion control plan. • Install and maintain sediment and erosion control measures prior to and during construction. • Maintain sediment and erosion controls until the works are complete and areas are stabilised. • Divert surface runoff away from sensitive areas, stockpiles and erodible material. • Reduce water velocity and capture sediment on site. • Inspect sediment and erosion control measures daily, as well as after rainfall events. Fix damaged controls immediately. • Stabilise disturbed areas as soon as possible.
	Inappropriate location of stockpiles and pre-fabricated materials: • Smothering of / damage to vegetation • Increased risk of erosion • Increased risk of lagoon sedimentation	• Locate stockpiles and / or construction materials away from vegetation and drainage lines, implement bunding practices. • Keep vehicles in designated areas.
	Disturbance to acid sulfate soils: • Release of acid sulfate soils (including copper, iron and arsenic) into the water column (mapped as high probability of occurrence at the site).	• Undertake further investigation into potential for acid sulfate soils prior to confirming construction methodology. • Sampling of soil and laboratory analysis should be carried out to confirm acid sulphate if required. • Minimise disturbance and prevent oxidation of soils or release of sediment into the water column. • Develop a construction protocol for addressing acid sulfate soils in the water column and include in the Aquatic Construction Environmental Management Plan (CEMP). • Implement all measures to avoid release of acid sulfate soils included in Aquatic CEMP.

Environmental component	Potential impacts	Mitigation measures and safeguards
Hydrology, water quality and lagoon ecosystems	Pollution of Narrabeen Lagoon: • Potential for sedimentation, increased turbidity • Damage to seagrass beds from sedimentation, wash and scouring resulting from vessel / barge movement. • Damage to seagrass beds from barges left in-situ and / or mooring.	• Do not store chemicals or fuels on-site. • Do not use equipment with fuel, oil or hydraulic leaks. Repair or remove immediately.do nor discharge any water into Narrabeen Lagoon. • Install floating silt curtains between the construction area and the offshore seagrass beds as per recommendations in the aquatic ecology report (MPR 2017). • All construction personnel to be inducted in regards to the need for the protection of the seagrass beds. • Ensure that towing or pushing vessels does not use excessive power to manoeuvre barges into place in the vicinity of the seagrass bed. • Work with the tides and wind to minimise the potential for propulsion related damage. • Barges that need to be placed over seagrass beds are not to be left in-situ if there is a risk of bottoming out over the tidal cycle. • Even where there is no risk of bottoming out barges are not to be left in-situ over seagrass beds for periods longer than three days when waters are clear of stormwater turbidity. • When there is stormwater turbidity the period where barges can be left in-situ could be extended to coincide with natural clearing rates but this is to be determined and specified in an Aquatic CEMP. • If mooring blocks or other anchoring gear to hold barges in place are to be used these must not be placed into the designated seagrass beds, and must be located so that associated mooring lines are unable to scrape the seagrass bed when slack of taut. • Identify additional / alternative mooring locations / options to minimise seagrass bed loss or damage in an Aquatic CEMP. • Develop and implement an Aquatic CEMP that addresses final construction methodology and includes all recommendations made in Aquatic Ecology report (MPR 2017). • Include emergency procedures for chemical / fuel spills in the CEMP. • Visual monitoring of local water quality (e.g. turbidity, hydrocarbon slicks / spills) is to be undertaken on a regular basis. Details of monitoring requirements and responsibilities are to be outlined in the Aquatic CEMP.

Flora and fauna	Damage to or removal of vegetation: • Loss of visual amenity • Loss of potential habitat • Removal of vegetation beyond what has been approved. • Introduction of contaminated fill or spread of weed propagules.	• Keep vegetation clearance and disturbance to a minimum, with access / egress via existing tracks. • All material stockpiles, vehicle parking and machinery storage will be located within cleared areas or areas proposed for clearing in the development site, and not in areas of adjacent retained native vegetation. • Vegetation to be removed in the development site will be clearly marked under the supervision of the project environmental advisor to ensure only the approved vegetation is removed. A spray-painted 'X' or standard marker will be placed on trees and patches to be removed. • All areas of retained vegetation in or near the development site will be clearly marked by means of high visibility temporary fencing, to be installed under the supervision of the project environmental advisor. High visibility temporary fencing (using high visibility bunting and star pickets) must be installed before clearing of other vegetation and construction work commences. These areas are to be treated as no-go zones and installed using the following principles: – The radius of the tree protection zone (TPZ) is calculated for each tree by multiplying its diameter at breast height (DBH) by 12 (i.e. TPZ = DBH x 12) in accordance with the Standards Australia Committee (2009). – A TPZ should not be less than 2 metres or greater than 15 metres, except where crown protection is required (Standards Australia Committee 2009). – Appropriate signage such as 'No Go Zone' or 'Environmental Protection Area' must be installed. – Identify the location of any 'No Go Zones' in site inductions and on site plans. • Clearing of vegetation should be completed prior to the spring breeding season of most bird species. Alternatively, a suitably qualified ecologist should be engaged to undertake a pre-clearing inspection of the proposed works area immediately prior to vegetation clearing. • If breeding/nesting birds are located, an exclusion area should be established around nests at an appropriate distance to avoid impacts during nesting. Clearing should only re-commence within these exclusion areas once nesting has finished, as advised by an ecologist. • If injured wildlife is encountered the project manager will be immediately notified by the site supervisor and a licenced wildlife handler/carer or local veterinarian will be consulted (phone WIRES on 1300 094 737, NSW rescue line). • Implement Biodiversity Management Plan (Biosis 2017b).

Environmental component	Potential impacts	Mitigation measures and safeguards
		• The existing pathway is to be revegetated with appropriate species for Swamp Oak Floodplain Forest, exact species list and number of plants to be revegetated is to be determined using the Biodiversity Management Plan (Biosis 2017b). • Follow up bush regeneration work ensuring suppression of weed species and survival of revegetated species will need to continue post proposed works for a further five year period. • In the unlikely event that unexpected threatened species are identified during the project, works should cease and an ecologist contacted. • Implement weed management of existing weeds identified in the Flora and Fauna Assessment (Biosis 2017a) and in conjunction with the Biodiversity Management Plan (Biosis 2017b). • Prior to works commencing any machinery, equipment and PPE will be washed down off-site to remove soil and weed seeds. • Ensure any imported construction materials area weed and pathogen free.
Aboriginal heritage	No Aboriginal sites, objects, PADs or places were recorded during the Aboriginal Cultural Heritage Due Diligence Assessment.	• Should any Aboriginal objects be encountered during works associated with this proposal, works must cease in the vicinity and the find should not be moved until assessed by a qualified archaeologist. If the find is determined to be an Aboriginal object the archaeologist will provide further recommendations. These may include notifying the OEH and Aboriginal stakeholders. • Aboriginal ancestral remains may be found in a variety of landscapes in NSW, including middens and sandy or soft sedimentary soils. If any suspected human remains are discovered during any activity you must: – Immediately cease all work at that location and not further move or disturb the remains – Notify the NSW Police and OEH's Environmental Line on 131 555 as soon as practicable and provide details of the remains and their location – Not recommence work at that location unless authorised in writing by OEH.
Non-Aboriginal heritage	An search of relevant statutory heritage registers was undertaken for the study area. The study area does not contain any heritage listed items.	• If encountered, archaeological remains will be assessed by an archaeologist to determine whether the suspected find constitutes a relic under the NSW Heritage Act 1977 and whether NSW Heritage Council should be notified.

Environmental component	Potential impacts	Mitigation measures and safeguards
Noise	Nuisance noise emissions: • Impacts on people • Impacts on fauna	• Wherever possible, limit work hours to those recommended by the NSW EPA: Monday to Friday 7am to 6pm, Saturday 8am to 1pm. No construction on Sundays or Public Holidays. • Equipment will have noise mufflers and be well maintained.
Air quality and energy	Pollution: • Emissions from machinery	• Ensure exposed areas and stockpiles are protected from excessive wind. • Monitor work areas and stockpiles for dust generation. • Maintain equipment to ensure no exhaust particulates are visible for more than 10 seconds. • Where possible, do not leave vehicles idling.
Waste generation	Inappropriate disposal of waste	• Waste generation should be minimised. • Recycle / reuse waste where appropriate (e.g. topsoil). • Waste disposal will occur at licenced waste disposal depots. • Secure all waste to avoid pollutants or weeds escaping.
Visual amenity	Loss of visual amenity	• Minimise spread of stockpiles, waste and parking. • Display public information signs until site restoration is complete. • Restore work sites to as close to their original condition as possible.
Traffic and access	Disruptions to vehicular and pedestrian access: • Closed tracks / access points	• Council or RMS requirements regarding traffic control, access and road / footway restoration will be complied with. • Erect signs regarding proposed works, temporary closures and diversions. • Restore access as quickly as possible.

5 Recommendations and conclusion

The proposed works are exempt development under the Infrastructure SEPP. Considering the EP&A Act, BC Act, FM Act, the proposed works are not likely to have a significant impact on any threatened species, communities, or their habitat; and they are not likely to have any significant impacts on the environment.

The primary measures for the proposed works to minimise potential impacts on Narrabeen Lagoon and the surrounding terrestrial and aquatic ecosystems are outlined in the ecological and heritage assessments (Biosis 2017a; Biosis 2017c, MPR 2017), the Biodiversity Management Plan (Biosis 2017b), and Table 3 of this REF. All recommendations and mitigation measures relating to environmental impacts are to be followed. A CEMP / Aquatic CEMP as well as a construction protocol for addressing potential acid sulfate soils in the water column are also to be developed and approved prior to commencing construction works.

This REF has been prepared based on information provided by the client and other consultants. It is recommended that stakeholder agencies (RMS, Department of Primary Industries Fisheries, Office of Environment and Heritage) are contacted prior to works commencing.

6 References

Biosis 2017a. Flora and fauna assessment for the proposed upgrade to the Narrabeen Multi Use Trail Alignment. Report for Northern Beaches Council. Authors: Corden, C. Biosis Pty Ltd, Sydney. Project no. 24787.

Biosis 2017b. Biodiversity Management Plan: Narrabeen Lagoon Stage 3 Multi Use Trail Alignment. Report for Northern Beaches Council c/o Thompson Berrill Landscape Design. Authors: Wilson, A. Biosis Pty Ltd, Sydney. Project no. 25499.

Biosis 2017 c. Aboriginal due diligence advice: Narrabeen Lagoon Multi Use Trail. Report for Northern Beaches Council c/o Thompson Berrill Landscape Design. Authors: Cole, J. Biosis Pty Ltd, Sydney. Project no. 25499.

MPR 2017. Aquatic ecology survey for Narrabeen Lagoon Boardwalk. Report for Northern Beaches Council. Marine Pollution Research Pty Ltd.

TBLD 2017. Stage 3: Feasibility Report Narrabeen Lagoon Multi Use Trail. Report for Northern Beaches Council. Thompson Berrill Landscape Design Pty Ltd.

TBLD 2017a. Narrabeen Lagoon Multi Use Trail – Stage 3 Preliminary Construction Methodology. Report prepared for Northern Beaches Council. Thompson Berrill Landscape Design Pty Ltd.

7 Appendices

30 October 2017

Andrew Zouroudis
Senior Landscape Architect
Thompson Berrill Landscape Design P/L
PO Box 1045
BLACKTOWN 2148

Dear Andrew

Re: Aboriginal due diligence advice: Narrabeen Lagoon Multi-Use Trail

Our Ref: Matter 25499

Biosis Pty Ltd has been commissioned by Thomson Berrill Landscape Design Pty Ltd (client) to provide Aboriginal due diligence advice for the proposed works along the Narrabeen Lagoon Multi-Use Track Narrabeen, NSW (the study area) (part Lot 9 DP 749900) (Figure 1 and Figure 2). The project involves the construction of a 185 metre long section of shared trail along Narrabeen Lagoon. The purpose of this advice is to assist the client in exercising due diligence in determining whether the project will involve activities that may harm Aboriginal objects and to determine whether consent in the form of an Aboriginal Heritage Impact Permit (AHIP) is required.

The *National Parks and Wildlife Act 1974* (NPW Act) provides specific protection for Aboriginal objects and declared Aboriginal places by establishing offences of harm. Harm is defined to mean destroying, defacing, damaging or moving an object from the land. There are a number of defences and exemptions to the offence of harming an Aboriginal object or place. The NPW Act states that a person or organisation who exercises due diligence in determining that their actions will not harm Aboriginal objects has a defence against prosecution for the strict liability offence of unknowingly harming an object without an AHIP.

The NPW Act allowed for a generic code of practice to explain what due diligence means. As a result, the National Parks and Wildlife Regulation 2009 (NPW Regulation) adopted the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (DECCW 2010a) ('the code'). The code sets out the reasonable and practicable steps which individuals and organisations need to take in order to:

- Identify whether or not Aboriginal objects are, or are likely to be, present in an area.
- Determine whether or not their activities are likely to harm Aboriginal objects (if present).
- Determine whether an AHIP application is required.

This advice follows the code and includes a background review, as well as an archaeological survey in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010b) ('the Code') was conducted, in order adequately map areas of high, moderate and low archaeological sensitivity. It is useful to determine whether the Code is applicable to the proposed project. The Code outlines a series of questions to clarify this, responses to these questions are outlined in Table 1.

Table 1 Questions required to detemine the applicabiltiy of the code

Question	Response
Is the activity a declared project under Part 3A of the EP&A Act?	No
Is the activity an exempt activity listed in the National Parks and Wildlife Act or other legislation?	No
Will the activity involve harm that is trivial or negligible?	No
Is the activity in an Aboriginal Place or are you already aware of Aboriginal objects on the land?	No
Is the activity a low impact activity for which there is a defence in the Regulation?	No
Do you want to use an industry specific code of practice?	No
Do you wish to follow your own procedure?	No

As none of the above questions apply to the project, due diligence must be established through using the code. The code consist of a series of five steps outlined below.

Step 1: Will the activity disturb the ground surface or any culturally modified trees?

The proposed project will consist of upgrades to the Narrabeen Lagoon Multi-Use Trail that will remove significant public safety hazards. The project will target a 185 metre long section of shared trail and include the following works:

- Construction of 28 metre long section of 2.5 metre wide unsealed on-ground trails with minor sandstone block retaining walls;
- 157 metre long section of 2.5 metre wide elevated boardwalks and lookout;
- Revegetation/regeneration of disturbed vegetation areas.

The above activities will disturb the ground surface and/or any culturally modified trees and therefore consideration of Steps 2a and 2b of the code is required.

Step 2a. Search the AHIMS database and use any other sources of information of which you are already aware

An extensive search of the AHIMS database was conducted on Date (Client service ID: 307661). The search identified 51 Aboriginal archaeological sites within a 5 kilometre search area, centred on the proposed study area (Table 2). None of these registered sites are located *within* the study area (Figure 3). The mapping coordinates recorded for these sites were checked for consistency with their descriptions and location on maps from Aboriginal heritage reports where available. These descriptions and maps were relied where notable discrepancies occurred.

Table 2 AHIMS Sites within the vicinity of the study area

Site type	Occurrences	Frequency (%)
Art (Pigment or Engraved)	40	77
Artefact	6	12
Grinding Groove	2	4
Potential Archaeological Deposit (PAD)	2	4
Stone Arrangement	1	2
Stone Quarry	1	2
Total	51	100

A simple analysis of the Aboriginal cultural heritage sites registered within 5 kilometres of the study area indicates that the dominant site type consists of art (pigment or engraved), making up 77% (n=40) of AHIMS sites. The next most frequent site type recorded in in AHIMS was Artefacts, accounting for 12% (n=6). His as followed by grinding grooves and PADs, each occurring in 4% (n=2) of AHIMS sites. Stone arrangements and stone quarry sites each also occurred once (2%) in the AHIMS record. All the sites were located within close proximity to the reliable sources of water, were either exposed by the land clearing works (artefact scatters) or within areas of relevant sandstone outcrops for grinding grooves and overhang development (shelters with art/deposit).

A review of the reports held by AHIMS identified that very little archaeological work has been undertaken in the immediate vicinity of the study area.

Archaeological assessment undertaken within 5 kilometres of the study area includes:

- **Archaeological Survey of Bicentennial Coastal Walkway: Queenscliff to Palm Beach**: Brayshaw McDonald Pty Ltd conducted surveys of the Bicentennial Coastal Walkway, which included a section of beach between Narrabeen Head and Turimatta Head, approximately 2.5 kilometres north-east of the current study area. The study identified 2 rock shelters with midden deposit, one midden with associated artefact scatter and two shell middens. One of these shell middens was located on a slope above a sheer drop form Narrabeen head down to the entrance of Narrabeen Lakes.
- **Aboriginal Due Diligence Assessment of Proposed Ausgrid 11kV access, Laurel Road East Ingleside, (Biosis Research 2011)**: Biosis conducted an Aboriginal due diligence assessment at Ingleside, approximately 3 kilometres north of the current study area. The assessment included a survey which determined that the study area had undergone past disturbances and did not contain any Aboriginal sites or objects.
- **Due Diligence Aboriginal Heritage Assessment of Mona Vale Hospital**: Biosis Pty Ltd undertook a due diligence assessment of the Mona Vale Hospital , located approximately 3.5 kilometres north east of the current study area. The Mona Vale study area was located in low rolling hills which the field survey determined had undergone ground disturbances. No Aboriginal sites or objects were identified by the survey and it was recommended that no further works were needed at the site.

Step 2b. Activities in areas where landscape features indicate the presence of Aboriginal objects

In order to determine whether the activity is within landscape features likely to contain Aboriginal objects a review of information pertaining to ethnohistories, soils, geology, landform, disturbance and potential resources has been undertaken.

Ethnohistory

It is generally accepted that people have inhabited the Australian continent for the last 50,000 years (Allen and O'Connell 2003). Dates of the earliest occupation of the continent by Aboriginal people are subject to continued revision as more research is undertaken. The timing for the human occupation of the Sydney Basin is still uncertain. While there is some possible evidence for occupation of the region around 40,000 years ago, the earliest known radiocarbon date for the Aboriginal occupation of the Sydney Basin is associated with a cultural / archaeological deposit at Parramatta, which was dated to 30,735 ± 407 BP (JMCHM 2005a and 2005b).

Our knowledge of Aboriginal people and their land-use patterns and lifestyles prior to European contact is mainly reliant on documents written by non-Aboriginal people. These documents are affected by the inherent bias of the class and cultures of their authors, who were also often describing a culture that they did not fully understand - a culture that was in a heightened state of disruption given the arrival of settlers and disease. Early written records can however be used in conjunction with archaeological information and surviving oral histories from members of the Aboriginal community in order to gain a picture of Aboriginal life in the region.

There is some confusion relating to group names, which can be explained by the use of differing terminologies in early historical references. Language groups were not the main political or social units in Aboriginal life. Instead, land custodianship and ownership centred on the smaller named groups that comprised the broader language grouping. There is some variation in the terminology used to categorise these smaller groups; the terms used by Attenbrow (2010) will be used here.

The project area is within in the vicinity of the Darug (coastal) language group as identified by Attenbrow (2010: 34):

- Darug, coastal dialect(s) – the Sydney Peninsula (north of Botany Bay, south of Port Jackson, west to Parramatta), as well as the country to the north of Port Jackson, possibly as far as Broken Bay.

These areas are considered to be indicative only and would have changed through time.

In 1788 Captain Arthur Phillip was on a reconnaissance mission around Port Jackson when he noticed a group of Aborigines at Manly (Egan 1999:10). Phillip wrote of the encounter that twenty of the men "waded into the water unarmed" and approached his boats, checking them out with great curiosity and "their confidence and manly behaviour made me give the name of Manly Cove to this place" (Egan 1999:10).

The arrival of Europeans had a rapid and dramatic effect on the people of the Sydney Basin. Even so, evidence of the continued presence of Aboriginal people, despite the disruptions to prior lifestyle, is also recorded and historically significant throughout the region. As in many places competition for land and resources and cultural differences led to conflict; this happened rapidly within the region and the project area following European settlement.

Geology, soils and hydrology

The study area is located on the banks of the Narrabeen Lagoon, which would have provided a permanent source of estuarine resources. The hydrological features associated with the study area are identified in Figure 4.

The study area is located within the Newport and Garie Formations of the Narrabeen Group, a Triassic aged sedimentary rock group that overlies Hawksbury. The Newport formation contains interbedded laminite, shale, quartz to lithic-quartz sandstone; minor red claystone, and the Garie Formation contains clay pellet sandstone, dark lithic fine sandstone, chocolate claystone bands. The geological formations associated with the study area are identified within Figure 5. The sandstone geology of the Newport and Garie formations has the potential to provide suitable resources for grinding grooves and shelter sites in the vicinity of the study area.

Soil landscapes have distinct morphological and topological characteristics that result in specific archaeological potential. Because they are defined by a combination of soils, topography, vegetation and weathering conditions, soil landscapes are essentially terrain units that provide a useful way to summarise archaeological potential and exposure. The Deep Creek soil landscape is present within the study area. It is characterised as a fluvial soil landscape that is formed predominately by deposition processes (Chapman and Murphy 1989). Soils in this landscape consist of loose grey-black loamy sands overlying loose greyish-brown sands and soft iron stained sands on well drained terraces, black friable silty loams on top of loose greyish-brown sands and organic stained sands in low lying areas, and grey-black loamy sands overlying loose greyish-brown sands in floodplains and recent depositional areas (Chapman and Murphy 1989). The soil landscapes associated with the study area are identified within Figure 6. The fluvial nature of the Deep Creek soil landscapes may result in the preservation of any potential subsurface sites as they will have been covered by depositional sediments.

Resources

The Narrabeen Lagoon would have generally provided a number of useful resources used by Aboriginal inhabitants.

The wider region includes distinct ecological zones, including estuarine reedland, mangroves, and seagrass with terrestrial vegetation likely to include swamp oak forest and swamp sclerophyll forest Each ecological zone hosts a different array of floral and faunal species, many of which would have been utilised according to seasonal availability.

Plant resources in the region were used in a variety of ways. Fibres from reeds were twisted into string, which was used for many purposes, including the weaving of nets, baskets and fishing lines (Attenbrow 2010). String was also used for personal adornment. Bark from swamp oak was used to make canoes (Worgan 1788).

Aboriginal inhabitants of the region would have had access to a wide range of avian, terrestrial and aquatic fauna that could be exploited as food sources. Areas of seagrass, mangrove and reedland vegetation would have provided habitat for a range of aquatic fauna, including fish and crabs, as well as migratory bird species (SMEC 2011). Swamp oak forest would have provided habitat for terrestrial species, such as possums and kangaroos (SMEC 2011).

As well as being important food sources, animal products were also used for tool making and fashioning a myriad of utilitarian and ceremonial items. For example, tail sinews are known to have been used to make fastening cord, while 'bone points', which would have functioned as awls or piercers, are often an abundant

part of the archaeological record. Animals such as Brush-tailed Possums were highly prized for their fur, with possum skin cloaks worn fastened over one shoulder and under the other. Kangaroo teeth were incorporated into decorative items, such as head bands (Attenbrow 2010).

Stone resources in the vicinity of the study area would have included quartz and sandstone both of which are used to manufacture stone tools. Silcrete and indurated mudstone were also present in the wider Sydney Basin along the Nepean River and are commonly used to produce stone tools throughout Sydney (AMBS 1997).

Disturbances

The study area has been subject to minor disturbances, including the construction of a trail through it, and the construction of drainage, associated with Wakehurst Parkway to the north of the study area. Within the areas which are to be impacted by the proposed lead in to the boardwalk, there is no clear evidence of disturbance.

Step 3. Can you avoid harm to the object or disturbance of the landscape feature?

It is not possible to avoid harm to the object or landscape feature if the proposed works are to proceed.

Step 4: Desktop assessment and visual inspection

Desktop assessment

Based upon the results from Stages 2a and 2b of the code a model has been formulated to broadly predict the type and character of Aboriginal cultural heritage sites likely to exist throughout the study area and where they are more likely to be located.

This model is based on:

- Local and regional site distribution in relation to landform features identified within the study area.
- Consideration of site type, raw material types and site densities likely to be present within the study area.
- Findings of the ethnohistorical research on the potential for material traces to present within the study area.
- Potential Aboriginal use of natural resources present or once present within the study area.
- Consideration of the temporal and spatial relationships of sites within the study area and surrounding region.

Based on this information, a predictive model has been developed, indicating the site types most likely to be encountered during the survey and subsequent sub-surface investigations across the present study area (Table 3). The definition of each site type is described firstly, followed by the predicted likelihood of this site type occurring within the study area.

Table 3 Aboriginal site prediction statements

Site type	Site description	Potential
Flaked stone artefact scatters and isolated artefacts	Artefact scatter sites can range from high-density concentrations of flaked stone and ground stone artefacts to sparse, low-density 'background' scatters and isolated finds.	Moderate: stone artefact sites have been previously recorded in the region. Due to the proximity to permanent water resources, the potential for artefacts to be present within the study area is assessed as moderate.
Shell middens	Deposits of shells accumulated over either singular large resource gathering events or over longer periods of time.	Moderate: shell midden sites have not been recorded within the vicinity of the study area. There is the potential for shell middens to be located in sandy deposits on the edge of Narrabeen Lagoon due to its proximity to a permanent water resource.
Potential Archaeological Deposits (PADs)	Potential sub surface deposits of cultural material.	Moderate: PADs have been previously recorded in the region. PADs are likely to be present within areas adjacent to water courses or on high points in undisturbed landforms.
Grinding grooves	Grooves created in stone platforms through ground stone tool manufacture.	Moderate: grinding grooves have been recorded in the vicinity of the study area. Suitable horizontal sandstone rock outcrops could occur in the study area.
Quarries	Raw stone material procurement sites.	Low: there is one record of a stone quarry in the vicinity of the study area. Suitable geology for stone quarries is not present in the study area so there is a low potential.
Scarred trees	Trees with cultural modifications	Low: scarred trees have not been recorded in the vicinity of the study area. Due to extensive vegetation clearance only a small number of mature native trees have survived in the study area.
Burials	Aboriginal burial sites.	Low: Aboriginal burial sites are generally situated within deep, soft sediments, caves or hollow trees. Areas of deep sandy deposits will have the potential for Aboriginal burials.
Rock shelters with art and / or deposit	Rock shelter sites include rock overhangs, shelters or caves, and generally occur on, or next to, moderate to steeply sloping ground characterised by cliff lines and escarpments. These naturally formed features may contain rock art, stone artefacts or midden deposits and may also be associated with grinding grooves.	Low: art sites are the most commonly recorded sites in the region and will occur where suitable sandstone exposures or overhangs possessing sufficient sheltered space exist. The study area is not likely to contain these outcrops

Site type	Site description	Potential
Aboriginal ceremony and dreaming sites	Such sites are often intangible places and features and are identified through oral histories, ethnohistoric data, or Aboriginal informants.	Low: there are currently no recorded mythological stories for the study area.
Post-contact sites	These are sites relating to the shared history of Aboriginal and non-Aboriginal people of an area and may include places such as missions, massacre sites, post-contact camp sites and buildings associated with post-contact Aboriginal use.	Low: there are no post-contact sites previously recorded in the study area and historical sources do not identify one.
Aboriginal places	Aboriginal places may not contain any "archaeological" indicators of a site, but are nonetheless important to Aboriginal people. They may be places of cultural, spiritual or historic significance. Often they are places tied to community history and may include natural features (such as swimming and fishing holes), places where Aboriginal political events commenced or particular buildings.	Low: there are currently no recorded Aboriginal historical associations for the study area.

Visual inspection

A visual inspection of the study area was undertaken on 25 October 2017 By James Cole (Archaeologist). The visual inspection consisted of a systematic survey of the study area to identify and record any Aboriginal archaeological sites visible on the surface or areas of Aboriginal archaeological potential and cultural sensitivity. The archaeological survey was conducted on foot. The methods used during the visual inspection conformed to Requirements 5 to 8 of the *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010b). For terminology and definitions used within this section, please refer to the aforementioned guideline.

The study area was located across a low lying alluvial flat adjacent to Narrabeen Lagoon. With the exception of the track running through it, the entirety of the impact area was densely vegetated, offering no visibility for the detection of Aboriginal objects. The results of the visual inspection are outlined in Figure 7.

The track itself appeared to be constructed of compacted earth (Plate 1), with raised boardwalk areas present (Plate 2, Plate 3), most likely installed as the area is relatively low lying and flood prone. Exposure and visibility along the existing track, which comprises the majority of the study area, was close to 100%, however this area has been subject to heavy disturbance. Not Aboriginal sites or areas of potential were identified in this area.

The two lead in areas adjacent to the track which are intended to be cleared to install the proposed boardwalk, exhibited no areas of exposure, and no visibility. These areas appeared to have been subject to less disturbance (Plate 4, Plate 5, Plate 6).

Background research undertaken for the assessment indicated that there was a moderate potential for stone artefacts, PADs, shell middens, and grinding grooves to occur within the study area. As outlined above, areas of exposure were investigated for surface manifestations of Aboriginal sites, particularly stone

artefacts, with none being identified during the survey. No appropriate surfaces for grinding grooves or rock engravings sites were identified during the survey.

There is the potential for sites such as PADs and shell middens to be present within a given area without any visible surface indicators. No areas of PAD were identified during the survey, nor were any indicators the shell middens may be present within the study area. Based on the context of the site, which is low lying and swampy, it is considered unlikely that it would have provided an opportune location for Aboriginal people to camp, and such sites, if present, would be more likely to be located in elevated areas to the north of the study area.

A review of the geotechnical investigation carried out for the proposed works identified that groundwater is present at depths of 300 to 500 millimetres across the site, however further information on water levels and the natural formation of the lagoon is unavailable at present. Available evidence suggests that the study area is contained within a low lying and naturally swampy area with elevations of 2 to 4 metres above sea level. This is supported by an examination of the existing track and road verge within the study area, both of which have been built up to avoid this issue.

The local context of the site suggests that a more opportune location for Aboriginal occupation would have been located to the north of the study area. This area is at a higher elevation and therefore not subject to the same issues as the study area, and is still in close proximity to the natural resources offered by the lagoon. Overall, it is considered that there is a low potential for Aboriginal sites to be present within the study area.

Step 5: Further investigations and impact assessment

Further assessment is not warranted based upon the completion of Steps 1 to 4 of the code. The study area has been determined to have a low potential to contain Aboriginal sites

The project may proceed with caution, subject to the following recommendations:

- All Aboriginal objects and Places are protected under the NPW Act. It is an offence to knowingly disturb an Aboriginal site without a consent permit issued by the Office of Environment and Heritage (OEH). Should any Aboriginal objects be encountered during works associated with this proposal, works must cease in the vicinity and the find should not be moved until assessed by a qualified archaeologist. If the find is determined to be an Aboriginal object the archaeologist will provide further recommendations. These may include notifying the OEH and Aboriginal stakeholders.
- Aboriginal ancestral remains may be found in a variety of landscapes in NSW, including middens and sandy or soft sedimentary soils. If any suspected human remains are discovered during any activity you must:
  - Immediately cease all work at that location and not further move or disturb the remains
  - Notify the NSW Police and OEH's Environmental Line on 131 555 as soon as practicable and provide details of the remains and their location
  - Not recommence work at that location unless authorised in writing by OEH.

Please contact me if you have any enquiries.

Yours sincerely

James Cole
Archaeologist

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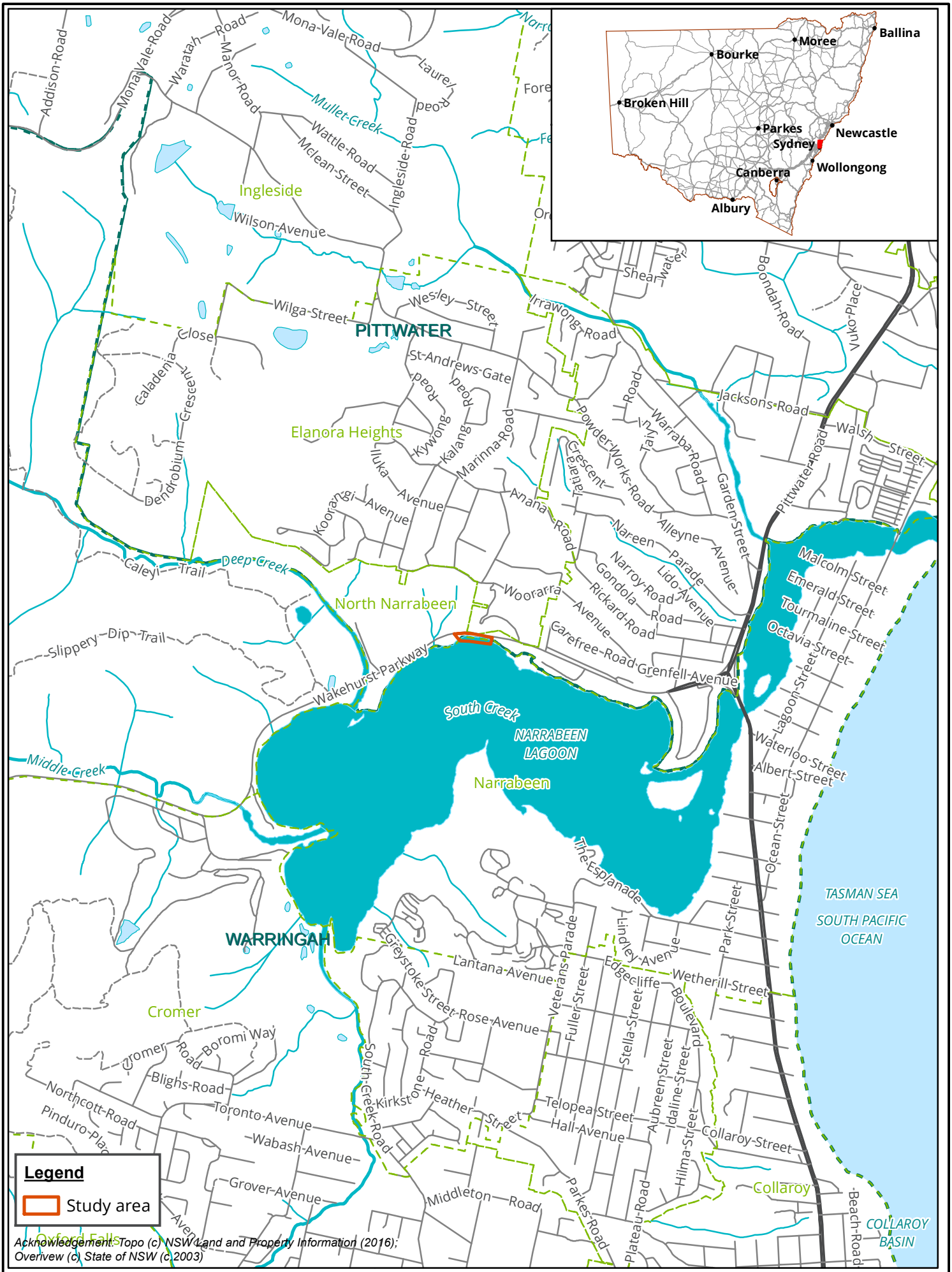
Appendix 1 Figures



Acknowledgement: Topo (c) NSW Land and Property Information (2016); Overivew (c) State of NSW (c.2003)

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Figure 1: Location of the study area in a regional context

Matter: 25499
Date: 25 October 2017,
Checked by: JAC, Drawn by: LH, Last edited by: lharley
Location:P:\25400s\25499\Mapping\

0 250 500 750 1,000
Metres

N

Scale 1:25,000 @ A4, GDA 1994 NSW Lambert

Legend

- Study area
- Proposed works footprint
- Existing trail

Figure 2: Detailed aerial of the study area

0 6 12 18 24 30

Metres

Scale: 1:700 @ A3

Coordinate System: GDA 1994 NSW Lambert

N

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Matter: 25499
Date: 25 October 2017,
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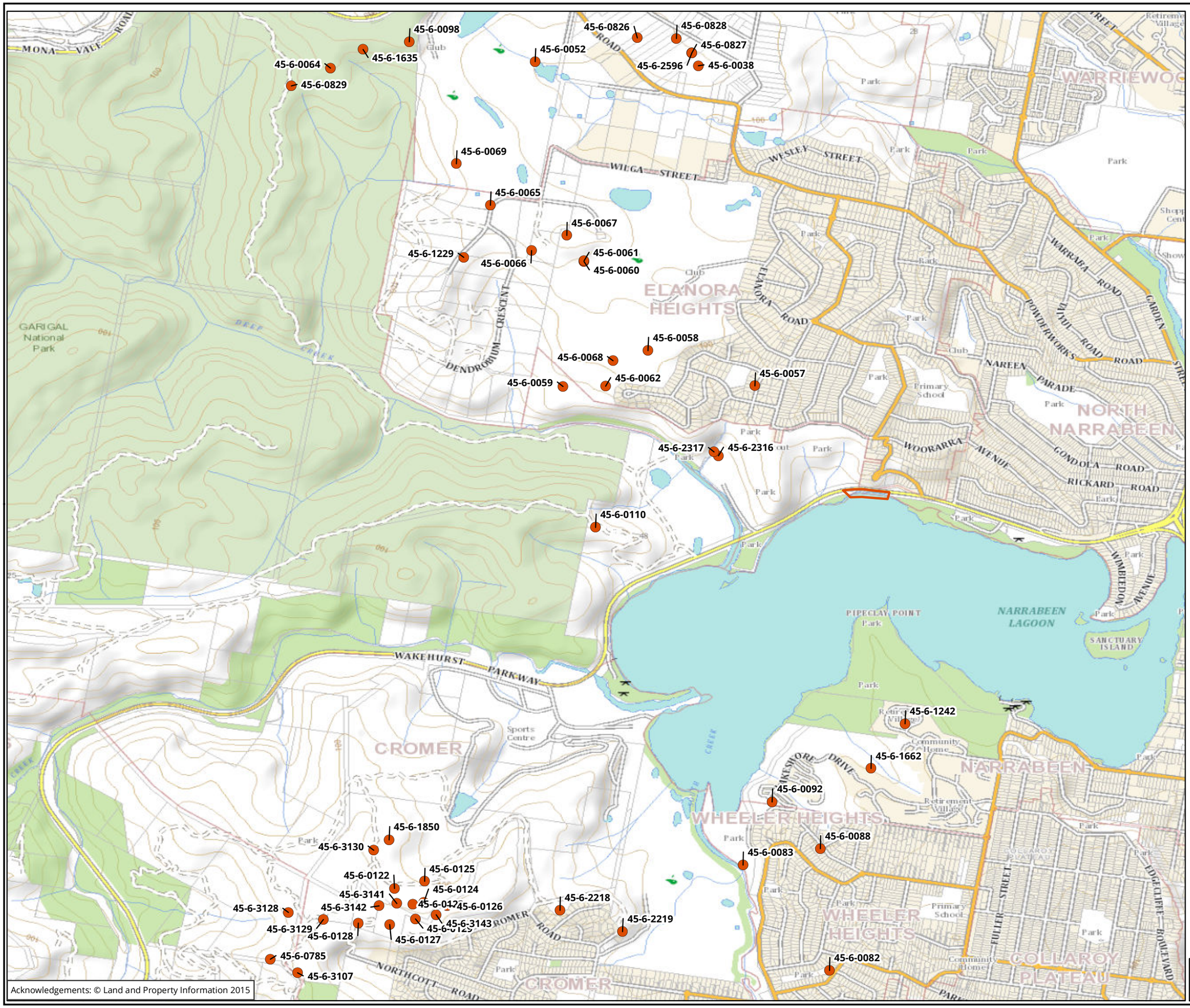

Acknowledgements: © Land and Property Information 2015

Figure 3: AHIMS sites in the vicinity of the study area

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Matter:
Date: 25 October 2017,
Checked by: lharley, Generated by: lharley
Location:P:\25400s\25499\Mapping
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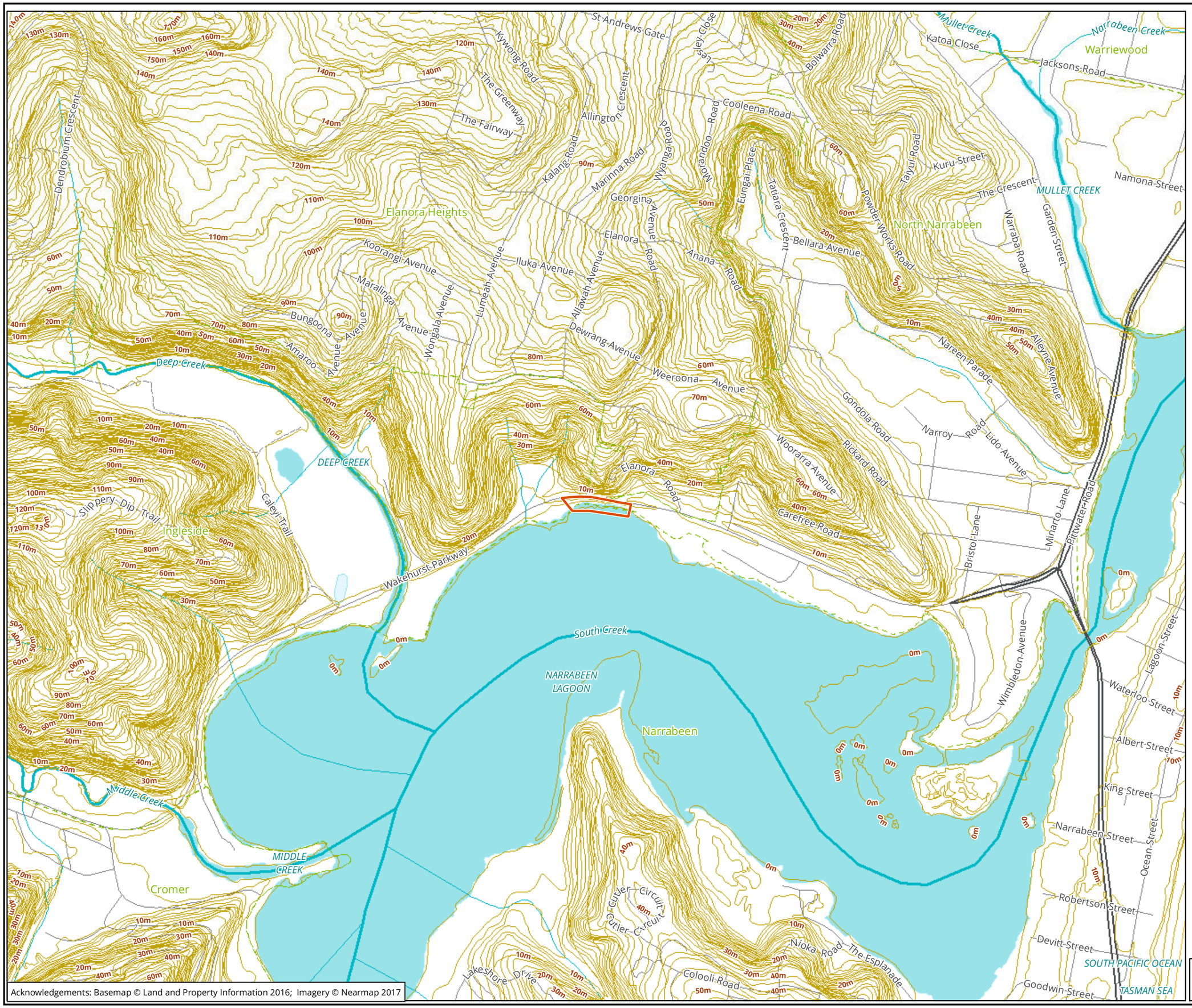

Acknowledgements: Basemap © Land and Property Information 2016; Imagery © Nearmap 2017

Legend

- Study area
- Contour

HydroArea

- Canal-Drain
- NaturalWatercourse

HydroLine

- NonPerennial
- Perennial

Figure 2: Hydrology associated with the study area

0 90 180 270 360 450

Metres
Scale: 1:10,000 @ A3
Coordinate System: GDA 1994 NSW Lambert

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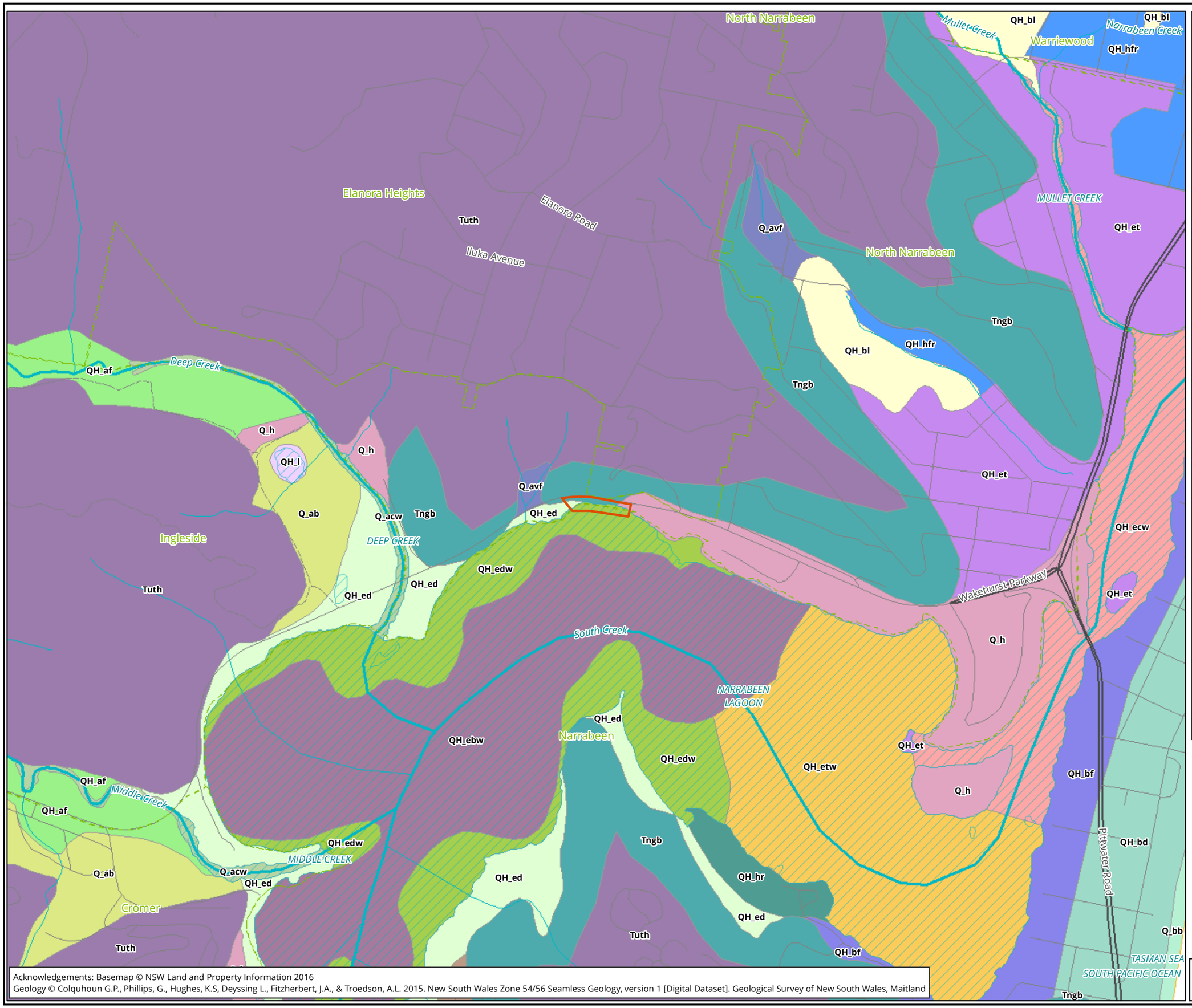

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Geology © Colquhoun G.P., Phillips, G., Hughes, K.S, Deyssing L., Fitzherbert, J.A., & Troedson, A.L. 2015. New South Wales Zone 54/56 Seamless Geology, version 1 [Digital Dataset]. Geological Survey of New South Wales, Maitland

Legend

- Study area

Geological Units

- Q_ab - Alluvial backswamp deposits
- Q_acw - Alluvial channel deposits-
- Q_av - Alluvial valley deposits
- Q_avf - Alluvial fan deposits
- Q_bb - Coastal deposits- beach facies
- Q_h - Anthropogenic deposits
- QH_af - Alluvial floodplain deposits
- QH_bd - Coastal deposits- dune facies
- QH_bf - Coastal deposits- backbarrier flat facies
- QH_bl - Coastal deposits- lagoon facies
- QH_ebw - Estuarine basin and bay (subaqueous)
- QH_ecw - Estuarine channel deposits (subaqueous)
- QH_ed - Estuarine- fluvial delta front
- QH_edw - Estuarine- fluvial delta front (subaqueous)
- QH_et - Estuarine tidal-delta flat
- QH_etw - Estuarine tidal delta flat (subaqueous)
- QH_hfr - Anthropogenic deposits-Fill on Quaternary deposits
- QH_hr - Anthropogenic deposits-Reclaimed estuarine areas
- QH_l - Claypan and lacustrine deposits
- Tngb - Burralow Formation
- Tuth - Hawkesbury Sandstone

Figure 5: Geological formations associated with the study area

0 100 200 300 400 500

Metres
Scale: 1:10,000 @ A3
Coordinate System: GDA 1994 NSW Lambert

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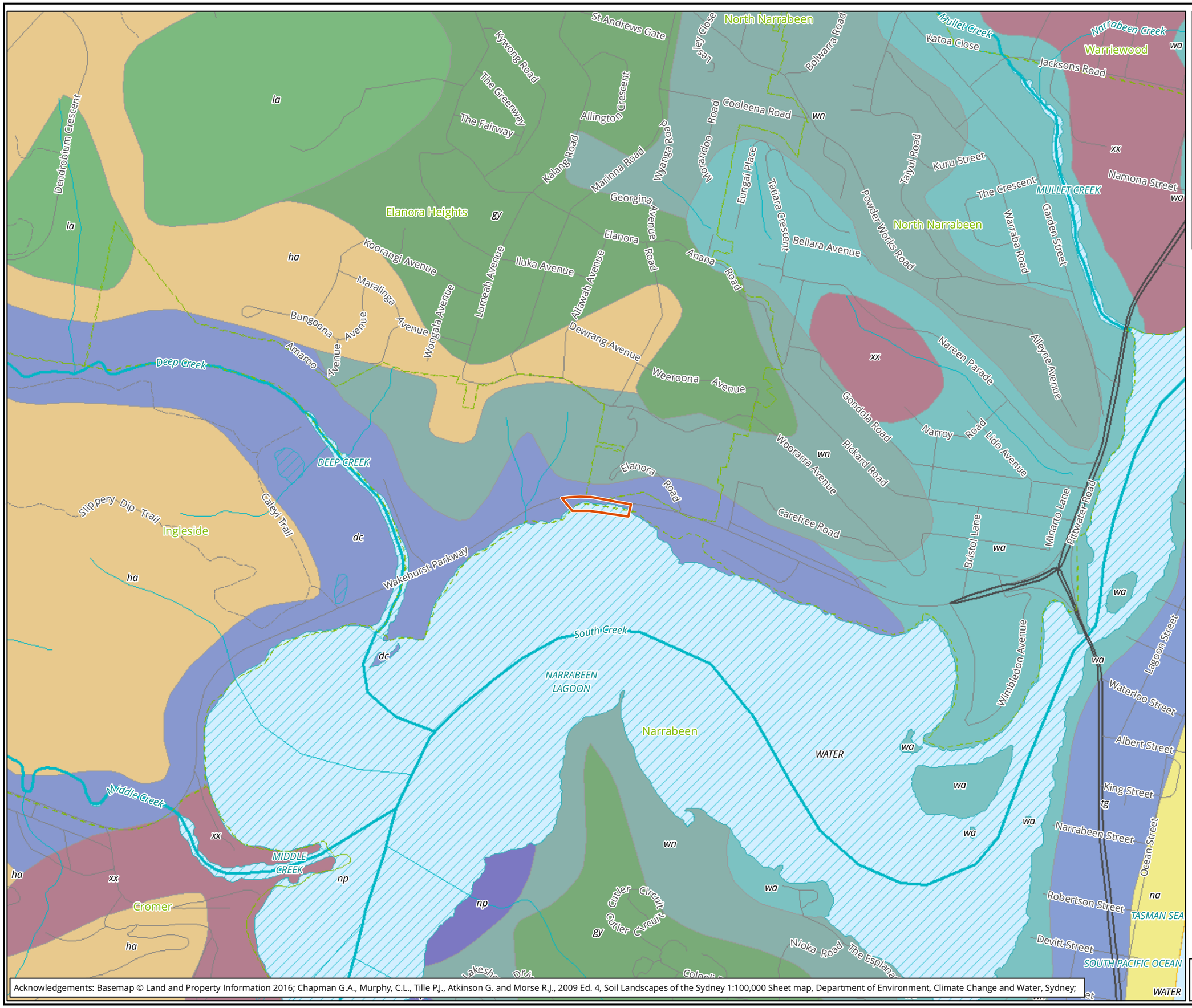

Legend

Study area

Soil Landscape units

- dc - DEEP CREEK
- gy - GYMEA
- ha - HAWKESBURY
- la - LAMBERT
- na - NARRABEEN
- np - NEWPORT
- tg - TUGGERAH
- wa - WARRIEWOOD
- WATER - WATER
- wn - WATAGAN
- xx - DISTURBED TERRAIN

Figure 6: Soil landscapes associated with the study area

0 100 200 300 400 500

Metres

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 NSW Lambert

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25499_ADD_F6_Soils

Acknowledgements: Basemap © Land and Property Information 2016; Chapman G.A., Murphy, C.L., Tille P.J., Atkinson G. and Morse R.J., 2009 Ed. 4, Soil Landscapes of the Sydney 1:100,000 Sheet map, Department of Environment, Climate Change and Water, Sydney;

Legend

- Study area
- Proposed works footprint
- Existing trail

Areas of archaeological potential

- Low

Figure 7: Survey results

0 6 12 18 24 30

Metres
Scale: 1:700 @ A3
Coordinate System: GDA 1994 NSW Lambert

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Matter: 25499
Date: 25 October 2017,
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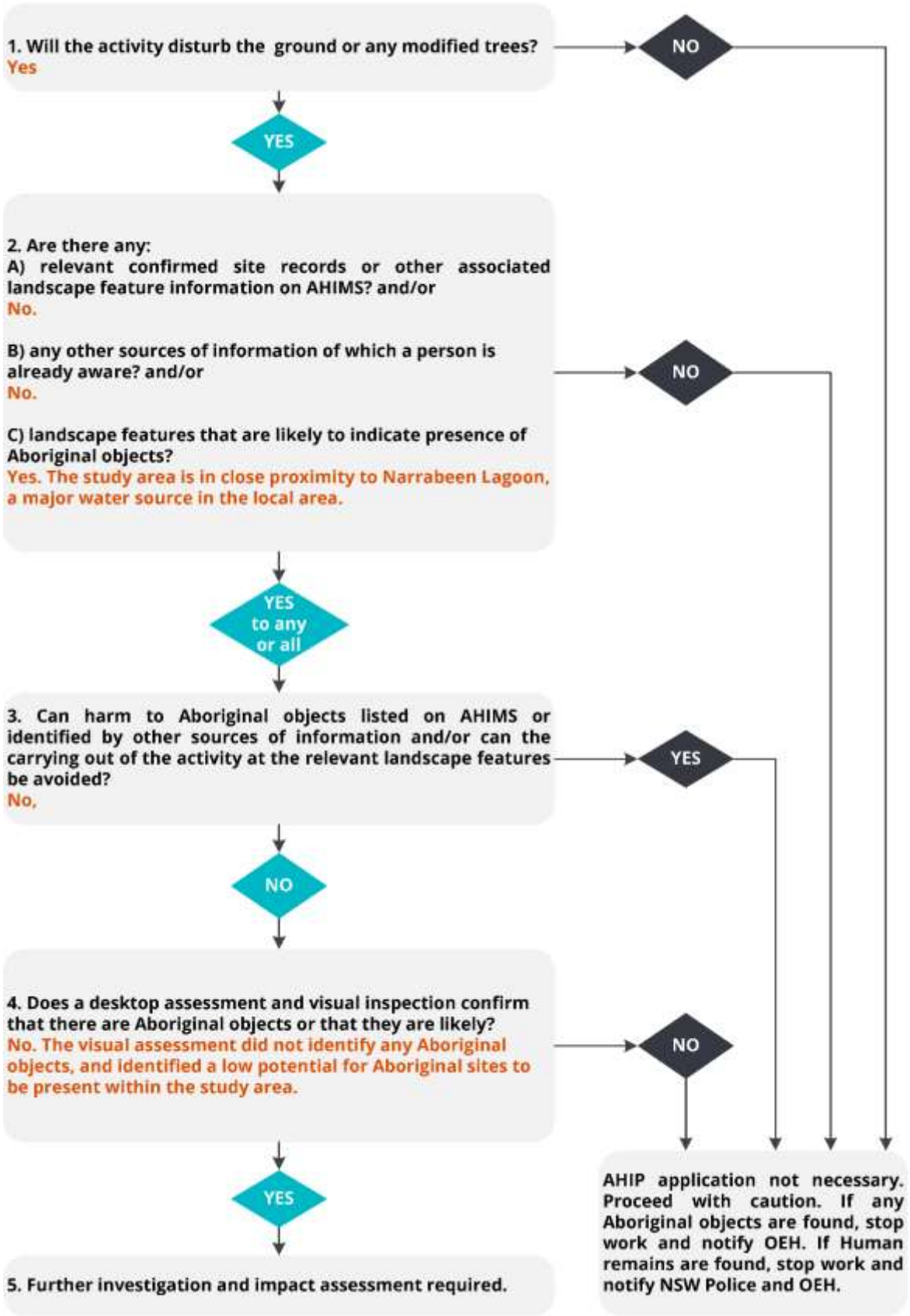
25499_ADD_F7_SurveyResults

Figure 8 Due diligence flow chart



Appendix 2 Plates

Plate 1 View west along track through the study area

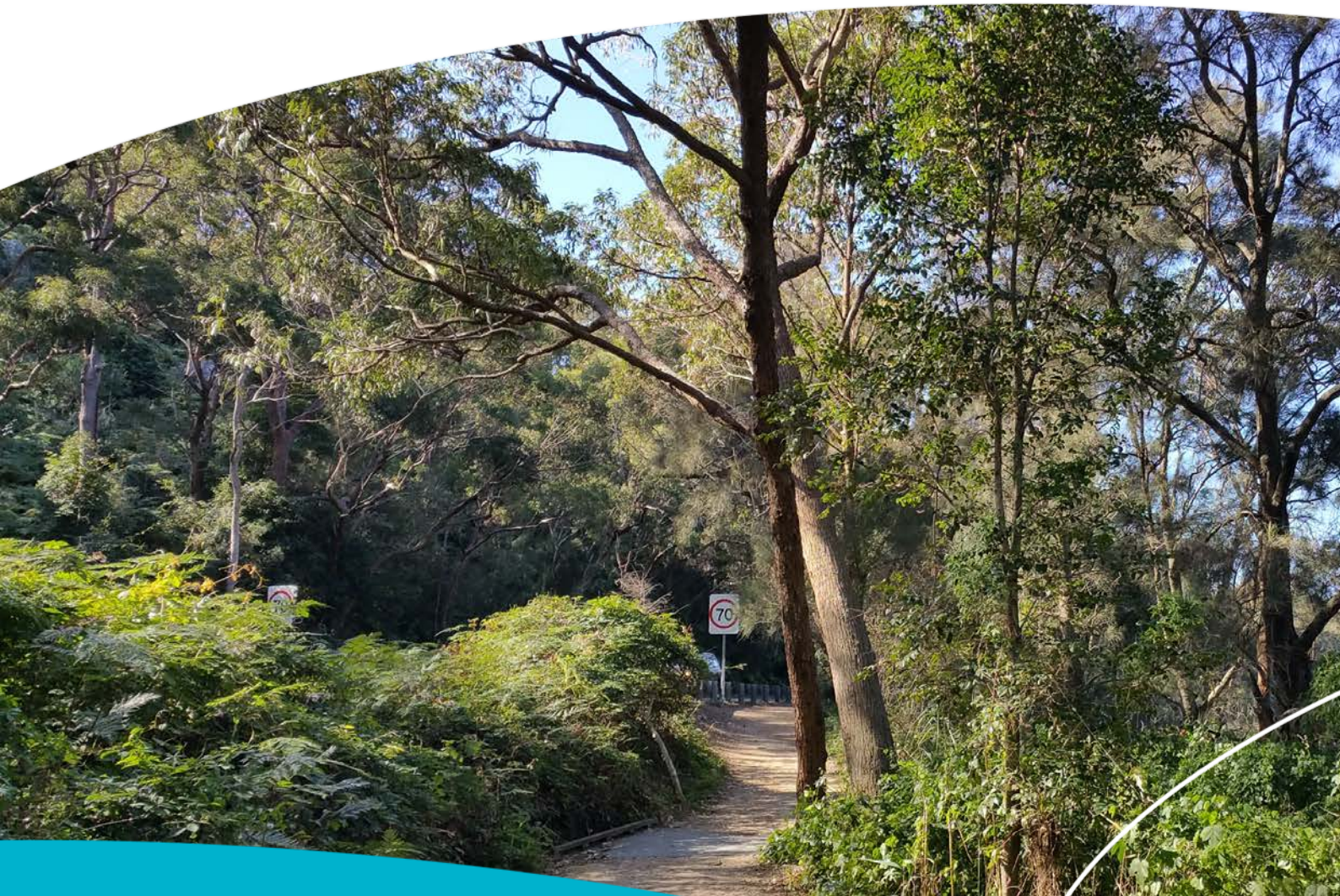
Plate 2 View east along track through the study area, showing boardwalk

Plate 3 View north showing built up boardwalk area

Plate 4 view north-east showing dense vegetation within lead in areas

Plate 5 View south-west showing dene undergrowth within the lead in areas

Plate 6 View south showing dense vegetation within the western lead in area.



Biodiversity Management Plan

Narrabeen Lagoon Stage 3 Multi Use Trail Alignment

DRAFT REPORT

Prepared for Northern Beaches Council c/o Thompson Berrill Landscape Design Pty Ltd

14 November 2017

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Version	Internal reviewer	Date issued
Draft report 01	Callan Wharfe	10/11/2017

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- Department of the Environment and Energy for access to the Protected Matters Search Tool of the Australian Government
- NSW Office of Environment and Heritage for access to the BioNet Atlas of NSW Wildlife.

Biosis staff involved in this project were:

- Carl Corden, Luke Stone, Callan Wharfe
- Gareth Davies (mapping)

Contents

Tables

Figures

Glossary

BMP	Biodiversity Management Plan
BMP area	Area consisting of proposed works zone, retained vegetation and revegetation areas
BC Act	*Biodiversity Conservation Act 2016*
CBD	Central Business District
DA	Development Application
DCP	Development Control Plan
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
LEP	Local Environment Plan
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
PCT	Plant Community Type
TEC	Threatened ecological community
WM Act	*Water Management Act 2000*

1 Introduction

1.1 Project background

Biosis Pty Ltd was commissioned by Thompson Berrill Landscape Design Pty Ltd (TBLD) on behalf of Northern Beaches Council ('Council') to prepare a Biodiversity Management Plan (BMP) for an area adjacent to the Narrabeen Multi Use Trail (NMUT) (Figure 1). Council proposes to improve the safety of a small section of the NMUT (the proposed works) by re-aligning a small section of the trail. This section is located between Bilarong Reserve and the Deep Creek Bridge, and passes the monument rocks adjacent to Wakehurst Parkway.

The site of the proposed trail re-alignment will require minor clearing of terrestrial vegetation and habitat where it detours to the south from the current track at the eastern and western end of the proposed works. The central section of the new alignment will be a constructed bridge supported on pylons over Narrabeen Lagoon. The impacts of the proposed works on marine habitats (specifically sea grass) have been assessed (Marine Pollution Research 2017) as part of the Review of Environmental Factors prepared by Biosis (Biosis 2017a).

Field investigations were carried out by Biosis on the 30 May 2017 and compiled into a report *Flora and fauna assessment for the proposed upgrade to the Narrabeen Multi Use Trail alignment* (Biosis 2017b) to determine the potential impacts of the proposed works. Data collected during this field work has also been used to inform the contents of this BMP.

1.2 BMP Scope

The overarching aim of this BMP is to ensure the conservation of the ecological values within the study area, with particular regard to the native vegetation in addition to any threatened species or populations likely to utilise it. The BMP will realise this aim by providing a management framework to guide the rehabilitation of retained vegetation and the installation of native plantings into the decommissioned existing trail within the study area along NMUT. The objectives of this BMP are to:

- Manage current vegetated areas to prevent damage and/or degradation to native vegetation and fauna habitat values pre, during and post construction.
- Restore native vegetation areas using ecological restoration and revegetation strategies.
- Protect and manage threatened species, populations and threatened ecological communities (TECs) (threatened biota) within the study area.
- Protect the catchment values of local waterways and sensitive receiving bodies.
- Prevent soil erosion and improve the soil stability within the study area.
- Offset any loss of fauna habitat values as required.
- Monitor the outcomes of ecological restoration works.

1.3 Location of the BMP area and study area

The study area is approximately 18 km from Sydney CBD and is bounded by the existing NMUT to the east and west, Wakehurst Parkway to the north and Narrabeen Lagoon to the south.

The study area occupies 0.21 hectares. Current zoning is *SP2 – Infrastructure: Waste or Resource management Facility* in the Pittwater Local Environmental Plan (LEP) 2014.

The study area is within the:

- Sydney Basin Interim Biogeographic Regionalisation of Australia (IBRA) Bioregion.
- Pittwater (Part B) IBRA Sub-region.
- Deep Creek Soil Landscape.
- Narrabeen Lagoon Basin (Port Jackson/Georges River catchment).
- Northern Beaches Council Local Government Area (LGA).

1.4 Impacts associated with the project

The following direct and indirect impacts are associated with the proposed works:

- Removal of 0.02 hectares of native vegetation.
- Potential indirect impacts to threatened fauna species and their habitat.
- Increased edge effects to the BMP area interface.
- Increased risk of accidental introduction of soil borne and plant pathogens.
- Potential spread of existing weed populations (including priority weeds) and risk of novel weed introduction.

Mitigation of these impacts will be achieved through undertaking ongoing biodiversity management actions within the BMP area as described in Sections 3 and 4 below.

1.5 Legislative context

The following legislation or planning instruments are relevant to the works associated with the proposal and the BMP within the study area.

Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The EPBC Act is the Australian Government's key piece of environmental legislation. The EPBC Act applies to developments and associated activities that have the potential to significantly impact on Matters of National Environmental Significance (NES) protected under the Act.

Under the EPBC Act, activities that have potential to result in significant impacts on Matters of NES must be referred to the Commonwealth Minister for the Environment for assessment. No significant impacts top matters of NES are expected to occur as a result of the proposed works.

Environmental Planning and Assessment Act 1979 (EP&A Act)

The EP&A Act was enacted to encourage the proper consideration and management of impacts of proposed development or land-use changes on the environment (both natural and built) and the community. The EP&A Act is administered by the NSW Department of Planning and Environment (DP&E).

The proposed works are to undergo assessment under the EP&A Act.

Biodiversity Conservation Act 2016 (BC Act)

The BC Act is the key piece of legislation providing for the protection and conservation of biodiversity in NSW through the listing of threatened biota, key threatening processes and critical habitat for threatened biota. Impacts to threatened biota listed on the BC Act are assessed under the EP&A Act.

Biosecurity Act 2015

The Biosecurity Act was enacted to provide for the identification, classification and control of all biosecurity threats within NSW. These threats include the priority exotic flora species which have been identified per Local Land Services (LLS) region. The study area is located within the Greater Sydney LLS region in which three priority weeds species have been identified, and are discussed further below.

Warringah Local Environmental Plan 2011 and Pittwater Local Environment Plan 2014

Local Environment Plans (LEP) are created by Councils in consultation with their community and guide planning decisions for LGAs. They apply either to the whole or part of a LGA and make provision for the protection or utilisation of the environment through zoning of land and development controls.

The terrestrial portion of the study area is within the old Pittwater LGA and hence is subject to the Pittwater LEP. The aquatic portion of the study area is within the old Warringah LGA and subject to the Warringah LEP

Warringah Development Control Plan 2011 and Pittwater Development Control Plan 2015

A Development Control Plan (DCP) provides detailed planning and design guidelines to support the planning controls in the LEP and is prepared and adopted by councils. They identify additional development controls and standards for addressing development issues at a local level and can be applied more flexibly than a LEP.

2 Site Description

The study area is situated between Bilarong Reserve to the east and Deep Creek Reserve to the west. Land surrounding the study area primarily consists of foreshore and bushland reserves to the north, south and west of Wakehurst Parkway and the existing NMUT. Beyond the bushland reserves to the north and east is residential development.

Regional soil landscape mapping indicates that the study area occurs on the Deep Creek soil landscape, characterised by level to gently undulating alluvial floodplain draining the Hawkesbury Sandstone. Soils are deep podzols on well-drained terraces, siliceous sands on current floodplain and humus podzols in low lying areas (Chapman and Murphy 1989). The composition of the soil is highly influential on the vegetation communities observed.

The ecological values of the study area are described below.

2.1 Flora

The flora of the study area has been assessed in the flora and fauna assessment prepared by Biosis (2017b). No RoTAPs or threatened flora species were recorded within the study area during the field surveys. Species recorded during the flora and fauna assessments are typical of the riparian vegetation present within the study area, with a moderate level of exotic species invasion, and are listed in Table A.1 of Appendix 1.

2.2 Plant communities

The flora and fauna assessment Biosis (2017b) confirmed the presence of one plant community type (PCT) within the study area Figure 1.

Table 1 Plant community types of the BMP area

PCT	1234: Swamp Oak Swamp Forest Fringing Estuaries, Sydney Basin and South East Corner
Extent within study area	Approximately 0.21 hectares of this PCT was recorded within the BMP area
Description including fauna habitat	This community is typical of coastal floodplains of NSW below 20 meters elevation on grey-black clay-loams and sandy loams, where the groundwater is saline and features on the lagoon margin associated with coastal floodplains. Within the study area the canopy is dominated by Swamp Oak *Casuarina glauca* as well as intermittent Lilly Pilly *Acmena smithii*, Cabbage Tree Palm *Livistonia australis* and Cheese Tree *Glochidion fernandi.* The understorey is characterised by frequent occurrences of vines, Common Silkpod *Parsonsia straminea*, Scrambling Lily *Geitonoplesium cymosum* and Snake Vine *Stephania japonica* var. *discolor*. A sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter was also present. Ground layer plants include forbs such as; Indian Pennywort *Centella asiatica,* Scurvy Weed *Commelina cyanea*, Warrigal Greens *Tetragonia tetragonoidies* and *Viola banksii,* Tall Sedge *Carex appressa, Gahnia clarkei,* Mat Rush *Lomandra longifolia,* Basket Grass *Oplismenus imbecillis,* Harsh Ground Fern *Hypolepis muelleri*, Knobby Club-sedge *Ficinia nodosa*, Bare Twig Rush *Baumea juncea,* Sea Rush *Juncus kraussii, Phragmites australis.* Dominant weeds with the study area include Pennywort *Hydrocotyle bonariensis* and Coastal

	Morning Glory *Ipomoea cairica.* Fauna habitats present include forest vegetation as well as dense reeds along the foreshore of Narrabeen Lagoon. The proposed works will require removal of only a very small portion of fauna habitat from the study area, and similar fauna habitats occur to the east and west of the study area that will not be-impacted by the proposed works. The study area does not support any hollow-bearing trees, active bird nests or possum dreys, freshwater aquatic habitats, caves and culverts or other important habitat features required by most threatened fauna recorded from the locality. The study area provides a small, linear area of suitable habitat for common fauna, including non-threatened birds. It is also likely that a small number of threatened fauna species would occasionally forage within or adjacent to the study area. However the study area does not provide suitable breeding habitat for these species.
Condition	The community is generally in moderate condition with occurrences of exotic vines and herbs common due to surrounding land use and associated edge impacts.
Threatened ecological community	Commonwealth EPBC Act: Not listed NSW BC Act: Listed as Swamp Oak Floodplain Forrest Endangered Ecological Community
Picture: Existing track with Swamp Oak Forest on either side of track	

2.3 Terrestrial habitats

2.3.1 Threatened species habitats

Background searches identified 27 threatened flora species recorded (OEH 2017) or predicted to occur (DEE 2017) within 5 kilometres of the study area. Based on the location of the study area, being on the foreshores of Narrabeen Lagoon, as well as the associated soils present within this location, none of the 27 recorded threatened flora within 5 kilometres are expected to occur within the study area. In addition, survey effort failed to locate any of locally occurring threatened flora listed species.

Limited threatened species habitat occurs within the study area in the form of:

- Black Bittern *Ixobrychus flavicollis* (Vulnerable, BC Act).
- White-bellied Sea-eagle *Haliaeetus leucogaster* (Vulnerable, BC Act).
- Eastern Osprey *Pandion cristatus* (Vulnerable, BC Act).

- Grey-headed Flying-fox *Pteropus poliocephalus* (Vulnerable, EPBC Act and BC Act).

An assessment of the likelihood of threatened flora and fauna species occurring in the study area, projected impacts to these species and assessment under the EPBC Act and BC Act have been undertaken in the fauna and flora assessment prepared by Biosis (2017b).

2.3.2 Non-threatened birds

The study area supports habitat for a range of non-threatened birds known to occur in the locality. Appendix 4 of the flora and fauna assessment (Biosis 2017) provides a list of all bird species recorded within the study area during the field investigation.

Bird habitat present within the study area includes:

- Forest vegetation, providing forage, shelter and breeding habitat in the form of dense understorey, mid-storey and canopy vegetation.
- Dense reeds along the foreshore of Narrabeen Lagoon providing forage and shelter habitat for cryptic wetland birds and small passerines.
- Intertidal areas of the foreshore providing forage habitat for resident and migratory wading birds and waterfowl.

The study area lies between similar areas of habitat to the east (Bilarong Reserve) and west (Deep Creek Reserve). Habitat to the north of the study area is also relatively intact forest/woodland vegetation. The impacts of edge effects such as exclusion or predation by more aggressive birds (e.g. Noisy Miner *Manorina melanocephala*) within the study area are therefore relatively low compared to similar habitats within urban surroundings. The assemblage recorded within the study area during the field investigation included a number of small passerines (e.g. Superb Fairy-wren *Malurus cyaneus* and Brown Thornbill *Acanthiza pusilla*) that are often excluded by Noisy Miners.

2.3.3 Wildlife connectivity

The study area lies within a narrow, linear strip of vegetation connecting larger areas of habitat to the east and west. Habitat continues to the west of Deep Creek Reserve, however wildlife connectivity to the east of Bilarong Reserve is limited due to residential development.

2.4 Aquatic habitats

Six tributaries feed Narrabeen Lagoon, which is an intermittent closed and open lagoon covering approximately 55 square kilometres (Harris et al. 2010). Saltmarsh, reed swamp and seagrass vegetation communities were mapped within the study area and recorded in the broader lagoon by Marine Pollution Research (2017). All of the mapped vegetation communities provide habitat for terrestrial and or aquatic fauna. No mangrove stands or individuals were recorded. Recommendations to protect and limit impacts to aquatic habitats within the study area associated with the proposed construction, provided by Marine Pollution Research (2017), are included within Table 7 below.

2.5 Weed presence and dispersal vectors

The flora and fauna assessment (Biosis, 2017b) recorded a total of nine exotic species as occurring within the study area. Three of these exotic species are declared priority weeds within the Greater Sydney LLS region (DPI 2017). The control class and legal requirements for these two priority weeds are outlined in Table 2.

Table 2 Priority weeds within the study area

Scientific name	Common name	Duty
Anredera cordifolia	Madeira Vine	Prohibition on dealings Must not be imported into the State or sold
Lantana camara	Lantana	Prohibition on dealings Must not be imported into the State or sold

Lantana and Madeira Vine are both fast growing species with the potential to outcompete surrounding native species. Lantana relies on bird transport of fruits for dispersal, with Madeira Vine utilising spread of its aerial tubers. These species do not currently occur as large infestation and as such it is recommended that their removal be prioritised to prevent increases in occurrence and maximise the potential for eradication.

The most abundant weeds within the study are Pennywort *Hydrocotyle bonariensis* and Coastal Morning Glory *Ipomoea cairica.* These weed species fall under the BS Act as 'All plants' and are subject to general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose.

The main method of dispersal for both of these species relies on a fast growth habit with the ability to out compete native species for optimal growing space. These species can be control using treatment techniques that allow native species time to recolonise areas following suppression of the weed species. In areas of thick infestation it is important to undertake multiple treatments to prevent recolonization and to to ensure that other weeds do not become established.

Based on the main dispersal mechanisms for the above weeds, it is recommended that future weed control sweeps concentrate on:

- Removing exotic species impacting directly the existing vegetation i.e. vine weeds growing on Swamp Oaks.
- Removal of all Madeira Vine aerial tubers from site.
- Treatment of plants using bird and mammal dispersal throughout the entire BMP area.
- Ensuring that newly planted species are not smothered by encroaching weed species.

Legend

- Study area
- Proposed works footprint

Vegetation communities

- S_FoW08: Estuarine Swamp Oak Forest

Figure 1: Ecological values

0 6 12 18 24 30

Metres
Scale: 1:700 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N

Biosis Pty Ltd

Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

Matter: 24787
Date: 16 June 2017,
Checked by: CAC, Drawn by: LH, Last edited by: lharley
Location:P:\24700s\24787\Mapping
24787_F1_EcologicalFeatures

Acknowledgements: Basemap © Land and Property Information 2016

3 BMP area and zones

3.1 BMP area and zones

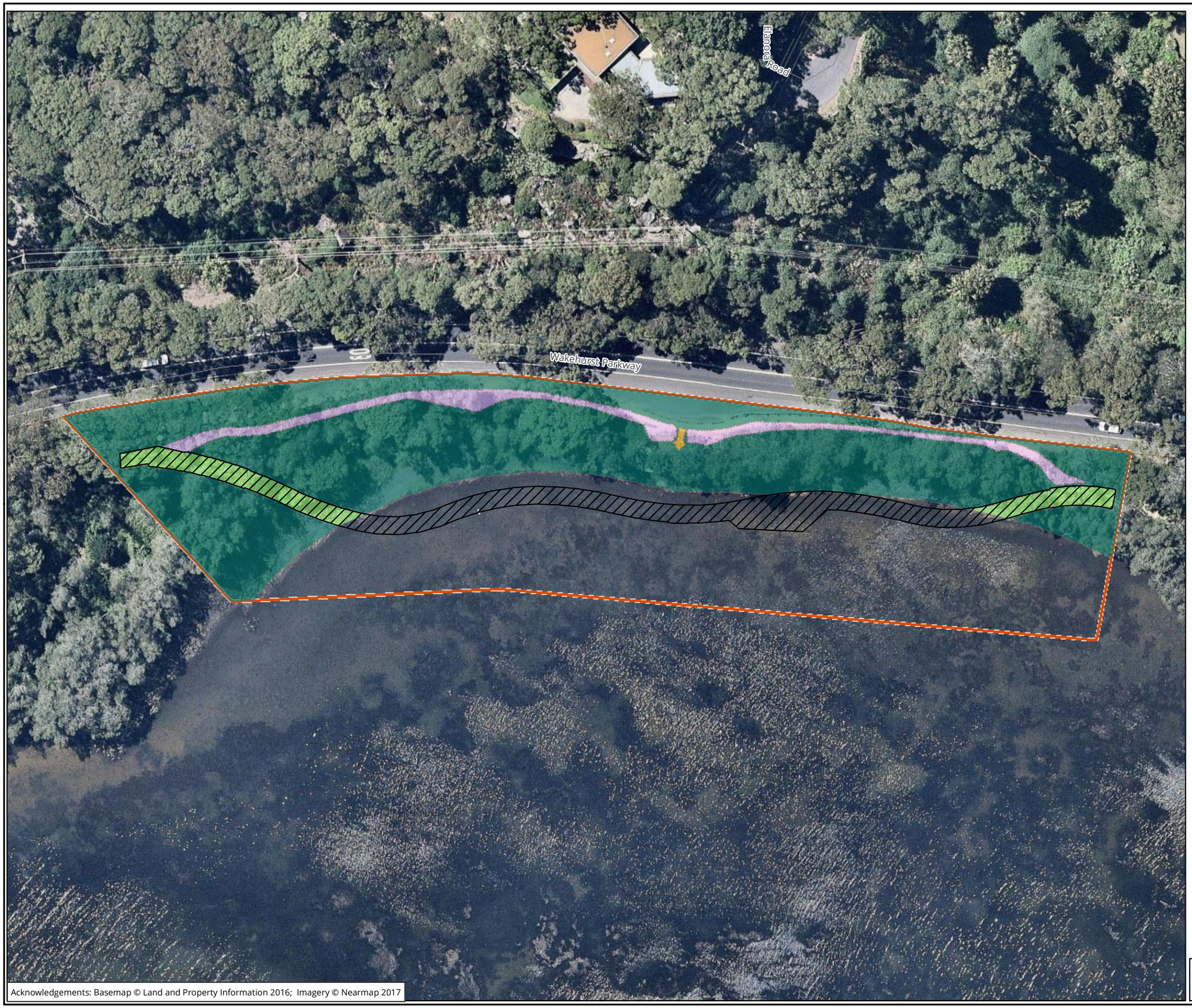
The BMP area covers the entire study area, such that it is a 0.21 hectare vegetation patch bounded by the existing NMUT to the east and west, Wakehurst Parkway to the north and Narrabeen Lagoon to the south.

The BMP area has been divided into three BMP zones (Figure 2):

- Revegetation zone – 20 meters from the edge of the BMP area.
  - Swamp Oak revegetation zone
  - Water Significant Urban Development (WSUD) revegetation zone
- Restoration zone – the remaining mapped vegetation within the BMP area not directly impacted by the works.
- Works zone - the area requiring vegetation removal.

The BMP area and BMP zones are illustrated on Figure 2.

Biodiversity management actions for each BMP zone and prescribed methods for their implementation are outlined in Sections 4 and 5 below.



Legend

- Study area
- Proposed works footprint

Management zone

- Restoration Zone
- Revegetation Swamp Oak
- Revegetation – WSUD
- Works zone

Figure 2: Management zones

0 6 12 18 24 30

Metres

Scale: 1:650 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

Biosis Pty Ltd

Albury, Ballarat, Melbourne,
Newcastle, Sydney, Wangaratta & Wollongong

Matter: 25499
Date: 14 November 2017,
Checked by: JAC, Drawn by: LH, Last edited by: lharley
Location:\\bio-data-01\matters$\25400s\25499\Mapping\25499_ManagementZones

4 Biodiversity management methods

4.1 General approach

This BMP provides a framework for the management of vegetation within the BMP area.

Works are to be undertaken by a professional, and suitability qualified bush regeneration contractor. This is necessary due to the presence of State listed vegetation and potential habitat for other threatened biota within and adjacent to the BMP area.

Works are to follow the standard best practice bush regeneration method of primary and secondary weed removal, followed by revegetation where required. Additional works include maintenance weeding to aid establishment of plantings and ensure sufficiently low levels of weed occurrence.

Works are to progress from areas in higher ecological condition towards areas of lower ecological condition. This will ensure areas more likely to respond positively to restoration actions are prioritised, whilst areas where high levels of resource input are required, are managed (at a minimum) to levels that ensure the protection of adjacent higher quality vegetation.

Where works occur within, or on the interface of the BMP area, they are to be guided by this BMP, and/or by the Project Ecologist.

4.2 Priority Weed management

The study area supports exotic species that require appropriate management under the Biosecurity Act. Twoexotic species recorded in the study area are listed as priority weeds under the Biosecurity Act for the Greater Sydney LLS region.

Table 3 outlines the priority weed species recorded within the study area during the field investigations, and outlines management recommendations.

Table 3 Priority and other weed species recorded in the study area and control measures

Scientific name	Common name	Manual control	Chemical control*[1]
Anredera cordifolia	Madeira Vine	Deep manual digging/shallow mechanical excavation	Scrape and paint • Glyphosate 360 g/L Rate: Undiluted Comments: Every specimen must be treated separately, remove tubers before scraping • All tubers and plant material must be bagged and removed from site.

Scientific name	Common name	Manual control	Chemical control*[1]
Lantana camara	Lantana	Hand removal (seedlings only). Seed pods should be collected from the plant, bagged and removed from site.	Can be treated by: • Cut and paint using Glyphosate 360 g/L (Roundup®) Rate: Undiluted • Spot spray using Glyphosate 360 g/L (Roundup®) Rate: 100ml glyphosate per 10 L water Comments: Knapsack sprayer, must be during actively growing with full foliage and not within summer

*[1] *Chemical control options are as per the NSW Department of Primary Industries (DPI) Noxious and Environmental Weed Control Handbook* (DPI 2014) in addition to the *NSW DPI WeedWise website (DPI 2017). All herbicide use is to be as listed on the herbicide label, or as permitted by above listed Australian Pesticides and Veterinary Medicines Authority Off-label Permits.*

4.3 Seed collection

Seed collection is to be carried out in accordance with the Florabank Guidelines (Florabank 2016, OEH 2011a), to ensure genetic diversity in plant stock, and is to be carried out by experienced and licenced seed collectors only. Collected seed should be provided to a registered local native nursery, noting provenance of the seed, for use in future revegetation projects within the BMP area and/or across the local area.

If project timing allows, seed collected from within the BMP area should be used to propagate plantings to be used within the Revegetation Zone.

4.3.1 Key species for seed collection

Table 4 outlines flora species that have been noted as commonly occurring within the study area, are suitable for propagation and are characteristic of the surrounding vegetation.

Table 4 Key flora species for seed collection

Species name	Common name	Growth form
Acmena smithii	Lilly Pilly	Small tree up to 15 m high.
Angophora costata	Sydney Red Gum	Tree to 30 m high.
Carex appressa	Tall Sedge	Tufted sedge up to 1 m high
Casuarina glauca	Swamp Oak	Tree to 30 m high.
Centella asiatica	Indian Pennywort	Creeping perennial herb
Commelina cyanea	Scurvy Weed	Creeping perennial herb
Eucalyptus robusta	Swamp Mahogany	Tree to 25 m high
Gahnia clarkei	Gahnia	Tall tussock-forming perennial sedge
Glochidion ferdinandi	Cheese Tree	Small tree up to 15 m high.
Juncus kraussii	Sea Rush	Tufted rush up to 1 m high

Species name	Common name	Growth form
Lomandra longifolia	Mat Rush	Tufted sedge up to 1 m high
Oplismenus imbecillis	Basket Grass	Creeping perennial herb
Stephania japonica* var. *discolor	Stephania	Climber or twiner
Viola banksii	Viola	Creeping perennial herb

4.3.2 Seed collection methods

General considerations for seed collection include:

- Collect seed from as many individual plants as possible to maximise genetic diversity.
- Collect from stands or groups of plants rather than isolated plants, even if they carry large amounts of seed.
- Neighbouring plants are likely to be related so ensure that seed is collected from plants across the entire area.
- Collect approximately equal amounts of seed from each plant.
- Collect seed from various parts of the plant (not just those easily accessible).
- Label each batch of seed collected with; species, location, date collected and collector's name, number of plants collected from, and details on position in the landscape, percentage of seed ripe, soil type, other relevant details.
- Seed may be collected from tall trees immediately after felling.
- Ensure only mature seed is collected. Key indications of seed maturity include; colour changes of fruits, seed heads or cones, seed or fruit hardness, dryness of fruits, ease of removal and opening of fruits.

4.4 Pre-clearance and staged vegetation removal

All vegetation designated for retention within or adjacent works zone area will require protection in an environmental exclusion zone demoted by fencing of flagging and accompanying signage. The location and extent of all environmental exclusion zones should be communicated to all personnel including staff and contractors who are to enter or work within the BMP area during site inductions and toolbox talks.

A suitably qualified ecologist is to undertake pre-clearance surveys for native flora and fauna habitat immediately prior to clearing activities and nominate and flag any features they deem "habitat". The ecologist is then to be present during the clearing of any habitat features identified. Vegetation clearing is to be undertaken in the following two-staged process:

- Vegetation surrounding the habitat feature will be removed first in order to give any fauna an opportunity to relocate.
- Habitat features will be removed under the supervision of the project ecologist after a minimum of 24 hours after clearing of non-habitat vegetation.

The following items should also be undertaken to ensure best practice for staged habitat removal:

- Works are timed to minimise impacts on fauna (e.g. avoid known breeding/nesting seasons), if possible.
- Contact vets and wildlife carers prior to commencing works to ensure willingness to assist if required.
- Fell any habitat trees using the "slow drop" technique involving first nudging and shaking the tree, followed by a controlled lowering of the tree to the ground.
- A thorough inspection of the felled habitat feature is then to be undertaken by the project ecologist once the tree is on the ground.
- Ensure any trees are felled away from areas of retained native vegetation.

If wildlife is discovered during the clearing of vegetation, the following steps should be taken:

- Stop all work in the vicinity of the fauna and immediately notify the Site Manager.
- Ideally the animal will relocate by itself, however if it is injured (or suspected to be injured), contact should be made with a licenced fauna handler or rescuer (e.g. WIRES) or the project ecologist.
- Injured fauna should be delivered to a local vet for treatment.
  - Nearest veterinary hospital is: Terrey Hills Animal Hospital at 97 Booralie Road, Terrey Hills. Ph. No. (02) 9450 2020.
- Non-injured fauna should be relocated to appropriate nearby habitat or, if juvenile, presented to an appropriate wildlife carer such as WIRES.
  - The most suitable nearby habitat for relocation of displaced, uninjured fauna is undisturbed bushland existing to the immediate west of the study area within Deep Creek Reserve.

Where possible tree limbs should be removed from the main tree trunk and relocated into the BMP area to ensure retention of salvaged habitat.

4.5 Revegetation Strategy

4.5.1 Revegetation areas

The revegetation zone occurs along the extent of the existing NMUT track which will be decommissioned as part of the works. Revegetation of this area will partly offset the vegetation removal required for the proposed works.

4.5.2 Revegetation species selection

A recommended species list for revegetation is provided in Table A.2 of Appendix 1. The recommended planting list is based on species that are characteristic of the Swamp Oak Forest PCT which has been recorded in the study area (Biosis 2017b) in addition to some other common species present in the locality. Additionally they are species that are easily propagated and established from readily available local provenance seed.

4.5.3 Sourcing

A nursery, local to the study area should be sourced prior to construction and provided with the proposed revegetation species list. Seed certified as of local provenance (i.e. Middle Harbour, Pittwater and Cowan Water catchments) is to be used for revegetation should seed collected from within the study area not be sufficient or otherwise unsuitable for revegetation works.

4.5.4 Recommended planting density

The recommended planting density by growth form is provided in Table 5 below.

Table 5 Recommended planting densityGrowth form	Planting density
Groundcover	4 plants per square meter – planted in clumps.
Vine/Scrambler	1 plant per square meter
Shrubs	1 plant per 2 square meters
Trees	1 plant per 10 square meters.

4.5.5 Watering

Watering of the planting works will be undertaken to ensure that an adequate survival and establishment rate is achieved. Watering is to abide by any local authority water restrictions or guidelines.

Watering of all planting will occur at the time of the planting itself, to minimise shock on the tubestock in their new conditions.

During the three to six month establishment period, the frequency of watering to achieve plant establishment will depend on the prevailing climatic conditions at the time of planting and thereafter. Watering will generally be carried out in the cooler hours of the day (morning or afternoon), and will be frequent enough to prevent wilting of plants. Tubestock is to be watered prior to planting as well as immediately after planting installation.

The watering will be carried out by the bush regeneration contractor who will be responsible to ensure the plants have a minimum 80% survival rating throughout the revegetation zone.

During the establishment phase the following watering program is recommended (dependent on weather):

Weeks 1 - 4	Months 2 - 4	Moths 5 -6
Once a week	Once a fortnight	Once a month

4.5.6 Pest control

Predation by native macropods, introduced herbivores (rabbits and hares), insect pests and infection caused by plant diseases/pathogens can have adverse effects on the establishment of plantings by defoliating, damaging, removing or killing young plants. To minimise the loss of plants through predation and/or disease, all new plantings may be protected by:

- Ensuring that equipment is clean prior to commencement of revegetation works as well as disease free certification of any landscaping materials required.
- Manual removal of insect pests or use of insecticides and fungal treatments where required.
- Preventing the spread of the pathogen Myrtle Rust by applying contact fungicide to infected plants, before moving or removing them, disposing of waste securely and decontaminating work clothes and vehicles (DPI 2011).

The need for pest control works or installation of plant bags (or similar) to prevent herbivory is to be determined at the time of planting and re-assessed during vegetation monitoring events as outlined in Section 5 below.

4.5.7 Planting survivorship

Installed plantings are to be maintained with key elements of water, prevention of predation and suppression of smothering weeds. There will be a maximum loss of 20% of the original planting numbers for an individual species.

Replacement planting is to be carried out throughout the maintenance period to sustain the 80% survival rate at the completion of the maintenance period. Losses of greater than 20% of originally installed plantings may have the maintenance period extended until survival rates have been achieved.

5 Biodiversity management actions

The proposed management strategy for this BMP has been divided into three components:

- **Roles and responsibilities** –assigning responsibilities and thus accountability.
- **Vegetation management actions** – incorporating weed removal and control, planting of native species, and planting and vegetation maintenance.
- **Vegetation management monitoring** – actions required to ensure the vegetation management measures of this BMP are being met and remain appropriate.

5.1 Roles and Responsibilities

The roles and responsibilities of all project personnel of relevance to this BMP are listed in Table 6 below. Council will be primarily responsible for the implementation of this BMP to its five year maintenance term, and will engage a qualified and experienced bush regeneration contractor to implement the major BMP tasks and a vegetation management consultant (project ecologist) with experience in bush regeneration for monitoring, auditing and overseeing the works included herein.

Table 6 BMP roles and responsibilities

Role	Minimum required qualifications	Responsibilities
Proponent (Council)	Not applicable.	• Ultimately responsible for the implementation of the BMP. • Project management of entire site including planning, contracting and coordination of all works, vegetation clearing, bush regeneration, revegetation and rehabilitation, compliance with Workplace, Health and Safety (WHS).
Bush regeneration contractor	• **Supervisor** - Minimum two years supervising experience of on–ground bush regeneration work and TAFE Certificate III in Conservation and Land Management - Natural Area Restoration or equivalent. • **Field worker** - TAFE Certificate II in Conservation and Land Management-Natural Area Restoration or equivalent.	• Implementation of BMP actions. • Responsible for achieving the vegetation management performance targets listed below in the Actions Tables. • Maintenance of plantings and regeneration areas for the 24 month maintenance term of this BMP. • Installation of native plantings for use in revegetation works.
Native plant nursery	• Minimum of five years production as a wholesale native nursery with at least one staff member having gained Certified Nursery Professional status from Nursery and Garden Industry Australia.	• Provide plantings grown from seed with local provenance. • Propagation of native seed collected from BMP area.

Role	Minimum required qualifications	Responsibilities
Project ecologist	• Minimum of three years practical experience and tertiary qualifications in environmental science, environmental management or equivalent preferably with membership to the NSW Ecological Consultants Association.	• Monitoring and provision of advice on restoration and revegetation works to all parties. • Monitoring of weed control and revegetation works, plant survivorship, weed densities. • Ensuring compliance with this BMP, DA conditions of consent and providing certification where required.
Northern Beaches Council	Not applicable.	• Provide certifications and consents as, and when, required. • Ensure compliance with consent conditions.

Timing of these responsibilities and actions are outlined in Table 7.

5.2 BMP actions tables

Table 7 Recommended management actions

Management Action	Responsibility	Task	Key Performance Indicator (KPI)	Timing
Pre-clearing				
Baseline monitoring	Project Ecologist	• Undertake initial vegetation monitoring of BMP area using random meander technique • Install fixed photographic monitoring points at two location in each zone • Undertake initial survey of weed cover and abundance within BMP area. • Provide a brief report containing % weed cover, % native cover and flora species list	• All zones include two fixed photographic point. • Initial weed survey has been conducted. • Brief report has been prepared detailing exotic species inventory and abundance and cover scores. • Map detailing overall weed cover in the BMP area to be provided with the abovementioned report.	Approximately 2 months before clearing commences and prior to weed control works.
Establish "No-Go" zones	Head Contractor	• Establish "No-Go" zones around vegetation to be retained to prevent access by construction personnel	• "No-Go" zones established.	Prior to vegetation clearance.
Priority weed control	Bush regeneration contractor	• All priority weeds are treated according to Table 3	• No priority weed species' propagules are present within the BMP area • All mature Lantana and Madeira Vine individuals existing within the BMP area have been treated.	Approximately 1-2 months before clearing commences.
		• Report and treat any novel priority weed species introductions identified within the BMP area.	• All novel priority weed species introductions have been reported. • No novel priority weed species populations established within the BMP area	Between 2 months before vegetation clearance and time of vegetation clearance.

Management Action	Responsibility	Task	Key Performance Indicator (KPI)	Timing
Bush regeneration weed control	Bush regeneration contractor	• Undertake initial weed control visits within the Revegetation Zone and Restoration Zone targeting species likely to impact negatively upon plantings installed in the Revegetation Zone. • Works to be undertaken utilising best practice bush regeneration techniques.	• At least two weed control visits undertaken prior to revegetation works.	Prior to vegetation clearance.
Arrange plant nursery	Head contractor	• Find a suitable native plant nursery and contract them to undertake propagation of native seeds collected.	• Suitable native plant nursery has been identified and contracted.	Prior to vegetation clearance
Seed collection	Project Ecologist	• Collect seed from BMP area from key species identified within Section 4.3.1 of this report before commencement of vegetation clearance.	• All ripened seed has been collected from vegetation designated for removal in BMP area.	During pre-clearance assessment prior to vegetation clearance and during clearance supervision.
Propagation	Contracted nursery	• Nursery propagates sufficient seed for use in revegetation works throughout the BMP area	• Seed propagated and grown on for plantings.	Immediately following seed collection.
Erosion and sediment controls	Head contractor	• Sediment and erosion controls such as silt fencing to be installed as required downslope in areas to undergo soil disturbance.	• All erosion and sediment control measures have been satisfactorily installed.	Prior to vegetation clearance.
Pre-clearance assessment	Project ecologist	• Conduct a single pre-clearance assessment of the works zone to mark all habitat features to be removed by spray painting a two foot high 'H' on the trunk of the tree or tying fluorescent pink flagging tape around the trunk.	• All habitat features designated for removal have been marked and flagged.	Prior to vegetation clearance.
During clearing				
Clearing supervision	Project ecologist	• Supervision of all vegetation clearance works as outlined in Section 4.5 above.	• All vegetation clearance works supervised by the Project ecologist.	During vegetation clearance.
		• Preparation of a brief report to document the outcomes of clearance supervision.	• Report detailing clearance supervision outcomes has been prepared.	Within one week post vegetation clearance.

Management Action	Responsibility	Task	Key Performance Indicator (KPI)	Timing
Re-use of hollows / logs as habitat	Project ecologist	• Identify any hollows or logs within the works zone which are suitable for translocation. • Translocate suitable hollows and/or logs into the BMP area.	• All suitable hollows and logs have been translocated from the works zone into the retain vegetation	During vegetation clearance.
Post clearing				
Revegetation – Swamp Oak	Bush regeneration contractor	• Undertake revegetation as outlined in Section4.6 above in the are outlined in Figure 2.	• Plantings installed and establishing as per Revegetation Strategy above.	Following completion of Pre-clearing weed control activities outlined above.
		• Supplementary planting may be required (at the discretion of the project ecologist) if survivorship is recorded as below 80%.	• Dead plants replaced ensuring a plant survivorship is over 80%.	Throughout two year maintenance period.
Revegetation - WSUD		•	•	
Priority weed control (maintenance)	Bush regeneration contractor	• Remove all priority weed individuals from within the BMP area within 12 months.	• No priority weed individuals existing within the BMP area and immediate surrounds by 12 months.	Following revegetation and vegetation removal for construction.
		• Seedlings of priority species are to be continually suppressed.	• No priority weed seedlings within BMP area.	Following revegetation and vegetation removal for construction.

Management Action	Responsibility	Task	Key Performance Indicator (KPI)	Timing
Regeneration/weed control (maintenance)	Bush regeneration contractor	• Undertake regular weed control visits at least quarterly from commencement of the vegetation management program. Frequency of visits over spring and summer months may need to be greater to maintain suppression of exotic species. • Works to be undertaken utilising best practice bush regeneration techniques.	• Exotic species % cover to be reduced to <5% by 24 months from the commencement of the maintenance period.	Minimum of each quarter over two year BMP maintenance period.
Litter management	Bush regeneration contractor	• Installation of no littering signs at each end of boardwalk • Collection of rubbish within the study area	• Minimize rubbish build up from use of path • Litter is not spread throughout rest of lagon	Minimum each quarter over two year BMP maintenance period
Post clearing – monitoring and evaluation				
Vegetation monitoring	Project Ecologist	• Undertake vegetation monitoring of BMP area using random meander technique • Take fixed photographic monitoring points at two locations in each zone • Undertake survey of weed cover and abundance within BMP area. • Provide a brief report containing % weed cover, % native cover and flora species list	• Vegetation monitoring has been conducted. • Map detailing changes in weed cover and abundance has been prepared. • Report detailing outcomes of vegetation monitoring has been prepared.	Once per 6 months.

Management Action	Responsibility	Task	Key Performance Indicator (KPI)	Timing
Review and Evaluation KPIs	Project Ecologist	• Data derived from monitoring is to be evaluated against the KPIs associated with this management action during the review and evaluation process. • Following each monitoring inspection the project ecologist will inform the bush regeneration contractor of any areas of concern with regard to meeting the above targets. • The Project ecologist is to "sign-off" on the completion of the maintenance period only when satisfied that the above targets for two years from commencement of the maintenance period" have been met. • If these targets are not met the maintenance period is to be extended to meet the above targets at the discretion of the Project ecologist.	• Planting establishment success rate: o Minimum 80% survival of original plantings measured a each review • Exotic species cover across BMP area: o 10% cover 6 months from commencement of the maintenance period. o 5% cover at 12-18 months from commencement of the maintenance period. o <5% cover maintained from 24 months after vegetation clearance • Priority weed cover across BMP area:: o <1% cover maintained from 6 months after vegetation clearance	After vegetation clearance and then every 6 months.
Aquatic biodiversity management				
	Bush regeneration contractor	• Undertake revegetation as outlined in Section4.6 above in the area outlined in Figure 2.	• Plantings installed and establishing as per Revegetation Strategy above.	Following completion of Pre-clearing weed control activities outlined above.
		• Supplementary planting may be required (at the discretion of the project ecologist) if survivorship is recorded as below 80%.	• Dead plants replaced ensuring a plant survivorship is over 80%.	Throughout two year maintenance period.
Aquatic biodiversity management				

Management Action	Responsibility	Task	Key Performance Indicator (KPI)	Timing
Aquatic management	All site visitors	• Minimise disturbance and impact on seagrass when works are undertaken • No barges or vessels left in-situ above seagrass if possibility for bottoming out with tide and for no longer than three days if no risk of bottoming out with the tide • Platform to be built with a mesh platform to minimise shading effect	• Reviewed in BMP review to ensure all management action are being abided to • Inspection of boardwalk to ensure no built up debris around boardwalk	Once per 6 months

5.3 BMP Gantt chart

Table 8 Recommended management timeframe

Monitoring activity	Pre vegetation clearing						Year 1												Year 2											
	Month1	Month 2	Month 3	Month 4	Month 5	Month 6	Month1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	Month1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Pre-clearing *[1]																														
Baseline monitoring and "No-Go" zone establishment																														
Initial Exotic species control																														
Arrange plant nursery																														
Seed collection																														
Propagation																														
Erosion controls																														
Pre-clearance assessment																														
During clearing																														
Clearance supervision																														
Re-use of hollows / logs																														
Post clearing																														
Exotic species control																														

Monitoring activity	Pre vegetation clearing						Year 1												Year 2											
	Month1	Month 2	Month 3	Month 4	Month 5	Month 6	Month1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	Month1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Regeneration/weed control								■			■			■			■			■			■			■			■	
Revegetation										■	■																			
Supplemental watering										■	■	■	■	■	■															
Vegetation monitoring							■						■						■						■					■
Review and Evaluation							■						■						■						■					■

*[1] – Timeframe associated with Pre-clearing tasks may be compressed into 1-2 months

6 Adaptive management

An adaptive management approach is to be employed in respect of the works forming part of this BMP. An adaptive management approach involves an integrated process of monitoring, reviewing and then responding to the health and condition of the native vegetation as well as the status of the weed species to identify any alterations to the design and maintenance of works that may be required to ensure the objectives of the BMP are achieved. For example, the watering schedule should be flexible in responding to the health and vigour of any plantings and changing climatic conditions. Monitoring of the outcomes of regeneration works will allow for an assessment of the suitability of current weed control methods used on extant weed populations and promote informed decisions allowing for creation of a more optimal management regime.

The revegetation species, planting densities and planting patterns nominated within this BMP may be subject to change and review if certain species are unavailable or are performing inadequately. The weed control works are also to be reviewed and appropriate changes implemented accordingly, if required. By example, if the nominated weed suppression schedule is not achieving the key performance indicators specified, the frequency and/or type of weed suppression activities should be altered accordingly.

The outcomes of all management actions recommended in this BMP are to be measured against the associated key performance indicators in Table 7 during the review and evaluation process to determine the viability of the prescribed management regime. Recommended timeframes for review and evaluation of BMP performance are outlined in Table 9 below.

Table 9 Recommended review and evaluation timeframe

Review number	Timeframe	Compliance certification
Initial review	Immediately after vegetation clearance.	Pre-clearing and during clearing tasks completed as per BMP requirements
Consequent reviews	Every 6 months after vegetation clearance.	Vegetation monitoring report concludes KPIs have been met and BMP targets are achievable.

Whilst the use of fire as an ecological restoration technique is not specifically mentioned as part of the implementation of this BMP, establishment of an appropriate fire regime is an essential part of ecosystem functioning in healthy vegetation communities.

It is recommended that Northern Beaches Council and the Rural Fire Service work with OEH to establish a future burning regime within the study area.

It is important to note that any changes should comply with the aims of this BMP and any licensing or approval conditions issued before implementation.

6.1 Reporting requirements

Each round of review and evaluation will require the preparation of a report detailing the outcomes of restoration and revegetation works conducted in accordance with the BMP. The report is to contain the following information as outlined in the *Warringah Council Report Guidelines: Biodiversity Management Plan (Warringah Council 2014)*:

- Include an executive summary.

- Be clearly referenced using an accepted academic referencing system such as Harvard.
- Demonstrate compliance with performance evaluation targets.
- Identify deficiencies and corrective actions taken to ensure KPIs are met.
- Provide a statement of compliance against relevant Commonwealth, State and local government legislation.
- A photographic record (6 monthly intervals) detailing pre, during and post construction conditions. The entire photographic record is to be submitted with final compliance certification.
- A conclusion describing key findings.
- Provide recommendations.
- Provide qualifications of the author/s.

A copy of each six-monthly report is to be provided to Northern Beaches Council's Natural Environment Unit.

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Appendices

Appendix 1 – Flora

Appendix 1.1 Flora species recorded from the study area

Table A.1 Flora species recorded by Biosis, 30/05/2017

Status	Scientific name	Common name
Native species		
	Acmena smithii	Lilly Pilly
	Angophora costata	Sydney Red Gum
	Baumea juncea	Bare Twig Rush
	Carex appressa	Tall Sedge
	Casuarina glauca	Swamp Oak
	Centella asiatica	Indian Pennywort
	Commelina cyanea	Scurvy Weed
	Eucalyptus robusta	Swamp Mahogany
	Ficinia nodosa	Knobby Club-sedge
	Gahnia clarkei	Gahnia
	Geitonoplesium cymosum	Scrambling Lily
	Glochidion ferdinandi	Cheese Tree
	Hypolepis muelleri	Harsh Ground Fern
	Juncus kraussii	Sea Rush
	Livistonia australis	Cabbage Tree Palm
	Lomandra longifolia	Mat Rush
	Oplismenus imbecillis	Basket Grass
	Parsonsia straminea	Common Silkpod
	Phragmites australis	Common Reed
	Stephania japonica var. *discolor*	Stephania
	Tetragonia tetragonoidies	Warrigal Greens
	Viola banksii	Viola
Exotic species		
Priority	*Anredera cordifolia*	Madeira Vine
	Erythrina sp.	Coral Tree
	Hydrocotyle bonariensis	Pennywort

Status	Scientific name	Common name
	Ipomoea cairica	Coastal Morning Glory
	Ipomoea indica	Purple Morning Glory
Priority	*Lantana camara*	Lantana
	Ligustrum lucidum	Broad-leaf Privet
	Stenotaphrum seccundatum	Buffalo Grass

Appendix1.2 Recommended revegetation species

Table A.2 Flora species recommended for revegetation within the Revegetation – Swamp Oak zone

Scientific name	Common name
Acmena smithii	Lilly Pilly
Carex appressa	Tall Sedge
Casuarina glauca	Swamp Oak
Centella asiatica	Indian Pennywort
Commelina cyanea	
Cupaniopsis anacardioides	Tuckeroo
Dianella caerula	Blue Flax-lily
Entolasia marginata	Bordered Panic
Glochidion ferinandi	Cheese Tree
Juncus usitatis	
Lomandra longifolia	Spiny-headed Mat-rush
Melalueca ericifolia	Swamp paperbark
Melalueca styphelioides	Prickley-leaved Tea Tree
Oplismenus imbecillis	Basket Grass
Stephania japonica* var. *discolor	Snake Vine

Table A.3 Flora species recommended for revegetation within the Revegetation – WSUD zone

Scientific name	Common name
Carex appressa	Tall Sedge
Dianella caerula	Blue Flax-lily
Juncus usitatis	
Lomandra longifolia	Spiny-headed Mat-rush