Lake Parramatta Swimming Area

Review of Environmental Factors

City of Parramatta

ecological AUSTRALIA
A TETRA TECH COMPANY

DOCUMENT TRACKING

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Project Manager	Courtney Blick
Prepared by	Courtney Blick**,** Alice Ridyard, Kate Storan and Jess Horton
Reviewed by	Rebecca Ben-Haim, Belinda Failes, Daniel McDonald, Karyn McLeod, and Peter Hancock
Approved by	Rebecca Ben-Haim
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Cover Image: Lake Parramatta, ELA 2022.

Template 2.8.1

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Abbreviations

Abbreviation	Description
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal Heritage Impact Permit
ASS	Acid Sulfate Soils
BC Act	*Biodiversity Conservation Act 2016*
BDAR	Biodiversity Development Assessment Report
Biodiversity and Conservation SEPP	*State Environmental Planning Policy (Biodiversity and Conservation) 2021*
Biosecurity Act	Biosecurity Act 2015
CAA	Controlled Activity Approval
CBD	Central Business District
CEMP	Construction Environmental Management Plan
DBYD	Dial Before You Dig
DCCEEW	Department of Climate Change, the Environment, Energy and Water
DPI	Department of Primary Industries
ELA	Eco Logical Australia
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning & Assessment Regulation 2021*
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPL	Environmental Protection License
FM Act	*Fisheries Management Act 1994*
Heritage Act	*Heritage Act 1977*
KFH	Key Fish Habitat
KTP	Key Threatening Process
LEP	Local Environmental Plan
LGA	Local Government Area
MNES	Matters of National Environmental Significance
NPW Act	*National Parks and Wildlife Act 1974*
NSW	New South Wales
PCT	Plant Community Type
POEO Act	*Protection of the Environment Operations Act 1997*
REF	Review of Environmental Factors
Resilience and Hazards SEPP	*State Environmental Planning Policy (Resilience and Hazards) 2021*
RSWMP	Regional Strategic Weed Management Plan

Abbreviation	Description
SDS	Safety Data Sheet
SEMP	Sediment Erosion Management Plan
SEPP	State Environmental Planning Policy
SHR	State Heritage Register
SIS	Species Impact Statement
TEC	Threatened Ecological Community
Transport and Infrastructure SEPP	*State Environmental Planning Policy (Transport and Infrastructure) 2021*
WIRES	NSW Wildlife Information, Rescue and Education Service Inc
WM Act	*Water Management Act 2000*
WoNS	Weeds of National Significance

Executive Summary

The City of Parramatta Council (herein referred to as Council) are proposing to undertake upgrade works to the Lake Parramatta swimming area (the project). This Review of Environmental Factors (REF) has been prepared to support the application for approval of the project under Part 5 of the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act). The REF describes the project, considers potential environmental, social, and economic impacts of the Project, and outlines measures to minimise and avoid these impacts. The project will deliver a positive community benefit by upgrading the current swimming area for the City of Parramatta community and beyond. The current swimming area is steep and requires regular maintenance.

The proposed works will level out the steep entry to the lake, install retaining wall structures to minimise ongoing maintenance requirements, and provide user amenities in the form of multi-use stairs and tiered seating. Given its large volumes of users, the upgrade to the swimming area is considered essential for safety and accessibility. The design of the swimming area has been refined through community consultation and feedback and is representative of community needs and values.

This REF has been prepared by Eco Logical Australia Pty Limited (ELA) on behalf of the Council to support the approval of the Project. Council is to carry out a regulatory assessment and determine whether the Project should be approved and any conditions to be applied to the consent, should it be granted. A summary of the project and the REF findings is provided below.

What is the Project?

Council is proposing upgrades to the existing Lake Parramatta swimming area located at 28 Bourke Street, North Parramatta NSW, 2 km north of the Parramatta CBD. The current Lake Parramatta Swimming Area opened in 2015 and provides a unique experience for locals and visitors to enjoy swimming in a natural bushland setting. The works aim to provide enhanced amenities and safety measures for visitors, while protecting the natural environment from high visitation numbers, and will include enlarging the swimming area and improving access from land to the water. It will expand opportunities within the City of Parramatta local government area (LGA) for locals to be physically and socially active, improving health outcomes and enhancing liveability throughout the LGA.

The proposed upgrades will consist of the following elements:

- An enlarged swimming area;
- Improved access from the 'beach' into the swimming area, by installing retaining wall structures and levelling out the steep entrance;
- Reduced ongoing maintenance requirements; and
- Addition of environmentally sensitive amenities (steps, seating) around the swimming area

The works support several strategic plans that apply within the City of Parramatta by providing social infrastructure, protection of the health of waterways and biodiversity and to deliver high quality open space. On a larger scale, the works support the Greater Sydney Commission's goals for the broader region and the city district, which are primarily to increase liveability and promote sustainability.

Statutory Requirements

The environmental assessment and determination of the Project has been undertaken in accordance with Part 5 of the NSW EP&A Act For this proposal, Council is both a public authority and the determining authority. Council must examine and consider, to the fullest extent possible, all matters affecting or likely to affect the environment because of the proposed works. This assessment has been prepared in accordance with Section 171 of the *Environmental Planning & Assessment Regulation 2021*, (EP&A Regulation) which sets out a non-exhaustive list of environmental factors required to be assessed by public authorities. Consideration of Section 171 factors is provided in Section 6.1.

Land Ownership and Notification

The works are proposed wholly within NSW Crown Land (Reserves #59927 and #77695), with the Council managing the park areas as trustee. While Council is responsible for park management, it is recommended that Council consult with Crown Land as the landowner, prior to finalisation of this REF. A permit, lease, license, or other right to work under the *Crown Land Management Act 2016* (Crown Land Management Act) is required to proceed.

Assessment of Impacts

Landform, Geology and Soils

The study area is located on Hawkesbury sandstone geology, and Gymea soil landscapes. The proposed works have been assessed and informed by bathymetric and geotechnical studies, prepared by GBG (2023) and JK Geotechnics (2023). There is some potential for sediment, erosion, and changes to the lake hydrology to occur as a result of the proposed work. Mitigation measures have been recommended that, if implemented, will avoid, or minimise the potential for impacts to landform and soils.

Waterways, Wetlands and Aquatic Habitat

Part of the proposed works will be in-stream within Lake Parramatta, which is mapped as Key Fish Habitat (KFH). An aquatic flora and fauna assessment prepared by ELA found that KFH Type 2 is present within the study area, however due to the underlying sandstone substrate and overall turbidity of the water, limited potential for aquatic flora and fauna habitat occurs within the impacted area. Minor impacts to water quality, inflow of groundwater during excavation or introduction of invasive aquatic species have the potential to occur because of the proposed works. A Part 7 Permit under Section 200 of the *Fisheries Management Act 1994* (FM Act) is not required due to the Project being subject to the Crown Land Management Act, however consultation with Department of Primary Industries (DPI) Fisheries will still be undertaken. The final Concept Plan (City of Parramatta 2023, Appendix A) and this REF will be provided to DPI Fisheries for comment.

Biodiversity and Arboriculture

A Flora and Fauna Assessment (FFA) was prepared by ELA (2022). Vegetation within the study area was categorised into the following vegetation types:

- Native Plant Community Type (PCT), PCT 3592 Sydney Coastal Enriched Sandstone Forest in both Low and Moderate conditions
- Exotic grasses
- Aquatic plants
- Other areas including water, cleared land, and built environment.

No threatened ecological communities (TECs) listed under either the *Biodiversity Conservation Act 2016* (BC Act) or *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were found within the study area.

The project will result in the removal of 0.03 ha of native vegetation, in the form of PCT 3592. A further 0.06 ha of exotic grasses will be impacted. Grass impacted for the purposes of site access will be reinstate following completion of works.

Tests of Significance under the BC Act were completed for the following threatened species with the potential or likelihood to occur within the study area:

- Birds
    - *Calyptorhynchus lathami* (Glossy Black-Cockatoo) – Vulnerable

  - *Daphoenositta chrysoptera* (Varied Sittella) – Vulnerable
  - *Glossopsitta pusilla* (Little Lorikeet) – Vulnerable
  - *Lathamus discolor* (Swift Parrot) – Endangered
  - *Ninox connivens* (Barking Owl) – Vulnerable
  - *Ninox strenua* (Powerful Owl) – Vulnerable
- Microbats
  - *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) – Vulnerable
  - *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat) – Vulnerable
  - *Miniopterus orianae oceanensis* (Large Bent-winged Bat) – Vulnerable
  - *Myotis Macropus* (Southern Myotis) – Vulnerable
  - *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat) – Vulnerable
  - *Scoteanax rueppellii* (Greater Broad-nosed Bat) – Vulnerable
- Megabats
  - *Pteropus poliocephalus* (Grey-headed Flying-fox) – Vulnerable
- Snails
  - *Pommerhelix duralensis* (Dural Land Snail) – Endangered

Assessments of Significance in accordance with the EPBC Act were completed for the following threatened species:

- *Hirundapus caudacutus* (White-throated Needletail) - Vulnerable/Migratory
- *Lathamus discolor* (Swift Parrot) – Critically Endangered
- *Pommerhelix duralensis* (Dural Land Snail) – Endangered
- *Pteropus poliocephalus* (Grey-headed Flying-fox) – Vulnerable

The application of Tests of Significance under the BC Act, and Assessments of Significance under the EPBC Act, concluded that no significant impact to threatened flora and fauna is likely to result from the proposed works. Some removal of groundcover and trimming of vegetation is likely to occur as a result of construction and machinery access.

A Preliminary Tree Assessment (PTA) was also prepared by ELA (2023b), which included a visual tree assessment and recommended tree protection measures. No trees are proposed to be removed by Council, however impacts to trees were not assessed as part of the PTA due to the unknown nature of construction methods. An AQF Level 5 Consulting Arborist must be present at all stages of construction to ensure protection of trees and appropriate construction methods are in place for maximum retention of trees.

Aboriginal Heritage

An extensive search of the Aboriginal Heritage Information Management System (AHIMS) resulted in the identification of fifty-six (56) Aboriginal sites within 1 km of the study area (Figure 3-23). No sites have previously been recorded as being within the study area. The closest site, AHIMS ID 45-6-2805, is located approximately 100 m to the south of the study area and will not be impacted by the proposed works.

An Aboriginal Heritage Due Diligence Assessment undertaken by ELA (2023) did not identify any new Aboriginal objects or areas of potential within the study area. The visual inspection revealed that most

of the study area had previously been disturbed in relation to the construction of and continued recreational use of the reserve, indicating a low likelihood for Aboriginal objects to be impacted by the proposed works.

Historic Heritage

The study area is located within the curtilage of one local heritage item listed on Schedule 5 of the Parramatta Local Environmental Plan 2023 (Parramatta LEP), being Lake Parramatta Reserve (LEP Item No. I305). The study area is also within 200 m of one State Heritage Register (SHR) item (Lake Parramatta Dam SHR listing No. 01879 / LEP Item No. I304).

The proposed works would introduce new visual elements within the Lake Parramatta Reserve heritage curtilage. Careful consideration has been taken in material and colouring choices including the use of sandstone and concrete, aligning with the existing setting and use of the area. Many of the proposed elements would be situated underwater and therefore not visible. The proposed works would not incur an indirect (visual) impact level above negligible within the Lake Parramatta Reserve heritage curtilage.

Lake Parramatta Dam (SHR Listing No. 01879 / LEP 2023 Item No. I304) is considered significant for its historic, associative, aesthetic, social, research potential, rarity, and representative value. As the Dam is located outside the study area, the proposed works would have no direct (physical) impact on the place or its curtilage. The Dam is located some distance from the proposed works, which would be partially obscured by vegetation, screening views to and from the proposed works. As such, the proposed works would have no indirect (visual) impact on the heritage item.

Evaluation

Overall, the identified potential environmental impacts associated with the proposed works can be adequately managed provided the design recommendations and mitigation measures outlined within this REF are adhered to.

The Project has been underpinned by principles to avoid and minimise environmental impacts where possible and has been developed through an iterative design and comprehensive assessment approach. This approach has resulted in significant environmental improvements and outcomes as described in the REF.

This REF has determined that the proposed works are not likely to have a significant impact on any aspect of the environment, subject to the implementation of recommended mitigation measures and safeguards. In addition, through the implementation of proposed mitigation measures, the REF found that the project could be undertaken without any significant long-term impacts on the local environment including on social and economic factors.

The works aim to provide an updated accessible and safe open space asset that meets the needs of the community and is in support of several planning priorities under local, regional and district strategic plans through the provision of a safe and enjoyable outdoor recreation asset. As such, the project is in the public interest, providing many benefits to the local Parramatta community and beyond.

SECTION 1

Introduction

1. Introduction

Eco Logical Australia Pty Ltd (ELA) was engaged by City of Parramatta Council (herein referred to as Council) to prepare a Review of Environmental Factors (REF) for the proposed upgrade of the Lake Parramatta swimming area (the project) in North Parramatta (Figure 1-1). The upgrade is proposed to provide the growing populations of Parramatta, North Parramatta, and surrounding suburbs access to recreational swimming to complement the various natural activities provided by the broader Lake Parramatta, bird watching and bushwalking.

The works have been assessed under Part 5 of the *Environmental Planning & Assessment Act 1979* (EP&A Act) with Council as the determining authority. This REF has assessed all environmental factors listed in Section 171 of the *Environmental Planning & Assessment Regulation, 2021* (EP&A Regulation); and outlined impact mitigation measures to be undertaken, in line with Council's policies and procedures.

As part of this assessment, the following studies were undertaken by ELA and other consultants. The findings of such studies have been incorporated into this REF:

- Geotechnical Investigation and Bathymetric Assessment (GBG Australia Pty Ltd, 2023) – Appendix B
- Aquatic Habitat Assessment (ELA 2023) – contained in Section 3.2
- Flora and Fauna Assessment (ELA 2023a) –Appendix C
- Preliminary Tree Assessment (ELA 2023b) – Appendix D
- Aboriginal Due Diligence Assessment (ELA 2023) – contained in Section 3.5; AHIMS search provided in Appendix E)
- Statement of Heritage Impacts (SoHI) (ELA 2023c) – Appendix F)

1.1 Terms used in this Report

1.1.1 Study Area

The study area is used throughout this report to describe the broader area subject to environmental assessment. This area is wider than the impact area (defined below), for example includes the study of nearby heritage items for the purposes of the SoHI, but these heritage items are located outside the defined area of works.

1.1.2 Impact Area

The impact area encompasses the entire area of land and water subject to direct impacts because of the project as assessed within this environmental assessment. The impact area is defined in as a solid red polygon. The impact area includes space needed for site access during construction, a construction compound, materials and equipment laydown and the proposed works layout (Figure 1-2).

1.1.3 Proposed Works Layout

The proposed works layout (defined in Figure 1-2) refers the precise concept layout provided by Council for the proposed works. It describes the different elements associated with the proposed project, encompassing the following:

- Sandstone rock outcrops/boulders

- Sandstone block seating/retaining wall
- Coarse river sand ‘beach’
- Concrete water access steps
- Underwater retaining wall
- Raised lifeguard platform

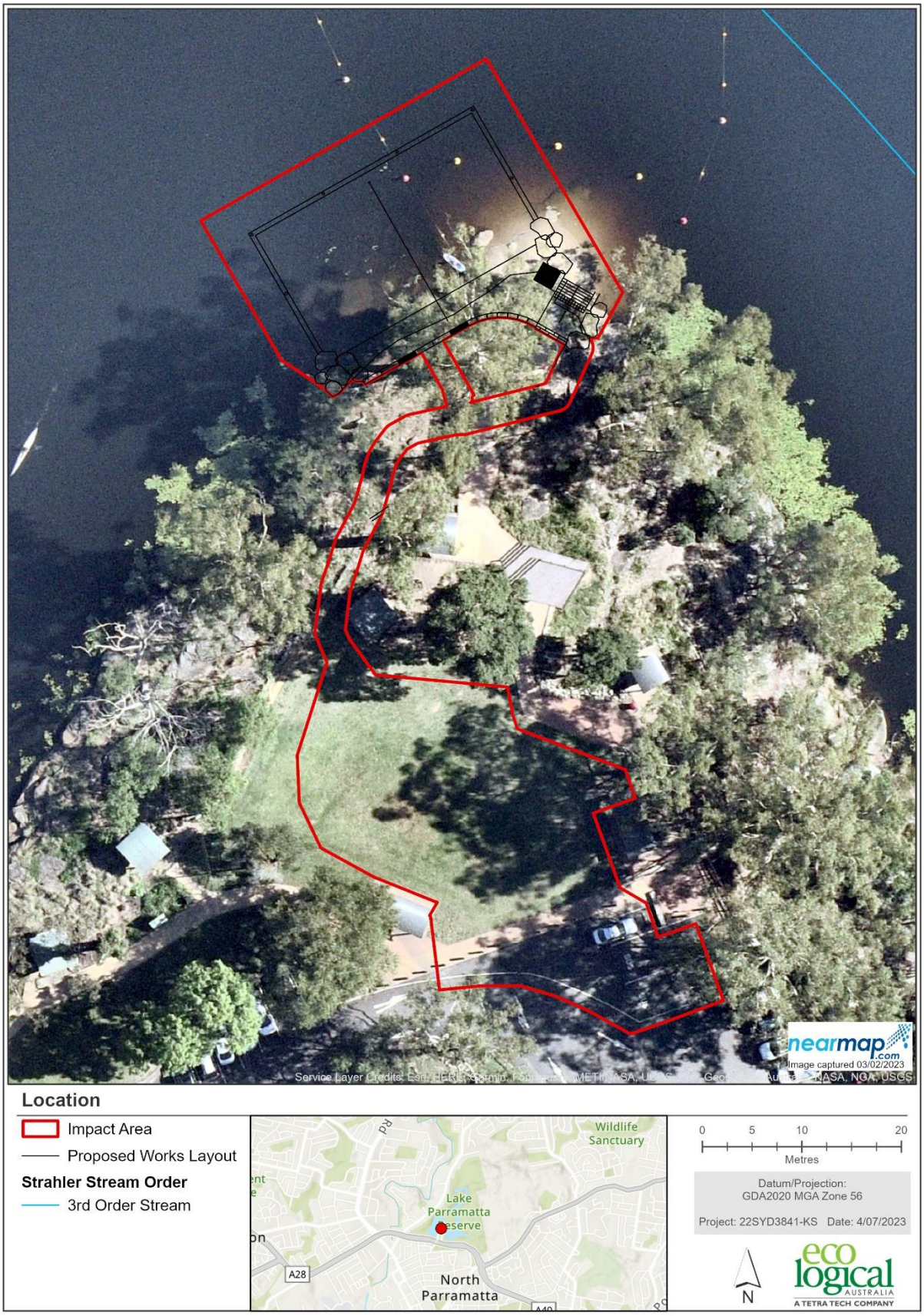

Figure 1-1: Location of the proposed works

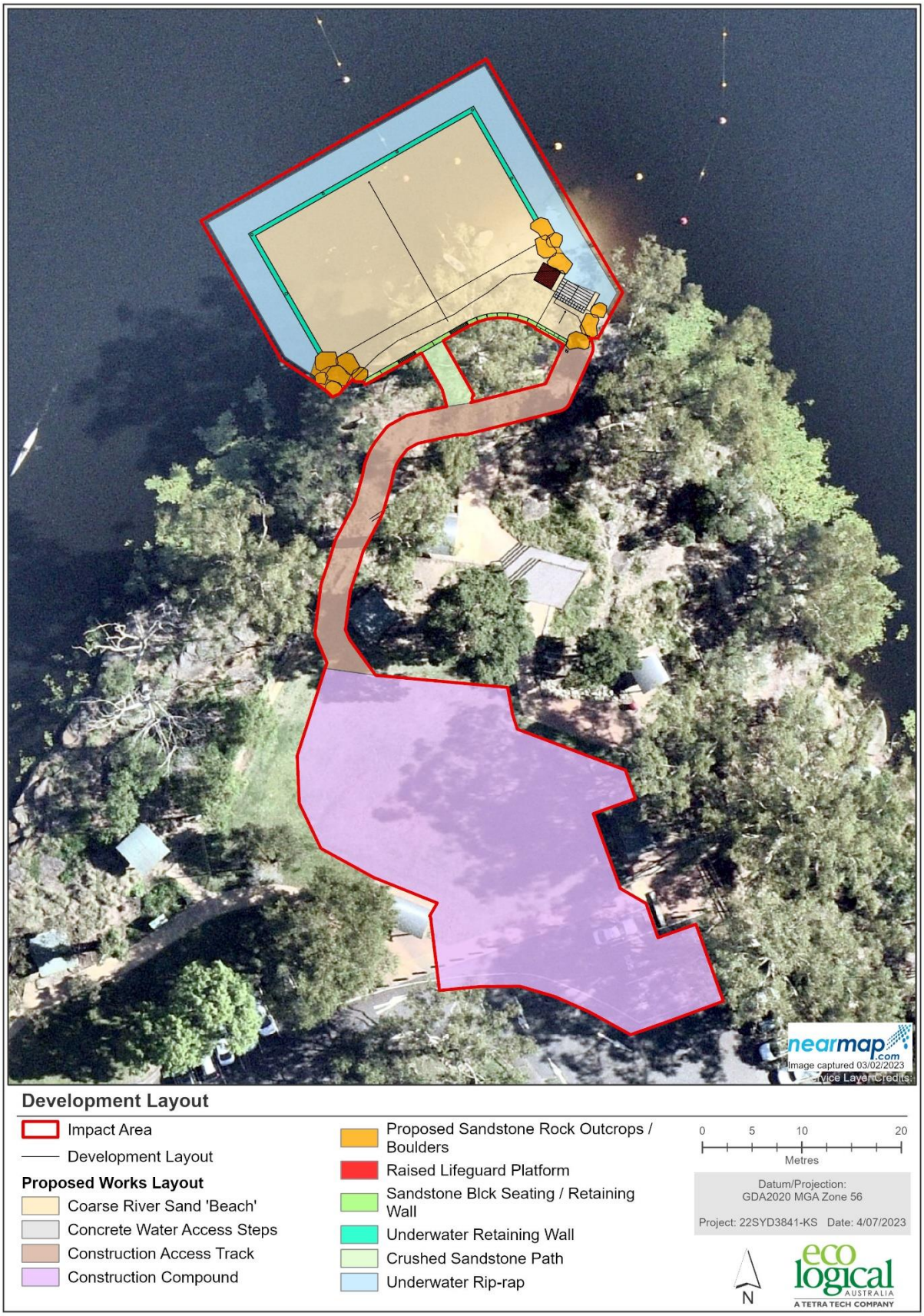

Figure 1-2: Proposed Works Layout

1.2 Project Background

Lake Parramatta and the surrounding reserve is a large open space bushland and water recreation area within the suburb of North Parramatta, in the City of Parramatta local government area (LGA). The lake and surrounding reserve host a diverse range of activities including swimming and kayaking, passive recreation opportunities such as walking, bird watching, picnicking and play spaces. The park forms part of an ecological corridor connecting vegetation communities across the LGA.

Lake Parramatta Reserve is located on the traditional lands of the Aboriginal People of the Dharug language group, however the reservoir that makes up Lake Parramatta was constructed in 1856 to supply water for domestic purposes up until 1909 (City of Parramatta, 2020), which has been closed to the public in the past due to water quality issues. The reserve has seen various uses, with recreational bushland and swimming being the primary use. The lake has become an increasingly popular swimming destination with 60-70,000 visitors per year, putting strain on the current design that is unable to cater to the demand from visitors since its official reopening in 2015. The primary issues faced at the study area include:

- safe and accessible entry/exit to water
- uneven underwater surface near transition from manageable depth to steep decline
- slippery rocks due to algae build up
- unsafe gaps between rocks underwater
- poor water visibility, exacerbated during periods of heavy rainfall
- crowding issues
- inadequate seating and amenities along the waterfront

1.3 Proposed Works

Council is proposing to upgrade the Lake Parramatta swimming area to enable better use of the existing swimming area and ensure the future recreational use can be maximised through enhanced accessibility and safe swimming and amenity features.

The proposed works are as follows:

- Improved accessibility to waters edge
- Improved accessibility to existing shelters and swimming area
- Underwater retaining wall
- Sandstone rock outcrops/boulders
- Coarse river sand ‘beach’ for improved level water access
- Lifeguard platform
- Planted native bush regeneration works
- Sandstone block seating, with backrest and armrests on seating

A detailed scope of works is provided in Section 1.6 in accordance with the final concept plan (Appendix A). The project has been divided into ‘Area A’ and ‘Area B’ shown in Appendix A to allow for construction under two different funding streams, and separate scopes of procurement and construction. The construction methodology is yet to be determined by the contractor(s) for Area A and Area B. As such, ELA has assumed a 10 m construction buffer around the proposed works to allow for machinery and personnel access, machinery and materials storage, and other ancillary impacts.

1.4 Location Context

The Lake Parramatta swimming area is located at the end of Illawong Drive, North Parramatta. It is approximately 2 km to the north of Parramatta Central Business District (CBD) and approximately 25 km northwest of the Sydney CBD. The study area is located within the broader Lake Parramatta Reserve extending between James Ruse Drive to the south, North Rocks Road to the west and north, and Pennant Hills Road to the east (Figure 1-1). North Parramatta is a residential area within the City of Parramatta LGA comprised mostly of low-density dwellings and some unit developments. The study area is 3 km from Parramatta train station and 3.5 km to the foreshore of the Parramatta River within Parramatta.

Lake Parramatta Reserve has road access primarily from Illawong Drive, as well as the residential road of North Rocks Road. The study area is serviced by multiple paths of varying grades that are well used by pedestrians using the broader reserve.

1.5 Land Use and Ownership

1.5.1 Land Zoning

The study area is zoned under the *Parramatta Local Environmental Plan 2011* (Parramatta LEP) as RE1 Public Recreation and W1 Natural Waterways (Figure 1-3). In accordance with Part 2 of the LEP, the objectives of the relevant land use zones are described below.

RE1 Public Recreation:

- *enable land to be used for public open space or recreational purposes*
- *provide a range of recreational settings and activities and compatible land uses*
- *protect and enhance the natural environment for recreational purposes*
- *conserve, enhance and promote the natural assets and cultural heritage significance of Parramatta Park*
- *create a riverfront recreational opportunity that enables a high quality relationship between the built and natural environment*

W1 Natural Waterways:

- *protect the ecological and scenic values of natural waterways*
- *prevent development that would have an adverse effect on the natural values of waterways in this zone*
- *provide for sustainable fishing industries and recreational fishing*
- *provide for cultural and scientific study of natural waterways*
- *enable works associated with the rehabilitation of land towards its natural state*

1.5.2 Land Ownership

Lake Parramatta is wholly located on Crown Land Reserve No. 146, with Council managing the park areas as trustee. The following reservations apply:

- Reserve 59927 (the land portion of the study area)
- Reserve 77695 (waterway)

The impact area encompasses land parcels Lot 7304 DP1148769 and Lot 7023 DP11244101. Crown Land is shown in Figure 1-4. Council, in its capacity as Crown land Manager (CLM) is a public authority for the purposes of the EP&A Act. As CLM, Council may submit a development or other application without the

need for consent of the Crown (the landowner) provided that notice of intention to make the application is served upon the Crown for comment prior to lodgement. The final construction documentation, along with this REF, will be provided to Crown Lands for comment prior to the commencement of works.

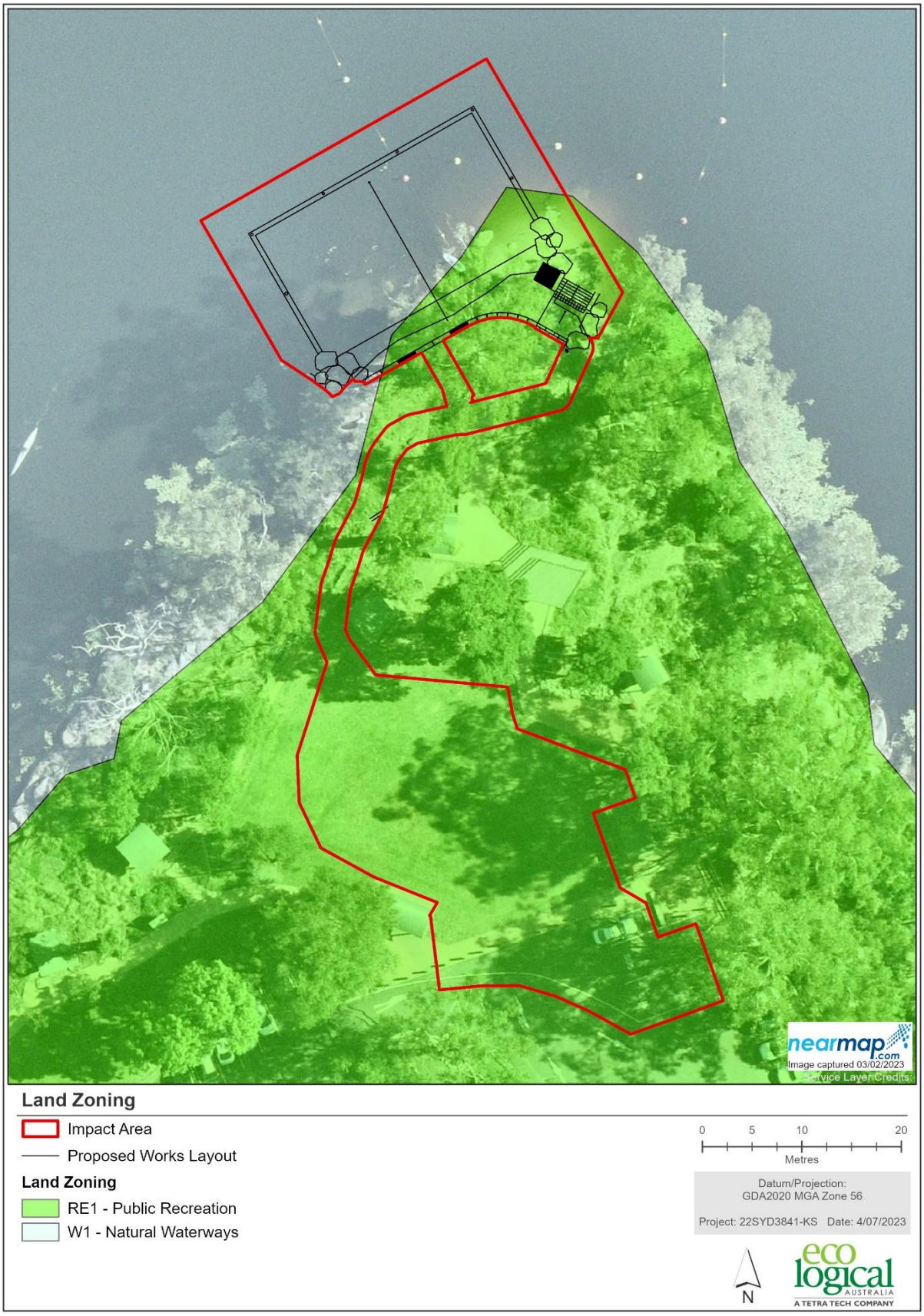

Figure 1-3: Land Zoning

Figure 1-4: Crown land in relation to the impact area and proposed works

1.6 Detailed Scope of Works

This section provides one possible construction method and is used as a guide to assess the impacts of the works. The actual construction methods and timing will be determined by the Contractor. The final concept plan (City of Parramatta, 2023) is provided in Appendix A. A Construction Environmental Management Plan (CEMP) is to be prepared and implemented prior to any on-ground works commence.

1.6.1 Site Set Up

- A Dial Before You Dig Assessment (DBYD) will be undertaken prior to any excavation or construction works to locate any service infrastructure present on site.
- Transport of machinery, equipment and materials to the site and establishment of site storage and parking areas (likely to utilise existing parking).
- Installation of sediment and erosion protection measures in accordance with the 'Blue Book' *Soils and Construction, Managing Urban Stormwater* (Landcom 2004) with reference to Chapter 5 'Erosion Control: Management of Water'.
- Installation of protection and exclusion fencing around vegetation that is to be protected and to delineate work area.
- Installation of fencing to restrict pedestrian access and temporary swimming area closure.

1.6.2 Main Works

The following main works are proposed:

- Coloured concrete pavement to improve accessibility to waters edge
- Coarse river sand 'beach' for improved level water access
- 2 x 2 m raised mod-wood lifeguard platform
- Concrete water access steps with central stainless steel handrail and tactile surface indicators
- Proposed sandstone rock outcrops/boulders
- Sandstone coloured concrete steps to match existing
- Planted native bush regeneration works
- Sandstone block seating / retaining wall
- Underwater retaining wall to 1.8 m depth with depth markers, to retain coarse river sand 'beach' material
- Backrest and armrests placed on sandstone block retaining wall
- Coloured concrete access pathway with steps and tactile surface indicators along pedestrian desire line improving accessibility to existing shelters and swimming area
- Tactile surface indicators placed at the top and bottom of existing deck steps for improved accessibility

Appendix A shows the proposed scope of main works.

1.6.3 Post Construction Work

On completion of the main construction works, the following tasks are to be completed:

- Removal of excess materials and disposal of excavated debris as appropriate
- Reinstate any disturbed surfaces
- Reinstate access
- Removal of signage and fencing

A CEMP is to be prepared by the contractor prior to on-ground works. This will specify the location of proposed site compound and stockpiling areas for materials and equipment and delineate 'no go' zones around environmentally sensitive areas where appropriate. The CEMP will also prescribe erosion and sediment controls during the construction period and include further mitigation and safeguards in accordance with Section 5.

An AQF Level 5 Consulting Arborist must be present on site during the works to ensure appropriate tree protection measures and construction methods are implemented as required for maximum retention of trees, in accordance with the PTA (ELA 2023b).

1.6.4 Site Compound and Access

A site compound would be established prior to the commencement of site works and would be retained in place throughout the works period. The location of the proposed compound is shown in Figure 1-2.

1.6.5 Finishing Works

Landscaping and ancillary works would generally be completed after all other activities being completed. Landscaping of areas would take place including replanting of vegetation (including lawn) impacted during construction. Any damage from access or construction would be rectified.

1.6.6 Machinery and Equipment

A list of machinery that may be used at different points within the Project is provided below:

- Excavator
- Crane
- Barge
- Hand tools for vegetation trimming, hand digging.

Required machinery will be determined by the contractor and stored in the designated construction compound location.

1.6.7 Site Access

Vehicular access is available via internal access roads south of the impact area, which is accessible via James Ruse Drive. Machinery (including any necessary cranes or barges) will then be transported via the access track shown in Figure 1-2.

1.6.8 Duration and Working Hours

Work hours will be in accordance with the *Draft Construction Noise Guidelines* (EPA 2020):

- 7am – 6pm Mondays to Fridays
- 8am – 1pm Saturdays
- No work on Sunday or public holidays.

Works are expected to commence March 2024 pending approval, avoiding the peak summer swimming season.

1.7 Project Justification and Consideration of Alternatives

1.7.1 Do-Nothing Approach

The continued maintenance challenges, coupled with the potentially unsafe swimming conditions of the existing swimming area, such as slippery and uneven surfaces at the site, limits use of the swimming area for its intended purpose, limits accessibility, and presents a potential hazard to the community. A do-nothing approach would not address these challenges and not in accordance with the Lake Parramatta Reserve Plan of Management (Crown Lands 2012), which outlines a Masterplan for the reinvigoration of the swimming area and main visitor precinct for improved use. Therefore, the 'do-nothing' approach is not the preferred approach.

1.7.2 Alternative Designs

Alternative design options were considered, namely alternatives to the proposed retaining wall. Sandbag walls and a contiguous pile wall were disregarded because they would be too expensive or have limited durability in the aquatic environment (JK Geotechnics 2023).

1.7.3 Preferred Option – The Proposed Works

The preferred option is the upgrade of the existing swimming pool area, as well as upgraded amenities along the foreshore. This option is the subject of this REF. The upgrade will include underwater retaining walls and works to level out the currently steep entry points, which will improve accessibility to the pool. Additional amenities will include sandstone blocks with seating. The preferred option (i.e., the proposed works) is justified by a range of reasons and benefits, including:

- Increased usability. The Project will allow the swimming area to be utilised by the local community for swimming and a range of water-based activities.
- Prolonged amenity. The Project will allow for the continued and safe use of a popular recreation area that sees a large volume of visitors each year.
- Improved safety, in its current condition the swimming area presents potential hazards to users due to a steep decline at the bed of Lake Parramatta. The current access to the water poses numerous accessibility and safety challenges such as hidden rocks, algae build-up and drop offs from shallow to deep water.

As such, the proposed works are the most beneficial option, socially and economically, allowing the continued use of Lake Parramatta swimming area. The works are in support of several strategic planning objectives, as discussed in Section 2.4.

SECTION 2

Statutory & Planning Context

2. Statutory and Planning Context

2.1 Commonwealth Statutory Framework

Table 2-1: Commonwealth Statutory Framework

Name	Relevance to the project
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	The EPBC Act protects Matters of National Environmental Significance (MNES), such as threatened species and ecological communities, migratory species (protected under international agreements), and National Heritage places (among others). Any actions that will or are likely to have a significant impact on the MNES require referral and approval from the Australian Government Environment Minister. Significant impacts are defined by the Commonwealth (reference http://www.environment.gov.au/epbc/guidelines-policies.html) for MNES. MNES have been identified within and near the study area. Significance Assessments were undertaken for: • *Hirundapus caudacutus* (White-throated Needletail) – Vulnerable/Migratory • *Lathamus discolor* (Swift Parrot) – Critically Endangered • *Pommerhelix duralensis* (Dural Land Snail) – Endangered • *Pteropus poliocephalus* (Grey-headed Flying-fox) – Vulnerable The assessments concluded that the proposed works are not unlikely to significantly impact the above listed or flora and fauna species.

2.2 New South Wales State Legislation

Table 2-2: NSW State Legislation

Name	Relevance to the project
Biodiversity Conservation Act 2016 (BC Act)	Section 7.3 of the Act requires proponents of activities subject to Part 5 of the EP&A Act to determine whether they will have a significant impact on matters listed under the BC Act. If a significant impact is likely to occur, the proponent of the activity must prepare a Species Impact Statement (SIS) consistent with section 7.20 of the BC Act or prepare a Biodiversity Development Assessment Report (BDAR). Tests of Significance were undertaken for the following threatened communities and species: • *Calyptorhynchus lathami* (Glossy Black-Cockatoo) – Vulnerable • *Daphoenositta chrysoptera* (Varied Sittella) – Vulnerable • *Glossopsitta pusilla* (Little Lorikeet) – Vulnerable • *Lathamus discolor* (Swift Parrot) – Endangered • *Ninox connivens* (Barking Owl) – Vulnerable • *Ninox strenua* (Powerful Owl) – Vulnerable • *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) – Vulnerable • *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat) – Vulnerable • *Miniopterus orianae oceanensis* (Large Bent-winged Bat) – Vulnerable • *Myotis Macropus* (Southern Myotis) – Vulnerable • *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat) – Vulnerable • *Scoteanax rueppellii* (Greater Broad-nosed Bat) – Vulnerable • *Pteropus poliocephalus* (Grey-headed Flying-fox) – Vulnerable • *Pommerhelix duralensis* (Dural Land Snail) – Endangered

Name	Relevance to the project
	The assessments concluded that the works are unlikely to result in a significant impact to any threatened ecological communities or species and therefore, the preparation of a BDAR or SIS is not required.
Biosecurity Act 2015 (Biosecurity Act)	The Biosecurity Act provides a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter, dealing with biosecurity matter, carriers and potential carriers, and other activities that involve biosecurity matter, carriers, or potential carriers. Part 3 of the Biosecurity Act applies a general biosecurity duty for any person who deals with a biosecurity matter or a carrier to prevent, eliminate or minimise any biosecurity risk they may pose. Under section 23 of the Act, a person who fails to discharge a biosecurity duty is guilty of an offence. Whilst the Act provides for all biosecurity risks, implementation of the Act for weeds is supported by Regional Strategic Weed Management Plans (RSWMP) developed for each region in NSW. Appendix 1 of each RSWMP identifies the priority weeds for control at a regional scale. However, landowners and managers must take appropriate actions to reduce the impact of problem weed species regardless of whether they are listed in Appendix 1 of the RSWMP or not as the general biosecurity duty applies to these species. Three priority weeds, as identified within the RSWMP, were present within the study area and will require management by Council: • *Senecio madagascariensis* (Fireweed) - Asset protection • *Cinnamomum camphora* (Camphor Laurel) - Other regional weeds • *Erthrina crista-galli* (Cockspur Coral Tree) - Other regional weeds.
Crown Land Management Act 2016 (Crown Land Management Act)	The proposed works are located primarily on NSW Crown land (Figure 1-4). In Council's capacity as CLM, Council may submit a development or other application without the need for consent of the Crown as landowner, provided that notice of intention is provided to Crown Land for comment prior to lodgement. The final construction documentation and REF will be provided to Crown Lands for comment. No further permits in the form of a Controlled Activity Approval (CAA) or Part 7 Fisheries permit are required for the proposed work where a lease, license, permit or other right under the Crown Land Management Act is granted.
Environmental Planning and Assessment Act 1979 (EP&A Act)	The EP&A Act is the principal planning legislation for NSW. It provides a framework for the overall environmental planning and assessment of proposals. As Council is the proponent, the works are to be assessed as 'development permissible without consent' under Part 5 of the EP&A Act (see Section 2.4). Accordingly, Council must satisfy Sections 5.5 and 5.6 of that Act by examining, and taking into account to the fullest extent possible, all matters which are likely to affect the environment. This REF is intended to assist, and ensure compliance, with the EP&A Act including Sections 5.5 and 5.6. This report addresses the requirements of Section 171 of the EP&A Regulation.
Environmental Planning and Assessment Regulation 2021 (EP&A Regulation)	Section 171 of the EP&A Regulation sets out the environmental factors which must be taken into consideration when preparing a Review of Environmental Factors (REF). This REF addresses all Section 171 factors. Section 171(4) of the EP&A Regulation sets out the conditions in which an REF must be published on the determining authority's website or NSW Planning Portal. These conditions are if – (a) the activity has a capital investment value of more than $5 million, or (b) the activity requires an approval or permit as referred to in any of the following provisions before it may be carried out— (i) Fisheries Management Act 1994, sections 144, 200, 205 or 219, (ii) Heritage Act 1977, section 57, (iii) National Parks and Wildlife Act 1974, section 90,

Name	Relevance to the project
	(iv) Protection of the Environment Operations Act 1997, sections 47–49 or 122, or (c) the determining authority considers that it is in the public interest to publish the review. The Project does not require a Part 7 Permit (per the Crown Land Management Act above, and the FM Act section below) or other permits listed therefore, the REF is not required to be published.
Fisheries Management Act 1994 (FM Act)	The FM Act provides for the protection, conservation and recovery of threatened species defined under the Act. It also makes provisions for the management of threats to threatened species, populations and ecological communities defined under the Act, as well as the protection of fish and fish habitat in general. The proposed works will involve dredging and reclamation within the lake which is classified as Type 2 Key Fish Habitat (KFH). An assessment of KFH and related aquatic ecology values has been included in Section 3.2 of this report. However, the proposed works are on Crown Land and will be carried out in accordance with the lease, license, permit or other right under the Crown Land Management Act. Therefore, in accordance with Section 200 of the FM Act, a Part 7 Fisheries Permit for dredging or reclamation of KFH is not required for work authorised under the Crown Land Management Act. Publication of the REF in accordance with Section 171(4) of the EP&A Regulation is therefore not required. Consultation with DPI Fisheries is still reccomended. The final Concept Plan (City of Paramatta 2023), along with this REF, will be provided to DPI Fisheries for comment prior to determination.
Heritage Act 1977 (Heritage Act)	The Heritage Act provides protection of the environmental heritage of the State which includes places, buildings, works, relics, movable objects, or precincts that are of State or local heritage significance. The NSW State Heritage Register (SHR) is the statutory register under Part 3A of the Heritage Act. Listing on the SHR means that any proposed works or alterations (unless exempted) to listed items must be approved by the Heritage Council or its delegates under section 60 of the Act. The proposed works would take place within the curtilage of one local heritage item, Lake Parramatta Reserve (Parramatta LEP 2023 Item No. I305), listed for its historic and research significance. The proposed upgrades to the existing swimming area are consistent with the current and historical land use as a place of recreation and leisure. There are no foreseeable impacts to the significance of this item.
National Parks and Wildlife Act 1974 (NPW Act)	The NPW Act is administered by the Director-General of the National Parks and Wildlife Services (NPWS), who is responsible for the control and management of all national parks, historic sites, nature reserves, and Aboriginal areas (among others). The main aim of the Act is to conserve the natural and cultural heritage of NSW. The Act aims to conserve the natural and cultural heritage of NSW. Where works will disturb Aboriginal objects, an Aboriginal Heritage Impact Permit (AHIP) is required. A requirement of Clause 15 of the Transport and Infrastructure SEPP is for consultation with the NPWS where the proposed works occur on or adjacent to National Parks Estate. The proposed works are not within or adjacent to national park and therefore consultation is not required. There are no previously recorded Aboriginal sites or objects within the study area. The majority of the study area has undergone prior ground disturbance in relation to the construction of and continued recreational use of the reserve, indicating there is a low potential for intact subsurface archaeological deposits.
Protection of the Environment Operations Act 1997 (POEO Act)	The POEO Act is the key environmental protection and pollution statute. The POEO Act is administered by the Environmental Protection Authority (EPA), and establishes a licensing regime for waste, air, water, and pollution. Relevant sections of the Act are listed below: • Part 5.3 Water Pollution

Name	Relevance to the project
	• Part 5.4 Air Pollution • Part 5.5 Noise Pollution • Part 5.6 Land Pollution and Waste. Any work potentially resulting in pollution must comply with the POEO Act. Relevant licences must be obtained if required. In accordance with Section 48 and Schedule 1(15) of the POEO Act, an Environmental Protection Licence (EPL) is required for contaminated soil treatment if: • Treatment of more than 1,000 m^3 per year of contaminated soil received from off site is proposed • Incineration of more than 1,000 m^3 of contaminated soil originating exclusively on site is proposed • Treatment (otherwise than by incineration) and storage of more than 30,000 m^3 of contaminated soil is proposed, or • Disturbance of more than an aggregate area of 3 ha of contaminated soil is proposed. Based on the Project, less than 1 ha in area of the study area is proposed to be excavated to the extent involved in removing the existing pedestrian access and pebble fill at the water's edge. On the basis that cover soils have not been deemed to be 'contaminated', the corresponding licensing threshold in Schedule 1 of the POEO Act is not triggered and an EPL is not required for this aspect of the proposed works.
Water Management Act 2000 (WM Act)	The WM Act aims to provide for the sustainable and integrated management of water resources for NSW. The Act requires developments on waterfront land to be ecologically sustainable and recognises the benefits of aquatic ecosystems to agriculture, fisheries, and recreation. The WM Act is administered by the Natural Resources Access Regulator (NRAR) and establishes an approval regime for activities within waterfront land, defined as the land 40 m from the highest bank of a river, lake, or estuary. A CAA is typically required for work within waterfront land. Section 91E of the Act creates an offence for carrying out a controlled activity within waterfront land without approval. However, according to Section 41 of the *Water Management (General) Regulation 2018* (WM Regulation), a public authority is exempt from Section 91E (1) of the Act 'in relation to all controlled activities that it carries out in, on or under waterfront land'. Therefore, Council does not need to obtain a CAA from NRAR as part of the works. Additionally, in accordance with Schedule 4 Clause 18 of the WM Regulation, any activity carried out in accordance with any lease, license or permit or other right in force under the Crown Land Management Act is exempt from controlled activities. A CAA is not required for the proposed works given that the works will be carried out with a lease, license, permit or other right under the Crown Land Management Act.

2.3 Environmental Planning Instruments

Table 2-3: NSW Environmental Planning Instruments (EPIs)

Name	Relevance to the Project
	State Environmental Planning Policy (SEPP)
State Environmental Planning Policy (Transport & Infrastructure) 2021 (Transport and Infrastructure SEPP)	The aim of the Transport and Infrastructure SEPP is to facilitate the effective delivery of infrastructure across NSW by identifying whether certain types of infrastructure require consent, can be carried out without consent or are exempt development. Pursuant to Section 73 of the TISEPP, development for the purpose of parks and other public reserves may be carried out by or on behalf of a public authority without consent on any land. Such works include:

Name	Relevance to the Project

	• *development for any of the following purposes—*
	  ○ *roads, pedestrian pathways, cycleways, single storey car parks, ticketing facilities, viewing platforms and pedestrian bridges,*
	  ○ ***recreation areas and recreation facilities (outdoor), but not including grandstands,***
	  ○ *visitor information centres, information boards and other information facilities,*
	  ○ *lighting, if light spill and artificial sky glow is minimised in accordance with the Lighting for Roads and Public Spaces Standard,*
	  ○ *landscaping, including landscape structures or features (such as artwork) and irrigation systems,*
	  ○ *amenities for people using the reserve, including toilets and change rooms,*
	  ○ *food preparation and related facilities for people using the reserve,*
	  ○ *maintenance depots,*
	  ○ *portable lifeguard towers,*
	  ○ *environmental management works,*
	  ○ *demolition of buildings (other than any building that is, or is part of, a State or local heritage item or is within a heritage conservation area).*
	Th proposed works are considered development without consent as the proposed works are recreation facilities and associated infrastructure and amenities. This is in accordance with Section 73 of the TISEPP.
	Part 2 of the TISEPP contains provisions for public authorities to consult with other agencies prior to the commencement of the proposed works, as described in Section 4 of this REF.

State Environmental Planning Policy (Resilience and Hazards) 2021 (Resilience and Hazards SEPP)	**Chapter 2 – Coastal Management** Chapter 2 of the Resilience and Hazards SEPP aims to manage development within coastal zones and protect the environmental assets of the coast. In accordance with Part 2, Section 5 of the *Coastal Management Act 2016*, the term coastal zone is defined as any area of land that is comprised of the following coastal management areas: • Coastal wetlands and littoral rainforests • Coastal vulnerability areas • Coastal environment areas • Coastal use areas. The study area is not located within land mapped as any of the above coastal management areas, therefore provisions of Chapter 2 do not apply to the project.
State Environmental Planning Policy (Biodiversity and Conservation) 2021 (Biodiversity and Conservation SEPP)	**Chapter 4 – Koala Habitat Protection 2021** Chapter 4 of the Biodiversity and Conservation SEPP applies to LGAs listed in Schedule 2. The Parramatta LGA is not listed under Schedule 2 therefore this chapter does not apply. **Chapter 6 – Water Catchments** Chapter 6 applies to land in specific regulated catchments, including the Sydney Harbour Catchment. The project is located within the Sydney Harbour Catchment, which extends from the most eastern extent of land around the Sydney Harbour to Prospect Reservoir in the west. This chapter includes development controls for regulated catchments. As the proposed works are not 'development', do not require development consent and are being assessed under Part 5 of the EP&A Act, these controls do not apply.
	Local Environmental Plan (LEP)
Parramatta Local Environmental Plan 2011	**Land Zoning**

Name	Relevance to the Project
(Parramatta LEP)	The study area zoned under the *Parramatta Local Environmental Plan 2011* (Parramatta LEP) as RE1 Public Recreation and W1 Natural Waterways (Figure 1-3). In accordance with Part 2 of the LEP, the objectives of the relevant land use zones are described below. **RE1 Public Recreation:** • *enable land to be used for public open space or recreational purposes* • *provide a range of recreational settings and activities and compatible land uses* • *protect and enhance the natural environment for recreational purposes* • *conserve, enhance and promote the natural assets and cultural heritage significance of Parramatta Park* • *create a riverfront recreational opportunity that enables a high quality relationship between the built and natural environment* **W1 Natural Waterways:** • *protect the ecological and scenic values of natural waterways* • *prevent development that would have an adverse effect on the natural values of waterways in this zone* • *provide for sustainable fishing industries and recreational fishing* • *provide for cultural and scientific study of natural waterways* • *enable works associated with the rehabilitation of land towards its natural state* The proposed works are in accordance with the objectives of RE1 and W1 zoning by allowing for the upgrade of a public recreation space while minimising adverse impacts to the scenic and ecological values of the waterway through project design and a range of mitigation measures, as provided in Section 5 of this REF.

2.4 Strategic Planning Context

2.4.1 Regional Plan: A Metropolis of Three Cities

The Greater Sydney Regional Plan: A Metropolis of Three Cities (Greater Sydney Commission 2018a), sets out a 40-year vision to the year 2056. It firstly establishes a 20-year plan to manage growth and change for Greater Sydney in the context of social, economic, and environmental matters. One of the four main themes of the plan is liveability.

Striving for liveability in communities is centred around providing the infrastructure and spaces for community members to be connected – socially, culturally, and more. Appropriate infrastructure and open recreation spaces are central to building healthy and resilient communities.

Table 2-4 below outlines the objectives within the plan that are most relevant to the proposed works and how the project will aid in achieving these objectives.

Table 2-4: *A Metropolis of Three Cities* objectives regarding green infrastructure

GSRP Strategy	Relevance to Proposed Works
Strategy 6.1: Deliver social infrastructure that reflects the needs of the community now and in the future	The proposed project will achieve this objective by: • Upgrading the existing swimming area to allow for better public use of Lake Parramatta Reserve • Undertaking upgrading works to provide waterfront amenities to extend the facilities lifespan
Strategy 6.2: Optimise the use of available public land for social infrastructure	The proposed project will achieve this objective by:

GSRP Strategy	Relevance to Proposed Works
	• Installing upgraded swimming infrastructure along with amenities for water and non-water-based activities and better supporting the influx of visitors to the broader reserve • Upgrading the access path from the parking lot to the upgraded swimming area allowing additional users access to the water and facilities • Upgrading the access path that connects to the broader walking tracks within the reserve, increasing accessibility
Strategy 7.1: Deliver healthy, safe, and inclusive places for people of all ages and abilities that support active, resilient, and socially connected communities	The proposed project will achieve this objective by: • Providing an opportunity to renew the swimming area and providing upgraded amenities, which respond to the needs of a growing population • Improving access to high quality and diverse local open space through access works from parking facilities • Delivering a high-quality recreational water area with associated amenities that will be inclusive for people of all ages and abilities aiding in an active, resilient, and socially connect community

2.4.2 Central City District Plan

The *Central City District Plan* (Greater Sydney Commission 2018b) applies to the Blacktown, Cumberland, Parramatta, and The Hills LGAs. It is a 20-year plan to manage growth in the context of economic, social, and environmental matters to achieve the 40-year vision for Greater Sydney. In many ways, it supports the regional plan described above but on a finer scale.

The *Central City District Plan* contains several objectives with four main goals. These include:

- promote infrastructure and collaboration
- to increase liveability
- to improve productivity
- promote sustainability

The goal of increasing liveability will be attained through the provision of a safer and more accessible swimming area within an existing recreation space, to meet the needs of the growing Central City District. Fostering healthy, creative, culturally rich, and socially connected communities will be achieved in part by developing accessible recreational opportunities. The project will promote healthy and social physical activity within the community, expand recreation opportunities, improve health outcomes, reduce impacts to local biodiversity and is intrinsically linked to the four (4) key planning priorities:

- Planning Priority N4: Fostering healthy, creative, culturally rich and socially connected communities
- Planning Priority N6: Creating and renewing great places and local centres, and respecting the District's heritage
- Planning Priority N13: Protecting and improving the health and enjoyment of the District's waterways
- Planning Priority N15: Protecting and enhancing bushland, biodiversity and scenic and cultural landscapes

2.4.3 Greener Places: Establishing an urban green infrastructure policy for New South Wales

Green infrastructure is the network of green spaces, natural systems and semi-natural systems that support sustainable communities. It has connected elements:

- waterways;
- urban bushland;
- urban tree canopy and green ground cover; and
- parks and open spaces.

It is fundamental to creating a high quality of life and is important in creating a region that is both climate resilient and meets future needs, for a growing region. The project is proposed within the Lake Parramatta Reserve, an area of approximately 70 ha of bushland and waterway within the urban setting of North Parramatta. The existing swimming area is currently an example of green infrastructure for the local community. The upgrade will improve the safety of, and access to, such green infrastructure so that diverse community members and increased volumes of visitors can access this important space.

The NSW Government's draft green infrastructure policy *Greener Places: Establishing an urban green infrastructure policy for New South Wales* was produced to guide the planning, design, and delivery of green infrastructure and has been considered during detailed design with the retention of trees alongside replacement plantings while providing environmentally recessive structures in and around the swimming area to support healthy, resilient and socially connected communities.

2.4.4 City 2036 – Local Strategic Planning Statement

City Plan 2036 – Local Strategic Planning Statement (LSPS) (City of Parramatta 2020b) sets out the vision for the area to 2036 and the actions that will be taken to achieve this vision. It provides the land-use planning framework for the LGA, providing a link between the *Central City District Plan* (Greater Sydney Commission, 2018) and *A Metropolis of Three Cities* (a land use plan for the Sydney region). The Plan sets out several planning priorities, the most relevant to the project summarised in Table 2-5 below.

Table 2-5: Planning Priorities under the LSPS relevant to the Project

Planning Priority	Response
P36: Promote and prioritise expansion of recreational opportunities and spaces with a focus on the Green Grid, Parramatta Ways Walking Strategy, and the Parramatta River	The Project will provide the local community with a functional recreational asset that enables casual and organised recreation and sport to occur in the locality.
P50: Improve water quality so that our waterways support water based recreation and a healthy ecosystem	The Project will aid in improving water quality through appropriate aquatic infrastructure that reduces.
P55: Protect and enhance urban bushland and biodiversity	The Project will provide increase amenities around the existing swimming area that seeks to reduce impacts to biodiversity and encourages the continued use and maintenance of surrounding bushland.
P58: Carefully manage development in areas of high environmental or cultural significance to ensure that these are not compromised	The Project will be implemented in a way that develops functional recreational facilities for the community in a way that is supporting of the environmentally significant location of Lake Parramatta.

SECTION 3

Environmental Impact Assessment

3. Environmental Impact Assessment

3.1 Landform, Geology and Soils

3.1.1 Existing Environment

3.1.1.1 Geology and soil landscapes

A desktop review of geology and soils found that the study area is underlain by Hawkesbury Sandstone. A review of the Soil Landscapes of Central and Eastern NSW dataset (DPIE 2020) indicates that the study area is underlain by the Gymea soil landscape (Figure 3-1) on Hawkesbury Sandstone geology which is a Triassic sediment (Figure 3-2) (DPIE 2020a). Hawkesbury Sandstone is a medium to coarse-grained quartz sandstone with minor shale and laminate lenses (DPIE 2020). Gymea soils are characterised by loose, coarse sandy loam topsoils and yellowish-brown clayey sand subsoils on the sandstone bedrock. Limitations of Gymea soils include localised steep slopes, high soil erosion hazard, stoniness, and highly permeable soils (DPIE 2020).

3.1.1.2 Subsurface conditions

Throughout the study area, the following surfaces and conditions were encountered during geotechnical investigation (JK Geotechnics 2023):

- Pavement – 50 mm thick concrete pavement outside the waters edge, in Borehole (BH) 3
- Silty sand fill in BH1 and BH2 to depths of 0.8 m and 0.4 m respectively
- A 0.4 m thick sandstone boulder in the fill profile of BH1. Other inclusions such as gravel, concrete fragments and foot fibres were encountered
- Lakebed sediments, comprising high plasticity silty clay in BH4 to BH9. Depths ranged from 0.05 m to 0.4 m below the lakebed surface.
- Weathered sandstone bedrock beneath fill in BH1 and BH2, and underlying the concrete pavement in BH3. Sandstone bedrock terminated at depths of 3.56 m to 4.46 m.

3.1.1.3 Topography and flood prone land

The topography of the site is slightly undulating, with a slope of less than 3°. The bed of the lake drops off at a steep incline north of the point of land, to approximately 7 m deep. The topography of the lakebed was assessed through bathymetry and is described below.

The study area is not identified on the FloodSmart Parramatta flood mapping. The nearest instance of flood warning areas is 200 m southwest of the study area, being a high-risk area where flooding is frequent and common and will see the deepest, fastest flowing waters. This mapped area is associated with Hunts Creek to the southwest, west of the Lake Parramatta Dam.

3.1.1.4 Acid Sulfate Soils

The study area is located outside the Acid Sulfate Soils (ASS) risk probability mapping (Naylor *et al.* 1998). Given that ASS are typically associated with coastal environments, it is considered unlikely that ASS would occur within the study area. ASS do not pose a risk left undisturbed. Geotechnical tests show a moderately acidic soils to highly alkaline soils, very low sulfate contents and chloride contents (JK Geotechnics 2023).

3.1.1.5 Soil salinity

The study area is mapped under the Salinity Potential Western Sydney dataset as having very low salinity potential (Figure 3-3) (DPE 2002). Nearby salinity soil profiling undertaken within Lake Parramatta Reserve, approximately 300 m southeast of the study area, found no evidence of salting (OEH n.d.). It is unlikely that the study area contains saline soils.

3.1.1.6 Contamination

A search of the NSW Environment Protection Authority (EPA) *Contaminated land record of notices* (EPA 2023) was undertaken, for the City of Paramatta LGA. Several current records of contamination were returned, however no records in proximity to the study area were found, being in North Parramatta, or surrounding suburbs of Oatlands, May Villa, North Rocks, Westmead, and Northmead.

It is unlikely that gross contamination exists within the study area. As discussed in Section 3.2 below, regular water quality monitoring is carried out within the lake and found that bacterial contamination levels are, on average, suitable for swimming. Some pollutants resulting from general waste and litter may occur within and around the study area.

Figure 3-1: Soil landscapes within the study area (DPIE 2020a)

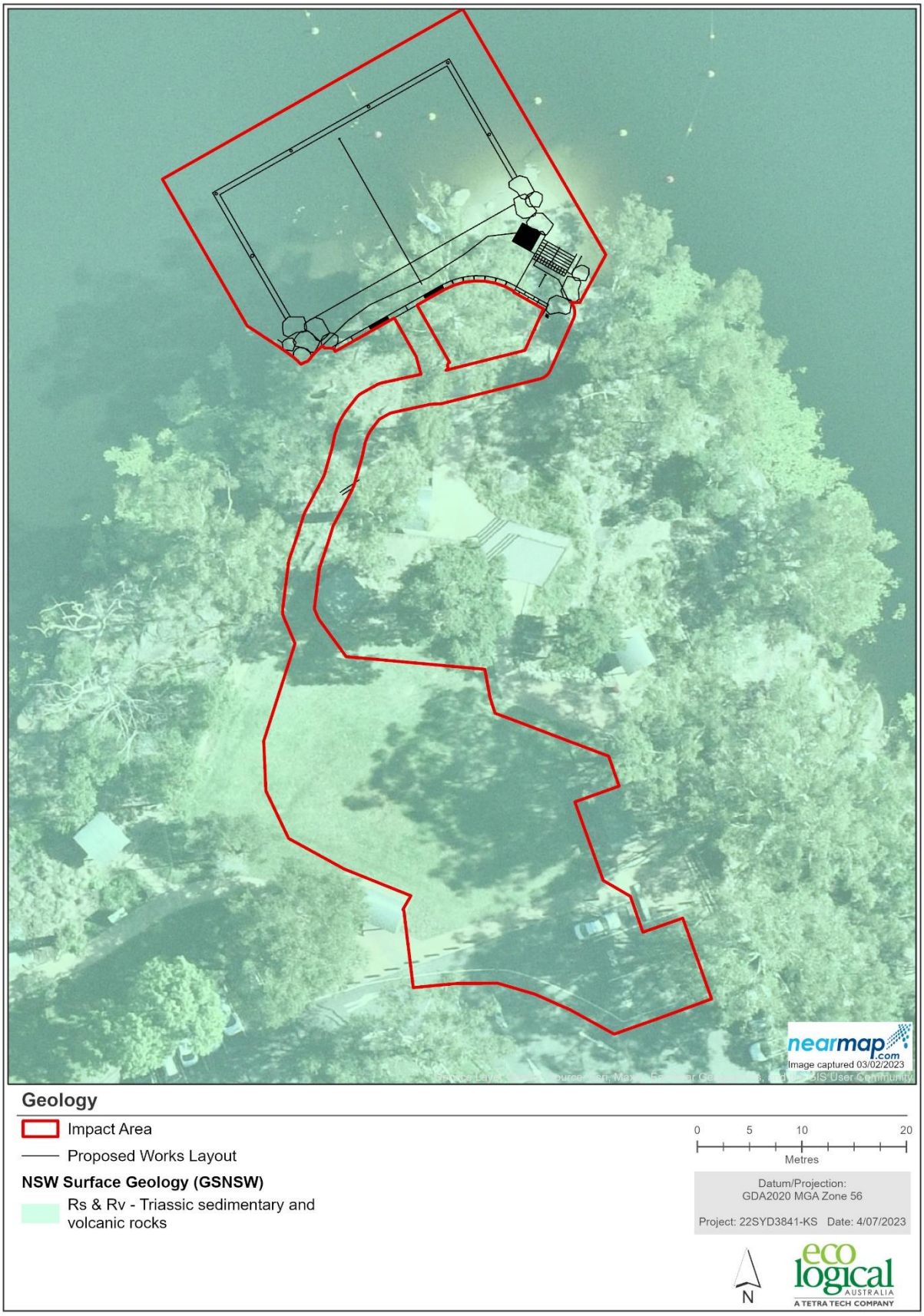

Figure 3-2: Geology of the study area (GSNSW)

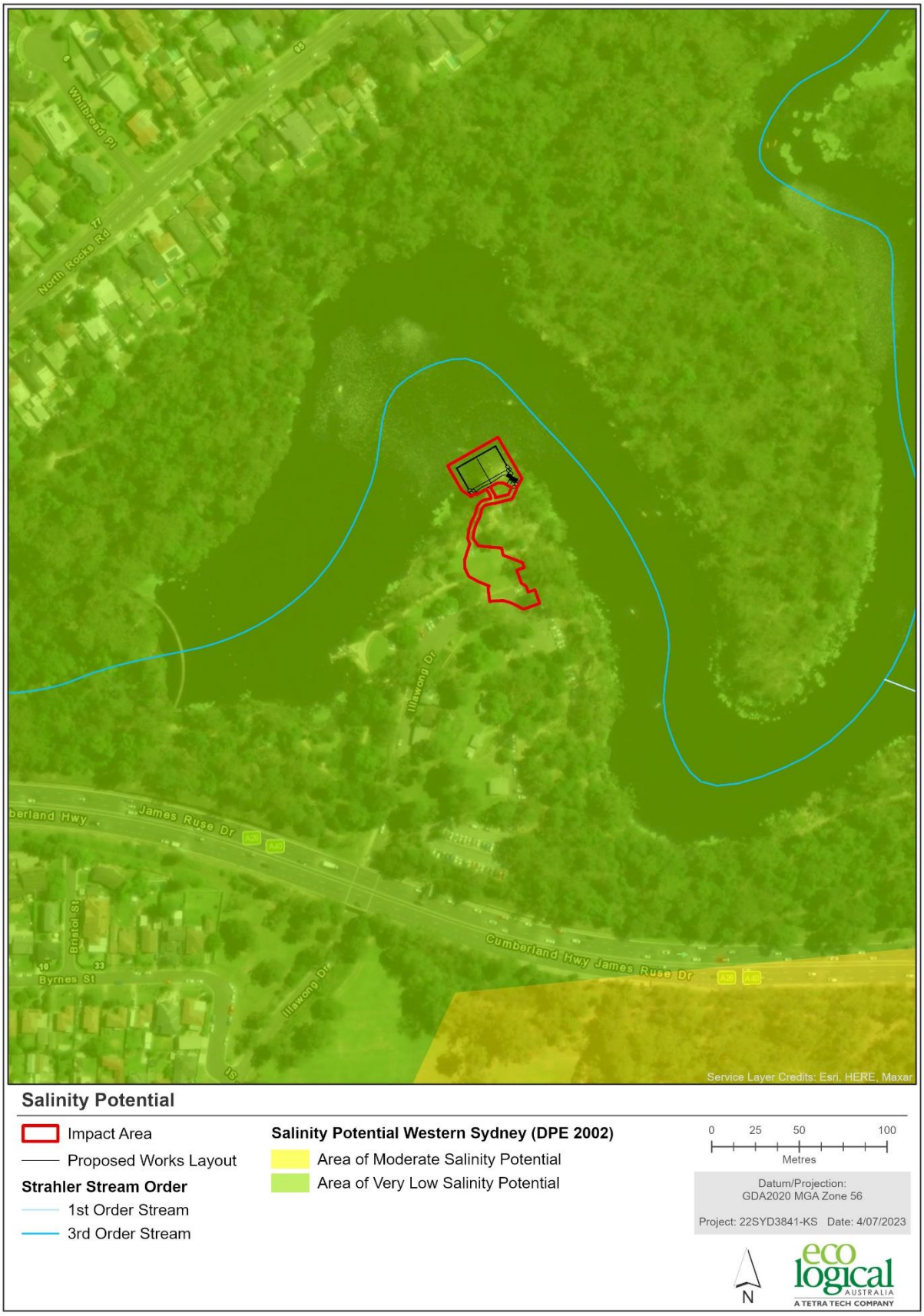

Figure 3-3: Salinity Potential of the study area (DPE 2002)

3.1.1.7 Geotechnical and bathymetry investigations

A Geotechnical Investigation was completed by GBG Australia Pty Ltd (GBG 2023) within the Lake Parramatta swimming area. The investigation area (shown in Figure 3-4 below) did not constitute the whole impact area of the works but focussed on the waterway, with three boreholes on land.

The following assessments were completed and are summarised in this report:

- Geotechnical works, carried out by JK Geotechnics on behalf of GBG:
  - Land boreholes (BH)
  - Grab samples of lakebed sediments
- Geophysical works, carried out by GBG:
  - Single beam echo sounder bathymetry
  - Static Marine Seismic Refraction

The bathymetry collected shows a steep slope running north of the point of the reserve, to a channel that is 7 m deep. The north-western side of the swimming area has a more gradual slope than the eastern side.

The geophysical investigations found that sandstone bedrock and boulders dominated the investigation area. Some superficial sandy fill/cover was present in some areas. Borehole results confirmed these observations, finding silty sandy fill in BH1 and BH2, to depths of 0.8 m and 0.4 m respectively (GBG 2023). In BH3, concrete pavement was present to 50 mm depth. Silty clays were encountered in disturbed samples from BH4 to BH9. Sandstone encountered beneath the fill of BH1 to BH3 was found to be moderately weathered, of low to high strength.

The full report prepared by GBG and supplemented by JK Geotechnics is provided in Appendix B.

Figure 3-4: Geotechnical investigation area indicated by white polygon (GBG Group 2023)

3.1.2 Impact Assessment

3.1.2.1 Sediment and erosion

Given the proposed works will involve reclamation of the existing lakebed, impacts relating to soils and geology are expected to occur. Sandy beach fill is also to be set down at the foreshore as part of the proposed works. Impacts are also likely to occur for the construction outside the water, for the purposes of construction the retaining wall and associated seating. This may cause erosion and sedimentation, especially around sensitive areas such as tree roots. Sediments have the potential to enter the waterway and affect water quality and cause turbidity during construction, however this potential impact is expected to be mitigated through the use of strict erosion and sediment controls.

The risk of soil erosion, sedimentation and turbidity is thought to be minimal if the mitigation measures recommended in Table 3-1 and Section 5 are implemented.

3.1.2.2 Soil salinity and ASS

The study area is unlikely to contain saline soils or potential for ASS to occur. As such, no further assessment has been undertaken within this REF. Given the very low potential for salinity to occur in the study area, no impacts related to saline soils are expected to occur because of the proposed works.

3.1.2.3 Contamination

Based on the current site condition discussed above, there is a low potential for contamination to exist on site. If contamination soils or fill are suspected through visual inspection or odorous smells, either prior to or during construction works, further surveys should be undertaken to assess the risk before work continues. Additionally, if contamination is suspected, contact the relevant Council environmental and/or compliance units. Obvious contaminated fill is to be removed (JKG 2023).

Stripping of vegetation and topsoil will be required. If any excess soils are to be taken offsite for disposal, or for reuse, materials should be tested for safety in accordance with the *Waste Classification Guidelines* (EPA 2014).

Use of fuels and oils for machinery is required to undertake the works. Proper use and storage of these materials is required and detailed in mitigation measures (Table 3-1 below). Accidental leaks and spills have the potential to contaminate or pollute soils on land, or the Lake Parramatta waterway. The risk of contamination and pollution is considered minimal if the recommended mitigation measures are implemented.

3.1.2.4 Geotechnical Issues

JK Geotechnics (2023) prepared a geotechnical assessment for the proposed works (Appendix B). The proposed works will influence the landform of the lakebed in the impact area, which is expected to influence the hydrology of the lake. Advice on the impact of the altered lake hydrology is reccomended to be sought from a coastal engineer prior to design finalisation (JKG 2023).

With regards to excavation impacts, JKG assumes a maximum excavation depth of 1 m. Most of the rock excavation profile is expected to be bedrock of low to medium and higher strength limited thickness of lesser strength bedrock will be encountered. Contractor equipment and methods should be adjusted according to the conditions. Lesser strength bedrock (being weathered sandstone) may be excavated by a conventional bucket attachment on a hydraulic excavator, though some ripping may be expected. Hydraulic impact rock hammers and rock saw fittings on hydraulic excavators are recommended for low to higher strength bedrock. This equipment is also recommended for breaking of boulders and rocks,

or for detailed excavations around proposed footings and buried services identified in a Dial Before You Dig (DBYD).

Excavation support is required to minimise the potential for erosion and sedimentation during construction. Temporary batter slopes are recommended (JKG 2023). There is a risk of some instability of temporary sand batters at or below the level of any groundwater seepage, especially after rain periods. The batter should be sand bagged to stabilise in the case that seepage or rain occurs. Works should be scheduled outside of heavy rain periods to further minimise this potential impact.

Local batters may be required where excavating higher strength bedrock. Specific recommendations provided by JKG (2023) (Appendix B) regarding retaining walls, artificial beach walls and footings should be referenced by the contractor.

Impacts relating to geotechnical issues are expected to be managed by the mitigation measures recommended in Table 3-1 and Section 5.

3.1.3 Mitigation Measures

Table 3-1 below provides recommended mitigation measures to minimise potential operational and construction impacts associated with soils and geology, in particular sediment and erosion potential.

Table 3-1: Mitigation measures for soils and geology

Environmental Impact	Mitigation Measures
Sediment and erosion	• Prepare a CEMP prior to any construction works to address measures to be adopted to minimise impacts on the environment as a result of the construction works, including erosion and sedimentation. • Prepare a Sediment and Erosion Control Plan (SEMP) in accordance with *The Blue Book – Managing Urban Stormwater: Soils and Construction* (Landcom, 2004) and implement prior to works. • Install appropriate soil and erosion control measures such as sediment fencing and local batters prior to commencing works. • Inspect controls regularly (weekly), and more frequently during rain periods to ensure structures are in proper working order. • Prior to forecast heavy rain, cease work, and remove accumulated material from sediment controls. • Schedule major earthworks outside of predicted heavy rain periods. • Stop work during and following heavy rainfall to reduce risk of mobilising sediment. • Monitor sedimentation down slope of excavated areas. • Leave erosion and sediment controls in place until after the works are completed
Geotechnical recommendations (JKG 2023)	• Seek advice from a coastal engineer on the effect of raising the lakebed and subsequent hydrological alterations. • Engage a professional scuba diver to check the perimeter outside the retaining walls for hazards. Appropriate warnings are to be signposted on the outer edge of the beach following completion of works. • Design should include the most appropriate retaining wall solutions, being most suitable retaining walls are mass gravity boulder walls and mass gravity concrete block walls. • Any obvious deleterious or contaminated existing fill should be removed. These stripped materials should be taken offsite as they are not suitable for reuse as engineered fill.

Environmental Impact	Mitigation Measures
	• Topsoil may be stockpiled and used for landscaping purposes if not deemed contaminated. Stockpiling recommendations are provided below. • Excavation works are to be undertaken with reference to the *Code of Practice – Excavation Works* (NSW Government 2020) and geotechnical findings (JKG 2023). • Appropriate excavation support in the form of temporary batter slopes, per specifications by JKG 2023 are recommended. • Contractor is to make provisions for sandbagging of batter slopes, in case it is required for instability or seepage. • Construct retaining walls with reference to geotechnical recommendations in JKG 2023.

Stockpiling of material	• Excavated soil and approved, imported materials must be stockpiled within a designated stockpile area.
	• During site establishment, stockpile areas must be prepared and managed using the following methods:
	  ○ Establishing stockpiles on existing paved surfaces wherever possible
	  ○ Construction of diversion drains and bunds around the perimeter of the stockpile areas. Installation of sediment and erosion control measures, where necessary
	  ○ Erection of signs at the entrance to the stockpile areas and at locations around the stockpile specifying individual stockpile number and the type of materials stored
	  ○ Limit stockpile height to no more than 2 m
	• All stockpiles must be maintained in a tidy and safe condition with stable batter slopes.

Imported fill or illegal dumping on site	• Develop and implement an unexpected finds protocol for the site to ensure any material which is potentially contaminated is identified and appropriately assessed and managed.
Contamination	• If contaminants are identified prior to or during works, further assessment is required before proceeding with excavation.
Pollution of soils from chemical spills (e.g., fuel or oil from machinery).	• For any excess spoil material which requires offsite disposal, formally classify waste before being taken to an appropriately licensed landfill in accordance with the *Waste Classification Guidelines* (EPA 2014). • Store all chemicals (e.g., fuel, oil) in appropriate bunding/storage systems within the approved storage facility. • Ensure appropriate spill kits are available on site. • Establish dedicated refuelling areas outside environmentally sensitive areas and away from creek lines. These areas are to be bunded to ensure any spills do not enter sensitive areas or waterways.

3.2 Waterways and Aquatic Habitat

3.2.1 Existing Environment

3.2.1.1 Waterways

Lake Parramatta is a 10.5 ha reservoir open to the public for swimming and recreational activities. Lake Parramatta offers several facilities as a recreational waterway, including:

- A designated swimming area
- Boat hire
- Non-motorised boating facilities

Dam reservoirs often have a range water quality issue associated to the trapping of sediments and nutrients and stratification of the water body (Winton et al. 2019). The water quality at the lake is monitored through Council's Water Quality Program. The program is designed to monitor Lake Parramatta's environmental status and advise the public of any changes to its water conditions that may affect ability to swim. This includes microbiological, pH, turbidity, and temperature monitoring. Heavy rainfall can cause microbial contamination of the lake. Two of the five monitoring locations are within the designated swimming area. Annual average bacterial levels are suitable for swimming (below 200 colony forming units), and the lake's average temperature is typically coldest in July (12^{o}C) and warmest in February (26^{o}C). The reservoir is approximately 10 m deep near the study area (Figure 3-5).

Lake Parramatta is formed by the damming of Hunts Creek, a Strahler third order stream. Hunts Creek flows from northeast to the southwest and is a tributary of the Parramatta River. Two unnamed first order streams flow into lake Paramatta from the east. Watercourses are shown in Figure 3-6.

3.2.1.2 Aquatic Ecology

Lake Parramatta is a manmade lake formed by the creation of the dam in 1856 on Hunts Creek. The dam was later increased in height in the mid-1890s. As such the aquatic habitat within the lake is not a naturally occurring system, but it has existed for more than 150 years and in that time has developed ecological processes consistent with lentic aquatic ecosystems.

ELA undertook a field survey of the lake in November 2022, the survey included a visual observations of lake surface and use of underwater camera to identify aquatic flora and fauna and potential habitat to occur within the lake. Aquatic vegetation observed during the survey included*, Nymphaea alba* (White Water Lilly), *Schoenoplectus validus* (Club-rush) and *Potamogeton* sp. (Figure 3-7 to Figure 3-9). Vegetation was only observed within 1 m – 3 m of the lake shoreline.

Observations of the underwater habitat were extremely difficult due to the turbidity of the lake. Visibility through the underwater camera was approximately 30 cm at 1–2 m below the surface (Figure 3-10). Visibility was anticipated to be worse below this due to the lack of light reaching these areas. Council currently creates a small beach to enter the lake for swimming purposes, no aquatic flora was identified in this area (Figure 3-11). Beyond this area the floor of the reservoir consisted of sediment-laden debris on top of old sandstone drop-offs (Figure 3-12). Beyond this point the Bathymetry Report prepared GBG Group (GBG 2023) found that the reservoir floor consisted of steps and ledges or platforms dropping 7 m from the water level to the creek north of the point (Figure 3-5). The reservoir does not provide the habitat typical of important feeding, spawning and nursery sites for many native fish which includes pools, gravel beds (or "riffles"), snags, wetlands, and riparian vegetation. In addition, the stratification of water within the dam can create an undesirable, and potentially uninhabitable,

environment for aquatic fauna, resulting from low level of oxygen in water and colder water temperatures (Winton et al. 2019).

No threatened fish species are likely to occur in the reservoir or upstream waterway. Modelling of the nearest threatened species, the Macquarie Perch, in the Nepean Rivers approx. 30 km to the west of the site (Riches et al. 2016). Other likely threatened species are Adam's Emerald Dragonfly and Sydney Hawk Dragonfly. Both species occur in permanently flowing rivers, so there is no suitable habitat for them in the static waters of the study area.

3.2.1.3 Key Fish Habitat

The study area is identified by the Department of Primary Industries (DPI) Fisheries as Key Fish Habitat (Figure 3-6). DPI Fisheries identify three types of Key Fish Habitat (KFH) in their *Policy and Guidelines for Fish Habitat Conservation and Management* (Fairfull, 2013):

- **TYPE 1** (highly sensitive aquatic habitat);
- **TYPE 2** (moderately sensitive key fish habitat); and
- **TYPE 3** (minimally sensitive key fish habitat).

The habitat within the reservoir at the study site is **TYPE 2** as it does not contain natural in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length.

Regarding other DPI Fisheries policies and guidelines, no aquaculture lease or hauling grounds are located near Lake Parramatta.

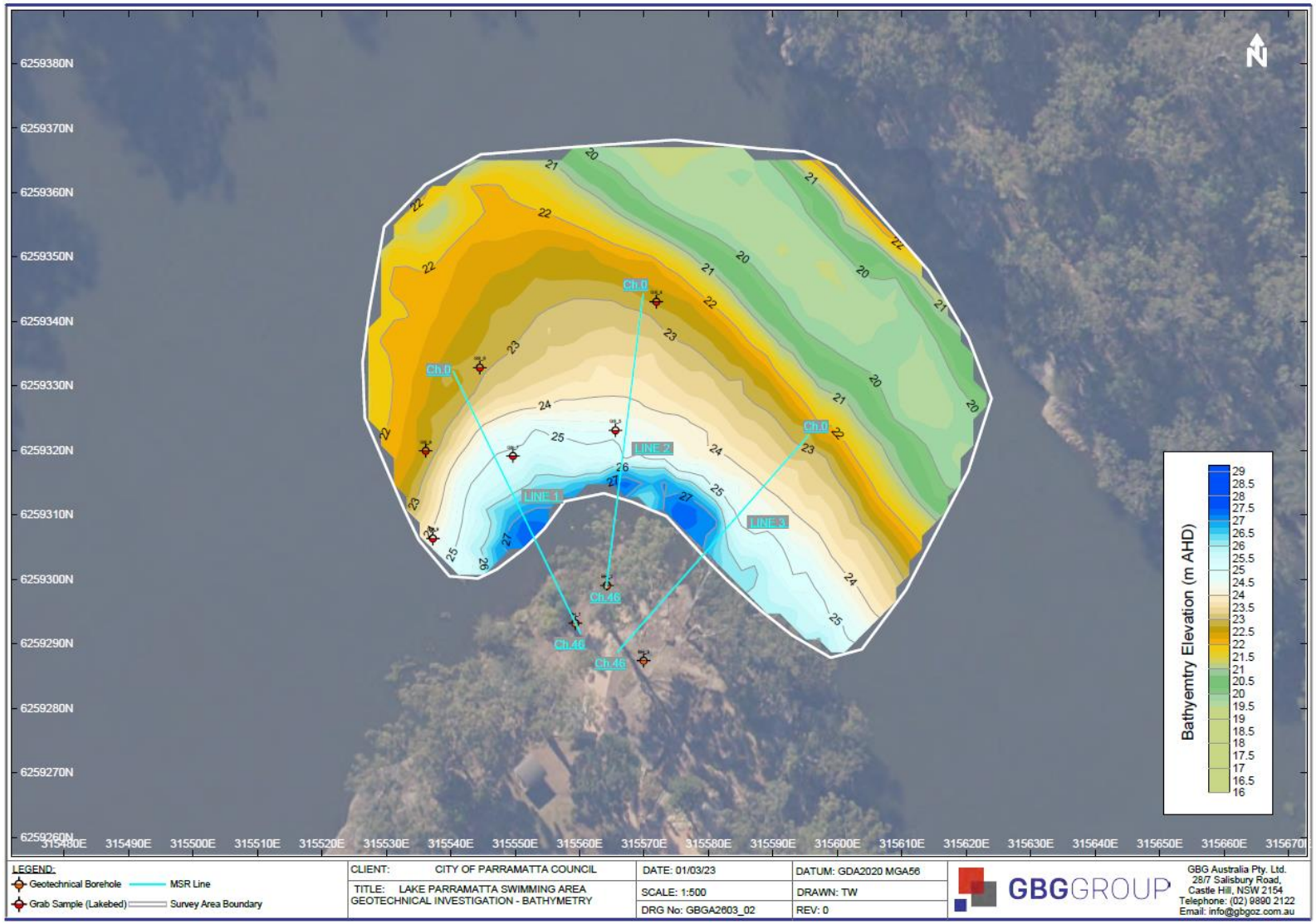

Figure 3-5 Lake bathymetry (GBG Group, 2023)

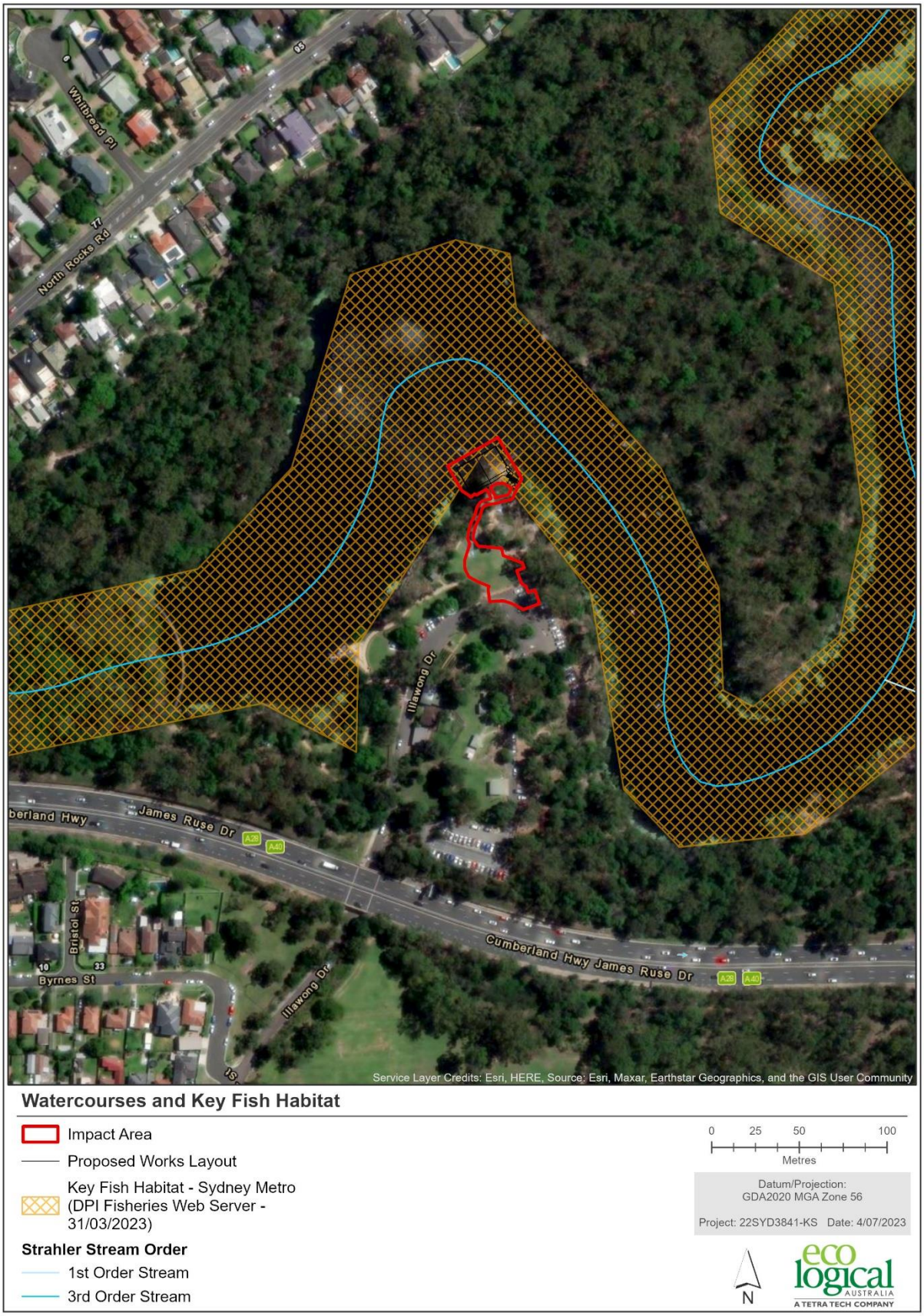

Figure 3-6: Strahler stream order and Key Fish Habitat

Figure 3-7: *Nymphaea alba* (White Water Lilly)

Figure 3-8: *Schoenoplectus validus* (Club-rush)

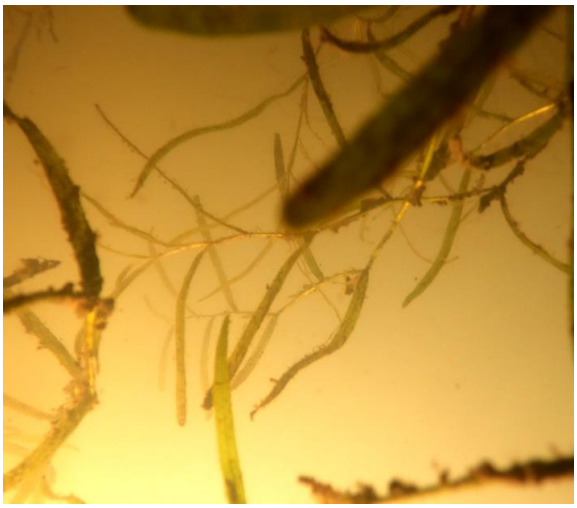

Figure 3-9: *Potamogeton* sp.

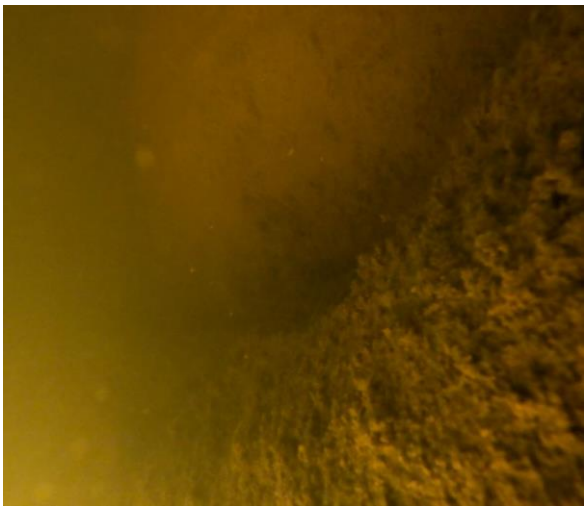

Figure 3-10: Turbidity within lake

Figure 3-11: Sand beach

Figure 3-12: Sediment covered debris

3.2.1.4 Groundwater

Groundwater was not encountered during auger drilling for geophysical investigations (JK Geotechnics in GBG 2023). Water levels recorded in BH1 and BH2 are considered to be artificially high, due to the use of water during coring. No long-term groundwater monitoring or assessment was undertaken.

3.2.1.5 Groundwater Dependent Ecosystems)

The Atlas of Groundwater Dependent Ecosystems (GDEs) (BoM 2017) was checked for the potential for aquatic and terrestrial GDEs to occur within the study area. No GDEs were identified within the study area (Figure 3-13). The potential for an aquatic GDE to occur was mapped approximately 5 m north of the study area.

Figure 3-13: Potential for aquatic and terrestrial GDEs to occur (BoM 2017)

3.2.2 Impact Assessment

3.2.2.1 Sedimentation

The proposed works include works above and below the reservoir water level. The primary potential impacts to water quality are associated to the mobilisation of sediment from works on land, the disturbance of sediment within the reservoir from underwater construction activities and the placement of materials within the reservoir. Increased sedimentation has the potential to degrade water quality by increasing turbidity within the reservoir, Impacts from sediment input should be mitigated in accordance with controls provided in Section 5.

3.2.2.2 Impacts to Key Fish Habitat

The proposed works would result in the loss of areas of 0.032 ha of Type 2 KFH. A Section 7 Permit for dredging and reclamation is not required to undertaken the proposed works, given that the works are on Crown Land in accordance with Section 200 of the FM Act. Regardless, DPI Fisheries has a 'no net loss' policy regarding aquatic habitats, as such mitigation measures are provided in Section 5 to protect and restore any impacted fish habitat. Consultation with DPI Fisheries is also recommended.

3.2.2.3 Water Pollution

Machinery is required to construct the proposed works. As discussed above, machinery will likely operate on the lake foreshore and within the reservoir. The operation of machinery within this environment has the potential to pollute the waterway through accidental chemical spills. Chemicals kept on site include diesel fuel, hydraulic fluid, lubricants, and cooling liquids. If these chemicals are spilt into the reservoir, they have potential to pollute the lake and cause the death of freshwater fauna and flora. Mitigation measures are provided in Section 5 to minimise the potential of water pollution occurring.

3.2.2.4 Introduction of invasive species

As discussed above machinery will likely operate on the lake foreshore and within the reservoir during construction. If machinery has previously worked in areas that have invasive aquatic flora species there is potential for aquatic weeds to be transported into the reservoir. This could cause large out breaks of invasive species within the reservoir which has potential to reduce the ability of native flora and fauna to utilise the dam and impact the enjoyment of swimmers and non-motorised boaters. Mitigation measures are provided in Section 5 to minimise the potential of introducing invasive species into the reservoir.

3.2.2.5 Groundwater inflows

Groundwater inflow has the potential to occur, especially after heavy rain (JKG 2023). This is most likely to occur in the sandy soil profile where it contacts the underlying bedrock. Inflows encountered during construction are expected to be small in volume and managed by gravity drainage (JKG 2023).

3.2.2.6 Groundwater Dependent Ecosystems

Given the low potential for GDEs to occur within the impact area, impacts to GDEs are not expected to occur. Additionally, the inflows of groundwater are expected to be minor as discussed above and will be managed by gravity drainage.

3.2.3 Mitigation Measures

Table 3-2: Mitigation measures for waterways and aquatic habitat

Potential Impact	Mitigation Measures
Excess sediment input into waterway	• A sediment and erosion control plan must be prepared in accordance *with Managing Urban Stormwater: Soils and construction - Volume 1* (Landcom 2004). • A sediment curtain must be installed around the in-reservoir works. • Weather forecasts will be checked daily to ensure that work is not carried out before or during high rainfall.
Pollution of foreshore from chemical spills (e.g. fuel or oil)	• Store all chemicals (e.g., fuel, oil) offsite and if required to be stored onsite, chemicals should be stored in appropriate bunding/storage systems and only for short periods. • Ensure appropriate spill kits are present onsite. • Ensure all equipment is in good working order. • Carry associated Safety Data Sheets (SDS) for all chemicals.
Impacts to Key Fish Habitat	• Consultation with DPI Fisheries is recommended prior to construction. Implement any recommendations provided by DPI Fisheries into the design and/or construction methodology. • Protect KFH wherever possible during construction. Allow for the restoration of any impacted fish habitat as part of the Project design.

Introduction of invasive species	• Adhere to the Saving our Species Hygiene guidelines (DPIE 2020b) at all times. In particularly:
	  ○ Wash down equipment and vehicles (including boats, boat trailers and barges) prior to entering the site, to manage the introduction and spread of pathogens. Pay particular attention to cleaning mud flaps and tyres.
	  ○ Thoroughly clean all equipment of soil and vegetation debris prior to entry into the study area.
	  ○ Use a solution of 70% ethanol or methylated spirits in 30% water for wash down and equipment cleaning to effectively disinfect areas.
	  ○ Wash down on a hard, well-drained surface, for example a road, and on ramps if possible. Do not allow wash-down water to drain into native bushland or waterways.
	  ○ Machinery and equipment must also be cleaned when leaving site.
	• Wash down protocols are required to control multiple impacts including, pathogens, weeds, and contaminated soils. The CEMP should develop a single wash down process that addresses the requirements of all three potential environmental impacts.

3.3 Biodiversity

3.3.1 Existing Environment

3.3.1.1 Terrestrial Vegetation Communities

Previous vegetation mapping under the State Vegetation Type Map (DPE 2022) did not identify any native plant community types (PCTs) within the study area (Figure 3-14**)**. However, the Trees Near Me app (DPE 2021) identifies the following PCTs within the study area pre-clearing:

- PCT 3259 *Sydney Coastal Shale-Sandstone Forest*
- PCT 3038 *Sydney Coastal Coachwood Gallery Rainforest.*

The following PCTs were mapped in areas surrounding the study area (Figure 3-19):

- PCT 3259 *Sydney Coastal Shale-Sandstone Forest*
- PCT 3136 *Blue Gum High Forest*
- PCT 3262 *Sydney Turpentine Ironbark Forest*
- PCT 3592 *Sydney Coastal Enriched Sandstone Forest*
- PCT 4024 *Cumberland Blue Box Riverflat Forest*

Field survey validated the study area as containing PCT 3592 Sydney Coastal Enriched Sandstone Forest in moderate and low conditions, and an area of exotic grasses (Figure 3-19). Vegetation identified as Exotic Grasses did not correspond with a PCT or TEC. Terrestrial vegetation types are described below in Table 3-3 and Table 3-4.

3.3.1.2 BioNet Threatened Species Search

The search for threatened species using the Protected Matters Search Tool and BioNet (Atlas of NSW Wildlife) (within a 5 km buffer around the study area) and the review of literature resulted in a list of 12 TECs, 38 threatened flora species and 67 threatened or migratory fauna species that are known to occur or have the potential to occur within the study area.

The likelihood of occurrence provided in Appendix C1 represents the assessment following the site inspection results. The BioNet database records of flora and fauna species are shown in Figure 3-15. It should be noted that sensitive species cannot be displayed.

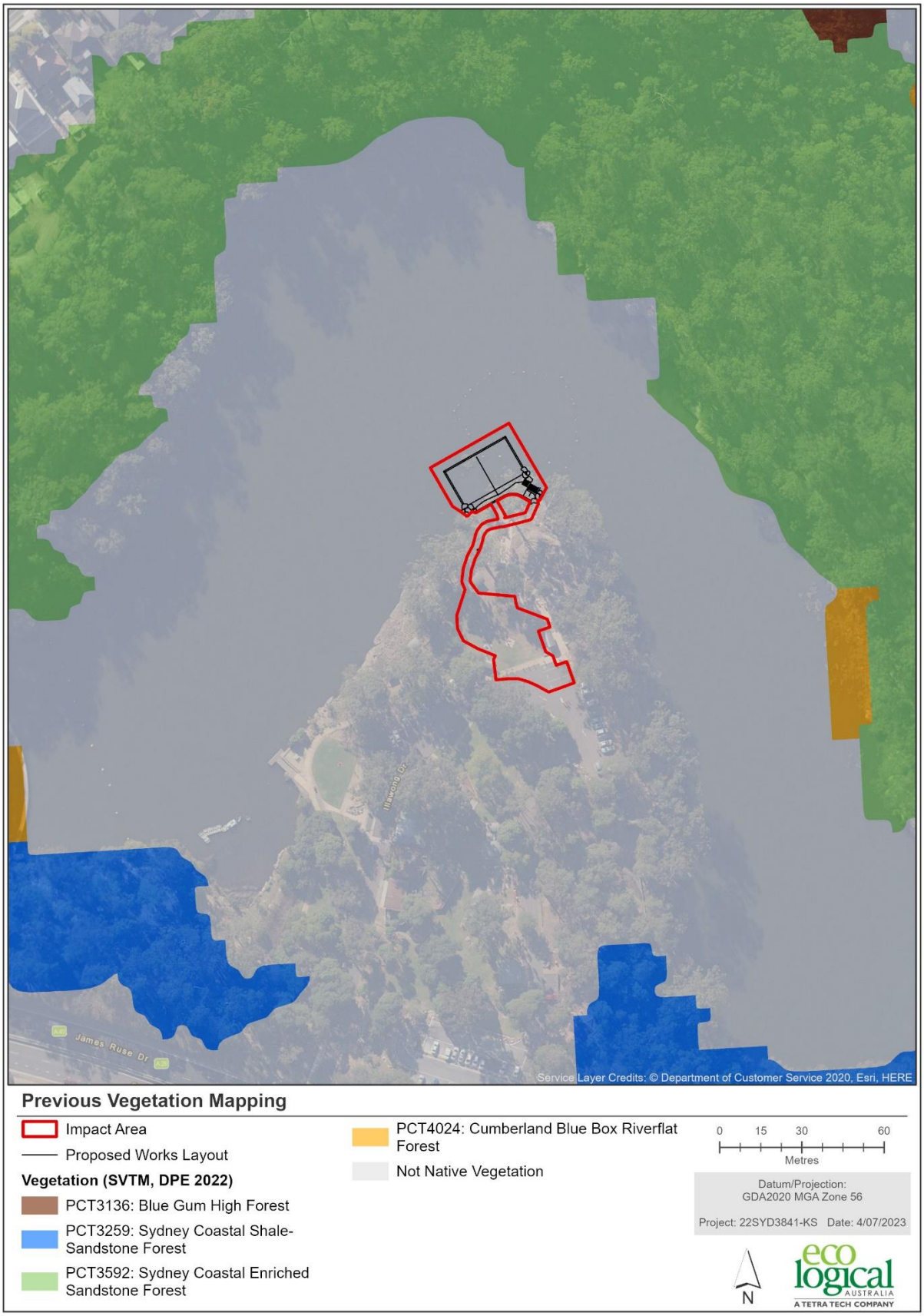

Figure 3-14: Previously mapped vegetation in the vicinity of the study area (DPE 2022)

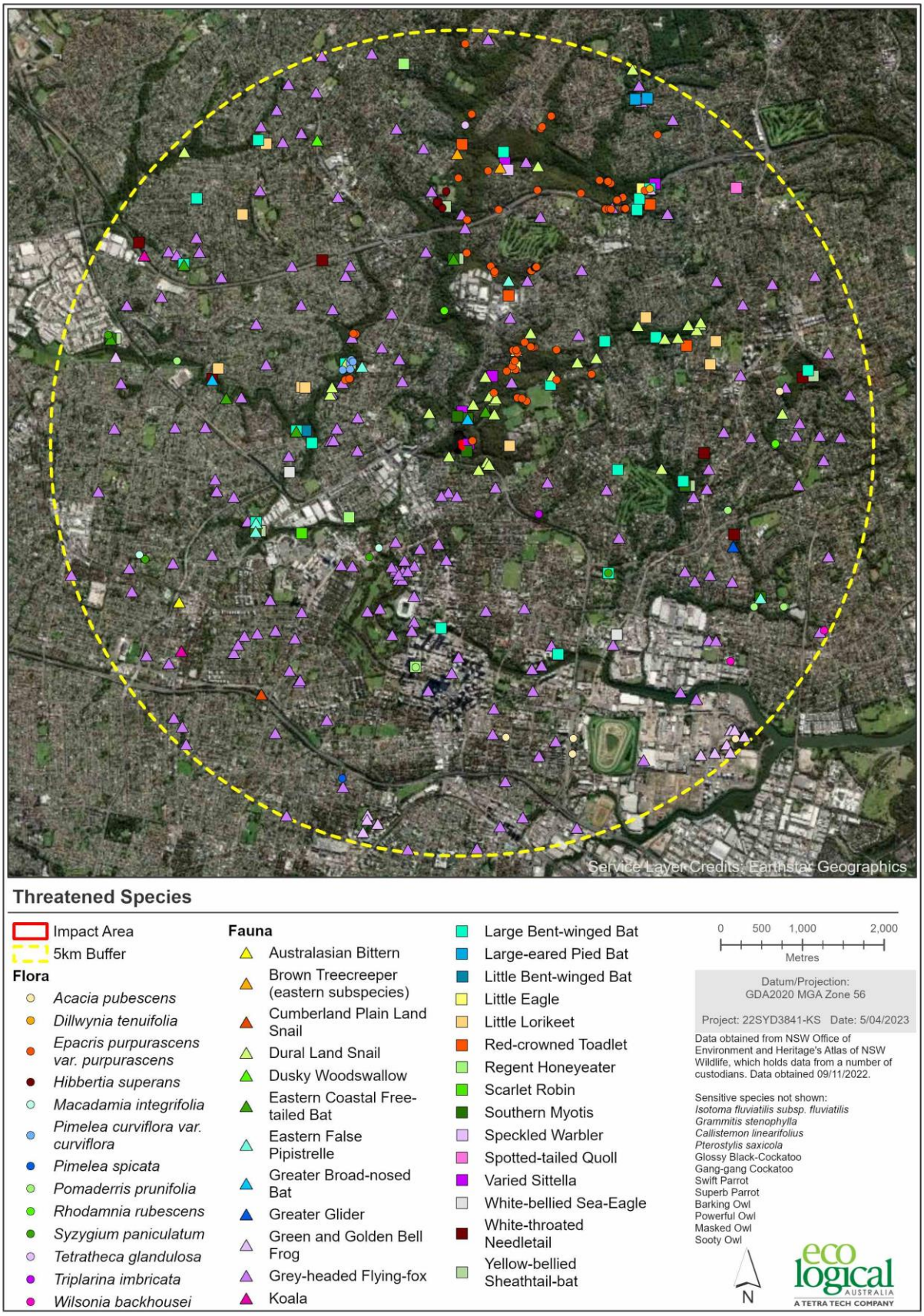

Figure 3-15: Previously recorded threatened species within the study area (DPE 2023)

Table 3-3: PCT 3592 description

PCT 3592 *Sydney Coastal Enriched Sandstone Forest*	
TEC: BC Act	Not listed
TEC: EPBC Act	Not listed
Vegetation Description	PCT 3592 occurred in moderate condition along the edges of the terrestrial land within the study area, bordering the lake, in low condition in the south west corner of the study area (Figure 3-16 and Figure 3-17). There are patches of moderate condition PCT 3593 is within the impact area. PCT 3592 in moderate condition was characterised by a canopy dominated by *Eucalyptus pilularis* (Blackbutt), *Syncarpia glomulifera* (Turpentine) and the occasional *Eucalyptus piperita* (Sydney Peppermint) and *Angophora floribunda* (Rough-barked Apple). The mid storey and ground storey appeared to be a combination of natural and revegetated occurrences. The midstorey was sparce, containing a dominance of *Pittosporum undulatum* (Sweet Pittosporum), *Glochidion ferdinandi* (Cheese Tree) and *Dodonaea triquetra* (Large-leaf Hop-bush). The ground storey was dominated by *Themeda triandra* (Kangaroo Grass), *Lomandra longifolia* (Spiny-headed Mat-rush) and *Poa labillardierei* (Tussock). PCT 3592 in low condition consists of two *S. glomulifera* with a cleared understorey, mainly consisting o*f Cynodon dactylon* (Couch), *Cenchrus clandestinus* (Kikuyu) and *Poa annua* (Winter Grass).
Area within surveyed study area (ha)	0.28

Figure 3-16: PCT 3592 in moderate condition within the study area

Figure 3-17: PCT 3592 in low condition within the study area

Table 3-4: Exotic Grasses

Exotic Grasses	
TEC: BC Act	N/A
TEC: EPBC Act	N/A
Vegetation Description	The southern portion of the study area is a cleared and regularly mown recreational area. This area is dominated by exotic species *Cynodon dactylon* (Couch), *Cenchrus clandestinus* (Kikuyu) and *Bromus catharticus* (Prairie Grass).
Area within surveyed study area (ha)	0.09

Figure 3-18: Exotic grasses within the study area

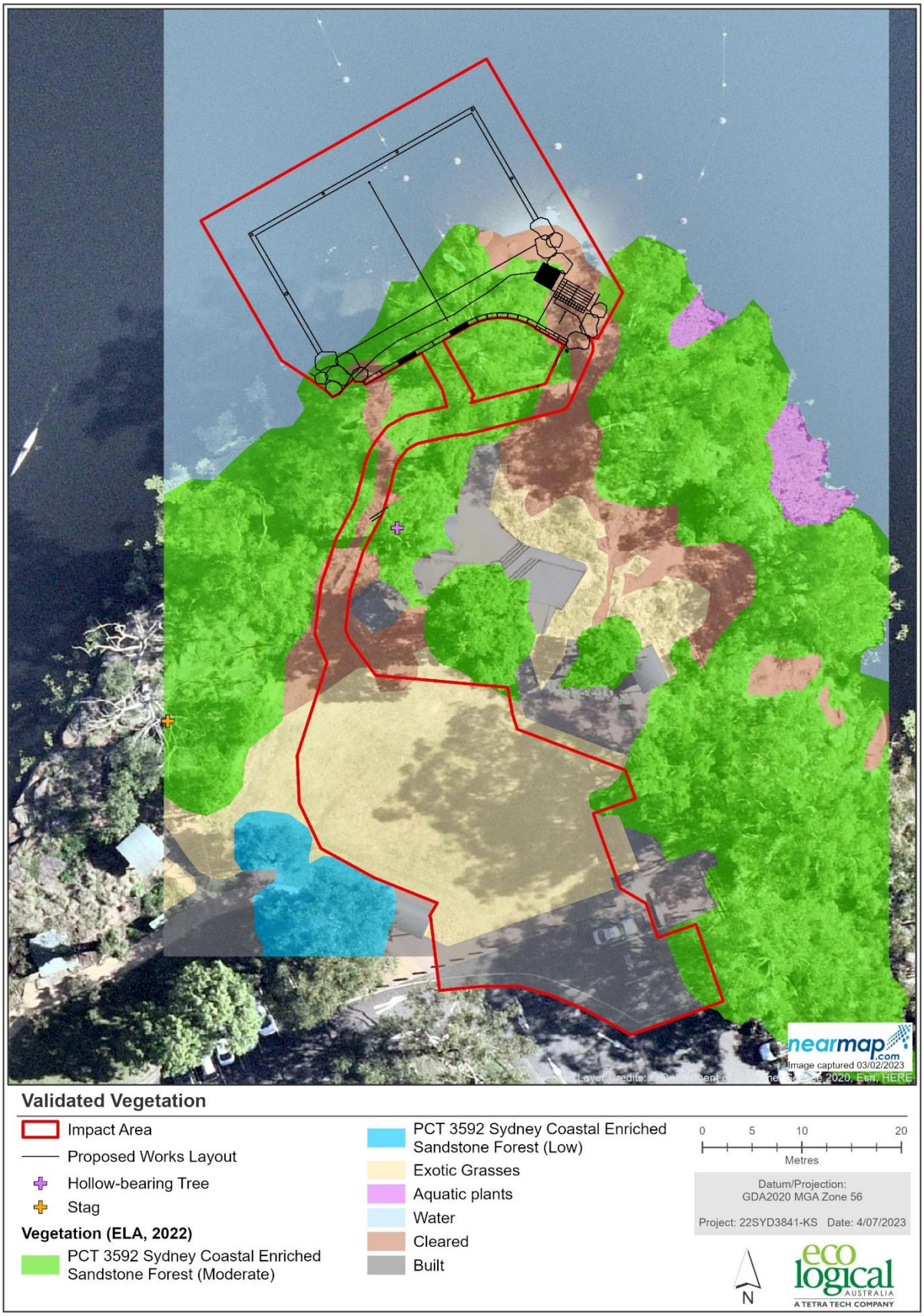

Figure 3-19: Validated vegetation communities within the study area (ELA 2022)

3.3.1.3 Priority Weeds and Weeds of National Significance (WoNS)

Of the weeds identified during the field survey, one species was listed as a state priority weed and two weeds were listed as other weeds of regional concern. The weeds present, their priority listing under the Act, their associated asset / value at risk and whether they are Weeds of National Significance (WoNS), are presented in Table 3-5.

Table 3-5: State level determined priority weeds and other weeds of concern present

Scientific name	Common name	WoNS	Priority Weed Obligation
State Level Priority Weeds			
Senecio madagascariensis	Fireweed	Yes	Asset protection
Other Weeds of Regional Concern			
Cinnamomum camphora	Camphor Laurel	No	Other regional weeds
Erthrina crista-galli	Cockspur Coral Tree	No	Other regional weeds

3.3.1.4 Threatened Flora

The field survey utilised the random meander technique (Cropper 1993). No threatened flora species were observed within the study area during survey. Flora identified with potential to occur based on BioNet records within 5 km are:

- *Pimelea curviflora* var. *curviflora* – Vulnerable under BC Act/EPBC Act
- *Rhodamnia rubescens* (Scrub Turpentine) – Critically Endangered under BC Act/EPBC Act
- *Syzygium paniculatum* (Magenta Lilly Pilly) – Endangered under the BC Act/Vulnerable under EPBC Act

3.3.1.5 Threatened Fauna

The field survey utilised the random meander technique (Cropper, 1993) and opportunistic fauna sighting. No threatened fauna species were observed within the study area during survey. A likelihood of occurrence table has been prepared for threatened species likely to occur within a 5 km radius of the study area and has been collected in Appendix C1.

Vegetation within the study area may provide suitable foraging and roosting habitat for highly mobile threatened fauna species.

A list of habitat features recorded in the study area is available in Table 3-6 below.

Table 3-6: Habitat features recorded in the study area

Habitat feature	Associated species	Presence
Large expanse of native vegetation	Birds, microchiropteran bats (microbats), megachiropteran bats (fruit bats), arboreal mammals, reptiles	Yes, connected to a large expanse of native vegetation surrounding Lake Parramatta and Hunt Creek.
Nectar producing species	Arboreal mammals/birds and fruit bats	Present in the study area as Eucalyptus species
Hollow-bearing trees (HBT)	Microbats, birds, mammals, amphibians, reptile	No HBT within the impact area, one hollow bearing tree (HBT) and one stag that contained hollows ranging from 10-20 cm were found within the surveyed study area

Habitat feature	Associated species	Presence
Coarse woody debris (fallen logs)	Terrestrial mammals, reptiles, invertebrates	Absent
Leaf litter	Reptiles, amphibians, invertebrates	Small amount of woody debris and leaf litter
Water body	Amphibians, reptiles, microbats	Part of the study area is a portion of Lake Parramatta, which includes some fringing native vegetation. An assessment of aquatic flora and fauna is addressed in Section 3.2. The waterbody may also provide habitat for terrestrial species such as microbats (e.g. Southern Mytotis).
Rocky outcrops	Microbats, reptiles	Absent
Mistletoe	Arboreal mammals/birds and fruit bats	Absent
Winter and spring flowering species	Winter migratory birds, arboreal mammals and megachiropteran bats (fruit bats)	Present (*Syncarpia glomulifera* (Turpentine) and *Eucalyptus pilularis* (Blackbutt))

One HBT and one stag that contained hollows ranging from 10-20 cm were found within the study area but are outside of the proposed impact area (Figure 3-20). As such, it was determined that potential breeding habitat for *Glossopsitta pusilla* (Little Lorikeet) and *Calyptorhynchus lathami* (Glossy Black-Cockatoo) exists within the study area, as well as foraging and roosting habitat. The moderate PCT 3592 vegetation adjoins Lake Parramatta. Lake Parramatta may provide foraging habitat for the Southern Myotis, and the hollows may provide roosting habitat for this species. There was a small amount of woody debris and leaf litter, which could provide habitat for *Pommerhelix duralensis* (Dural Land Snail). No other habitat features, such as buildings, caves, or culverts, were identified in the study area during survey.

The study area potentially contains foraging habitat within PCT 3592 for the following threatened species:

- Birds
  - *Calyptorhynchus lathami* (Glossy Black-Cockatoo) – Vulnerable under BC Act
  - *Daphoenositta chrysoptera* (Varied Sittella) – Vulnerable under BC Act
  - *Glossopsitta pusilla* (Little Lorikeet) – Vulnerable under BC Act
  - *Hirundapus caudacutus* (White-throated Needletail) – Vulnerable/Migratory under EPBC Act
  - *Lathamus discolor* (Swift Parrot) – Endangered under BC Act/Critically endangered under EPBC Act
  - *Ninox connivens* (Barking Owl) – Vulnerable under BC Act
  - *Ninox strenua* (Powerful Owl) – Vulnerable under BC Act
- Microbats
  - *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) – Vulnerable under BC Act
  - *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat) – Vulnerable under BC Act
  - *Miniopterus orianae oceanensis* (Large Bent-winged Bat) – Vulnerable under BC Act
  - *Myotis Macropus* (Southern Myotis) (forages over water, not within the forest) - Vulnerable under BC Act
  - *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat) – Vulnerable under BC Act

    - *Scoteanax rueppellii* (Greater Broad-nosed Bat) – Vulnerable under BC Act
- Megabats
    - *Pteropus poliocephalus* (Grey-headed Flying-fox) – Vulnerable under BC Act/EPBC Act
- Snails
    - *Pommerhelix duralensis* (Dural Land Snail) – Endangered under BC Act/EPBC Act

Tests of Significance and Assessments of Significance under the BC Act and EPBC Act are described in further detail in Section 3.3.2.3.

Figure 3-20: Habitat features within the study area

3.3.2 Impact Assessment

3.3.2.1 Direct Impacts

3.3.2.1.1 Clearing of Vegetation

The proposed works would remove a total of 0.03 ha of vegetation identified as PCT 3592 *Sydney Coastal Enriched Sandstone Forest* in moderate condition, and 0.06 Exotic Grasses from within the study area (Table 3-7). A Preliminary Tree Assessment (PTA) (ELA 2023b, Appendix D) was undertaken which did not determine the quantity or identities of trees to be removed, but rather identified potential impacts that may result from construction works (such as compaction, excavation) and recommended mitigation measures. The PTA provides a suite of recommendations to guide the retention of trees with the supervision of a AQF Level 5 arborist on site at all times. For the purposes of this biodiversity assessment, it is assumed as a 'worst-case' scenario that some trees are at risk of being impacted or removed because of the works.

While appropriate mitigation measures including arborist supervision must be implemented to maximise potential for tree retention, as described in Section 3.4, Section 5 and the PTA (Appendix D), this assessment considers the removal of all vegetation within the impact area. As the hollow-bearing tree and stag are located outside of the impact area, it is assumed that these features will not be impacted by the proposed works.

For the purposes of construction access, some trimming to overhanging branches and disturbance or removal of understorey vegetation where required is proposed.

There are no TECs listed a under the BC Act or EPBC Act that will be directly affected by the proposed works. Tests of Significance and Assessments of Significance under the BC Act and EPBC Act are described in further detail in Section 3.3.2.3.

Table 3-7: Assessment of the vegetation impacted within the study area

Vegetation community	TEC listing	Direct Impacts (ha)
PCT 3592: *Sydney Coastal Enriched Sandstone Forest*	Not listed	0.03
Exotic	N/A	0.06
	TOTAL	**0.09**

3.3.2.1.2 Threatened Flora

A list of threatened flora identified as having the potential to occur within the study area was compiled based on a review of the existing literature and habitat assessments conducted as part of the field survey (Appendix C1). The following threatened flora species were considered as having potential to occur within the impact area:

- *Pimelea curviflora* var. *curviflora* – Vulnerable under BC Act/EPBC Act
- *Rhodamnia rubescens* (Scrub Turpentine) – Critically Endangered under BC Act/EPBC Act
- *Syzygium paniculatum* (Magenta Lilly Pilly) – Endangered under the BC Act/Vulnerable under EPBC Act

No targeted surveys for threatened flora species were undertaken within the study area. No threatened flora species were identified within the study area during the field survey utilising the random meander method. As *Rhodamnia rubescens* (Scrub Turpentine) and *Syzygium paniculatum* (Magenta Lilly Pilly)

are large species and were not identified during the field survey, it is unlikely that they occur within the study area. Due to the degraded condition of the study area, it is unlikely that *Pimelea curviflora* var. *curviflora* occurs within the study area. As such, Tests of Significance and Assessments of Significance under the BC Act and EPBC Act were not undertaken for these species.

3.3.2.1.3 Threatened Fauna

A list of threatened fauna known to occur within the study area or identified as likely or having the potential to occur within the study area was compiled based on a review of the existing literature and habitat assessments conducted as part of the field survey (Appendix C1). The following threatened fauna species were considered as having potential to occur within the impact area:

- Birds
  - *Calyptorhynchus lathami* (Glossy Black-Cockatoo) – Vulnerable under BC Act
  - *Daphoenositta chrysoptera* (Varied Sittella) – Vulnerable under BC Act
  - *Glossopsitta pusilla* (Little Lorikeet) – Vulnerable under BC Act
  - *Hirundapus caudacutus* (White-throated Needletail) – Vulnerable/Migratory under EPBC Act
  - *Lathamus discolor* (Swift Parrot) – Endangered under BC Act/Critically endangered under EPBC Act
  - *Ninox connivens* (Barking Owl) – Vulnerable under BC Act
  - *Ninox strenua* (Powerful Owl) – Vulnerable under BC Act
- Microbats
  - *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) – Vulnerable under BC Act
  - *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat) – Vulnerable under BC Act
  - *Miniopterus orianae oceanensis* (Large Bent-winged Bat) – Vulnerable under BC Act
  - *Myotis Macropus* (Southern Myotis) – Vulnerable under BC Act
  - *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat) – Vulnerable under BC Act
  - *Scoteanax rueppellii* (Greater Broad-nosed Bat) – Vulnerable under BC Act
- Megabats
  - *Pteropus poliocephalus* (Grey-headed Flying-fox) – Vulnerable under BC Act/EPBC Act
- Snails
  - *Pommerhelix duralensis* (Dural Land Snail) – Endangered under BC Act/EPBC Act

Tests of Significance and Assessments of Significance under the BC Act and EPBC Act are described in further detail in Section 3.3.2.3, and contained in Appendix C2 and Appendix C3.

3.3.2.2 Indirect Impacts

Indirect impacts are those impacts that do not directly affect habitat and individuals but that have the potential to interfere through indirect action.

3.3.2.2.1 Noise, Dust and Vibration

Indirect impacts considered for this assessment are site impacts (noise, light, weed invasion and pathogens) and downwind impacts (sedimentation, dust, accidental spills, and leaks). During the

construction, noise, dust and to a small degree vibration will be emitted which could have an indirect impact on local fauna. These impacts result from the operation of heavy machinery. These impacts are short term only and therefore are unlikely to significantly impact fauna. Also, during the construction period there is a risk that sediment runoff may impact adjacent native vegetation, Lake Parramatta, and nearby tributaries if appropriate sediment and erosion measures are not in place. These impacts will be managed via a sediment and erosion control plan.

3.3.2.2.2 Weeds

Possible increase in weed infestation can result if weed propagules are introduced or moved around by machinery during construction. Weed control measures are recommended to minimise this risk.

3.3.2.2.3 Pathogens

Pathogens are agents such as bacterium, virus or fungus that cause disease in flora and fauna, which are spread on footwear, vehicles, or machinery. The three most common pathogens found in NSW include:

- **Phytophthora (*Phytophthora cinnamomi*):** A soil-borne fungus that attacks the roots of native plant species, causing them to rot and eventually die
- **Chytrid fungus (*Batrachochytrium dendrobatdis*):** A waterborne fungus that affects native frog species
- **Myrtle rust (*Uredo rangelli*):** An introduced fungus that attacks young leaves, shoot tips and stems of Myrtaceous plants (such as Bottle Brush, Tea Tree, Lilly Pilly and Turpentine), eventually killing the plant.

Indirect impacts to threatened species, TECs and native vegetation are unlikely to be substantial subject to the implementation of mitigation measures presented in Section 5.

3.3.2.3 Assessment under the BC Act and EPBC Act

No TECs listed under the BC Act or EPBC Act will be directly affected by the proposed works. A summary of the assessment for fauna and flora species is presented in Table 3-8. Tests of Significance in accordance with the BC Act and Assessments of Significance in accordance with the EPBC Act were applied to threatened fauna species considered as having potential to occur. The assessments are contained in Appendix C2 and Appendix C3.

Table 3-8: Summary of threatened fauna assessment

Fauna	Threatened Fauna Species
Birds	Potential foraging habitat for threatened birds was identified within the study area for the following threatened birds, in the form of flowering Eucalypt species: • *Calyptorhynchus lathami* (Glossy Black-Cockatoo) – Vulnerable under BC Act • *Glossopsitta pusilla* (Little Lorikeet) – Vulnerable under BC Act • *Lathamus discolor* (Swift Parrot) – Endangered under BC Act/Critically endangered under EPBC Act PCT 3592 also represents minor hunting habitat for the following species: • *Hirundapus caudacutus* (White-throated Needletail) – Vulnerable/Migratory under EPBC Act • *Daphoenositta chrysoptera* (Varied Sittella) – Vulnerable under BC Act • *Ninox connivens* (Barking Owl) – Vulnerable under BC Act • *Ninox strenua* (Powerful Owl) – Vulnerable under BC Act

Fauna	Threatened Fauna Species
	One HBT and one stag that contained hollows ranging from 10-20 cm were found within the study area. As such, it was determined that potential roosting and/or breeding habitat for Little Lorikeet and Glossy Black-Cockatoo exists within the study area, but not within the impact area. The Tests of Significance/Assessments of Significance found that proposed vegetation removal is not considered to impact the foraging activities of these species as they are highly mobile and there is a large area of native vegetation containing flowering eucalypts adjacent to the study area surrounding Lake Parramatta and Hunts Creek.
Microbats	The following microbats have records within 5 km of the study area: • *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) – Vulnerable under BC Act • *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat) – Vulnerable under BC Act • *Miniopterus orianae oceanensis* (Large Bent-winged Bat) – Vulnerable under BC Act • *Myotis Macropus* (Southern Myotis) – Vulnerable under BC Act • *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat) – Vulnerable under BC Act • *Scoteanax rueppellii* (Greater Broad-nosed Bat) – Vulnerable under BC Act The study area contains suitable hunting habitat for all species, being Lake Parramatta for the Southern Myotis and forest vegetation for the remaining species. There was no roosting habitat for microbats in the study area (hollows were 10-20 cm and not in the direct impact area). The Tests of Significance found that proposed vegetation removal is not considered to impact the hunting activities of these species as they are highly mobile and there is a large area of native vegetation containing flowering eucalypts adjacent to the study area surrounding Lake Parramatta and Hunts Creek.
Megabats	Flowering Eucalypts are considered to provide foraging habitat for megabat, *Pteropus poliocephalus* (Grey-headed flying fox) and there are records within 5 km of the study area. No camps are located within the study area. The Grey-headed Flying-fox is vulnerable under BC Act/EPBC Act The Test of Significance found the proposed vegetation removal is not considered to impact the foraging activities of this species as there is a large area of native vegetation containing flowering eucalypts adjacent to the study area surrounding Lake Parramatta and Hunts Creek.
Amphibians	Threatened amphibians are not likely to occur within the study area.
Snails	PCT 3592 is potential habitat for the *Pommerhelix duralensis* (Dural Land Snail), which is endangered under BC Act/EPBC Act. The Test of Significance and Assessment of Significance found the proposed vegetation removal is not considered to impact this species due to the small amount of vegetation to be removed and disturbed condition of the vegetation.

3.3.2.4 Key Threatening Processes

The Key Threatened Process (KTP), clearing of native vegetation, is associated with the proposed works. However, impacts resulting from this process would be minimal given that native vegetation removal is only 0.03 ha.

Invasion of native plant communities by exotic perennial grasses is another KTP also associated with the proposed works. Impacts resulting from this process are considered minimal given that the study area already contains exotic grasses. Weed control measures are recommended in Table 3-9 to minimise this KTP.

3.3.3 Mitigation Measures

Table 3-9: Mitigation measures for biodiversity

Potential Impact	Mitigation Measures
Accidental damage / clearing	• Delineate no-go zones using high visibility bunting, fencing or similar. • Maintain temporary fencing to prevent access into the native vegetation. • Council staff are to undertake a pre-works briefing advising of sensitive areas and relevant safeguards for these areas. This includes vegetation to be retained, and stag/hollow-bearing tree outside the impact area which are to be retained. • Stop works if any previously undiscovered threatened species are discovered during works. An assessment of the impact and any required approvals must be obtained. Works must not recommence until Council has provided written approval to do so. • Ensure the site-specific CEMP includes instructions for dealing with orphaned or injured native animals and ensure the CEMP includes the contact details for the NSW Wildlife Information, Rescue and Education Service Inc (WIRES). • Install temporary barrier fencing to prevent entry into adjacent vegetation and appropriate 'no-go zone' signage. This must include areas of Council and any areas of Community bush regeneration activities. • Install tree protection measures around trees to be retained (i.e. all trees) in the study area. Structures should be adequate to prevent machinery from entering within the drip zone.
Indirect lighting to adjacent vegetation and waterbody	• Manage artificial lights using motion sensors and timers. • Aim light onto the exact surface area requiring illumination. Use shielding on lights to prevent light spill into the atmosphere and outside the footprint of the target area. • Avoid lights containing short wavelength, violet / blue light, and white LEDs. • Avoid high intensity light of any colour.
Spread of priority weeds	• Wash down equipment and vehicles prior to and after use, to manage the introduction and spread of weed propagules. • Thoroughly clean all equipment of soil and weed propagules prior to entry into the study area. • Remove Priority weeds using best management practices (including appropriate controls to prevent impacts to threatened species) prior to removal of native vegetation. Remove weed propagules offsite. • Bag and remove all weed propagules offsite, preferably the same day and dispose of at designated green waste facility.

Introduction/ spread of pathogens	• Adhere to the *Saving our Species Hygiene* guidelines (DPIE 2020b) at all times. In particular:
	  ○ Wash down equipment and vehicles prior to entering the site, to manage the introduction and spread of pathogens. Pay particular attention to cleaning mud flaps and tyres.
	  ○ Thoroughly clean all equipment of soil and vegetation debris prior to entry into the study area.
	  ○ Use a solution of 70% ethanol or methylated spirits in 30% water for wash down and equipment cleaning to effectively disinfect areas.
	  ○ Wash down on a hard, well-drained surface, for example a road, and on ramps if possible. Do not allow wash-down water to drain into native bushland.
	  ○ Machinery and equipment must also be cleaned when leaving site.

Potential Impact	Mitigation Measures
	• Wash down protocols are required to control multiple impacts including, pathogens, weeds, and contaminated soils. The CEMP should develop a single wash down process that addresses the requirements of all three potential environmental impacts.

3.4 Arboriculture

ELA prepared a Preliminary Tree Assessment (PTA) to assess trees present within the study area, and provide detailed background on potential impacts and mitigation measures in relation to the proposed works. Impacts to trees were not assessed as part of the PTA due to the uncertain nature of construction methods. The PTA has been completed as a standalone report, contained in Appendix D and summarised in this section.

3.4.1 Existing Environment

3.4.1.1 Terminology used in this section

A tree is defined under the Australian Standard, AS 4970-2009 'Protection of Trees on Development Sites' as a long lived woody perennial plant greater than (or usually greater than) 3 m in height with one or relatively few main stems or trunks.

For the purpose of this report this PTA has assessed trees in line with the local Councils definition of a tree. The Parramatta DCP defines a tree as:

- *Any tree or palm – whether indigenous, endemic, exotic or introduced species with a height equal to or exceeding 5 metres*
- *Any tree or mangrove vegetation located on public lang, irrespective of size*
- *Any tree or plant, irrespective of size:*
    - *that is listed in a Register of Significant Trees; or*
    - *that is or forms part of a heritage item, or that is within a heritage conservation area; or*
    - *that is or forms part of an Aboriginal object, or that is within an Aboriginal place of heritage significance.*

The PTA provides 'protection zones' for each tree assessed as defined in Figure 3-21 and presented in Figure 3-22.

The 'tree protection zone' (TPZ) refers to a specific radius area above and below ground and at a distance from the trunk set aside for the protection of a tree's roots and crown to provide for the viability and stability of a tree to be retained where it is potentially subject to damage by the Project. The TPZ (as defined by AS 4970-2009) requires restriction of access during the proposed works. Groups of trees with overlapping TPZs may be included within a single protection area. Tree sensitive measures must be implemented if works are to proceed within the TPZ.

The 'structural root zone' (SRZ) is the area of the root system (as defined by AS 4970-2009) used for stability, mechanical support, and anchorage of the tree. It is critical for the support and stability of trees. Severance of roots within the SRZ is not recommended as it may lead to the destabilisation and/or decline of the tree. The SRZ does not apply for palms and monocots (as outlined in AS 4970-2009).

3.4.1.2 Visual Tree Assessment

A total of 35 trees (including 2 groups of 3 trees) were inspected by AQF Level 5 Consulting Arborist, David Bidwell in November 2022 for the purposes of the PTA (ELA 2023b). Trees were assigned retention values, which takes into consideration the safe useful life expectancy (SULE) and landscape significance. These ratings are:

- **High – priority for retention:** These trees are considered important and should be retained and protected. Design modification or re-location of building/s should be considered to accommodate the setbacks as prescribed by Australian Standard AS 4970–2009 Protection of trees on development sites.
- **Medium - consider for retention:** These trees are moderately important for retention. Their removal should only be considered if adversely affected by the proposed works and all other alternatives have been considered and exhausted.
- **Low - consider for removal:** These trees are not considered important for retention, nor require special works or design modification to be implemented for their retention.
- **Priority for removal:** These trees are considered hazardous, or in irreversible decline, or weeds and should be removed irrespective of development.

A total of 13 priority retention trees were identified within the study area (Table 3-10). A further 20 medium retention trees (to be considered for retention), and 2 low retention value trees were identified. No trees that are considered a priority for removal were identified.

Table 3-10: Summary of tree retention values

Tree Retention Values	Total trees assessed
Priority for retention (high)	13
Consider for retention (medium)	20
Consider for removal (low)	2
Total	**35**

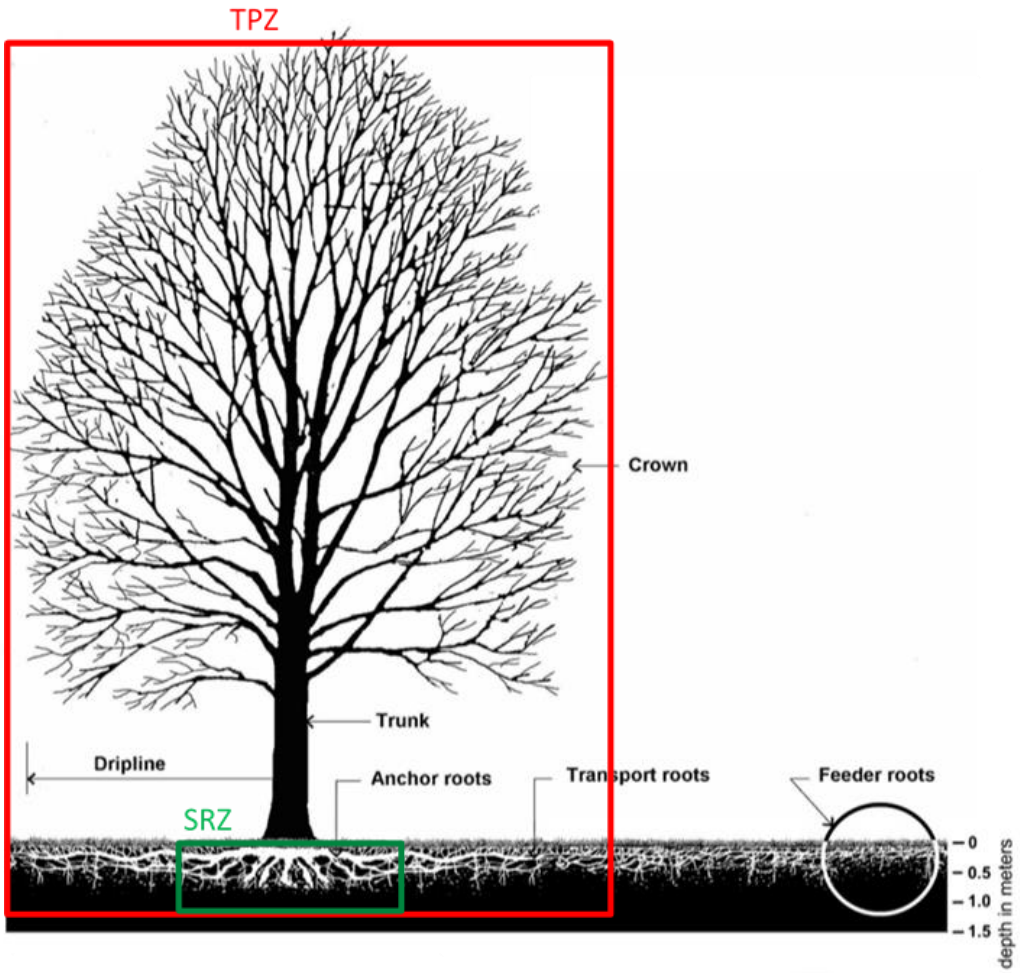

Figure 3-21: Representative tree structure and indicative TPZ and SRZ

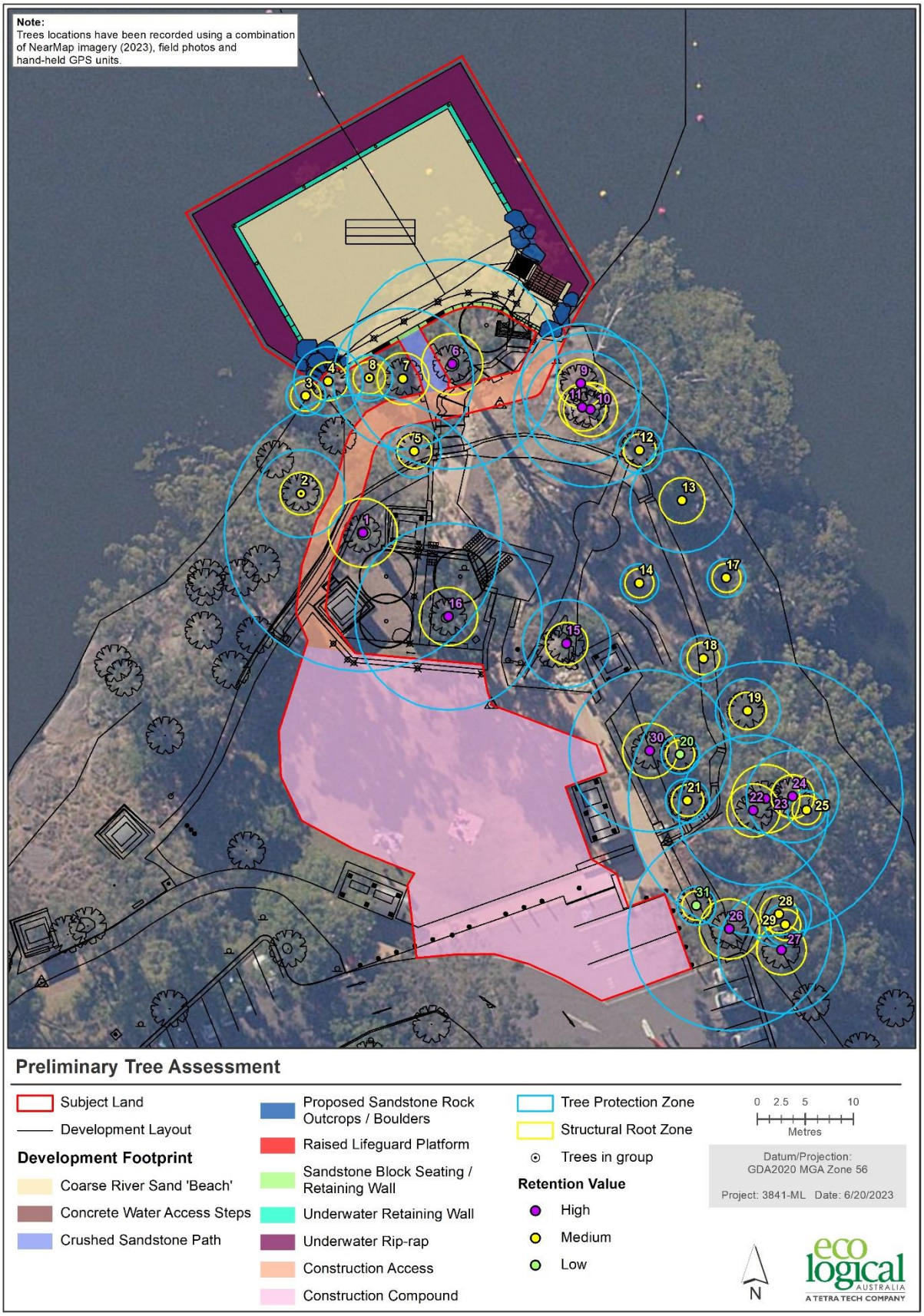

Figure 3-22: Preliminary Tree Assessment (PTA) results

3.4.2 Impact Assessment

3.4.2.1 Potential Impacts

Tree impacts were not assessed as part of the PTA considering the unknown nature of construction methods due to site constraints. All works must be supervised by an AQF Level 5 Consulting Arborist to maximise retention and protection of trees. However, the PTA provides consideration of potential impacts and recommendations to avoid impacts.

Impacts to trees can occur by physical or chemical damage, to either roots or above tree parts (e.g., branches). Potential impacts to trees within a construction site are detailed within the PTA (Appendix D) and include the following:

- Site grading
- Soil compaction
- Root severance
- Excavation
- Stockpiling within the TPZ
- Changes in site hydrology
- Changes in soil level
- Site contamination

Recommendations to minimise impacts as provided in the PTA (Appendix D) to trees are provided in Table 3-11 below and Section 5.

3.4.3 Mitigation Measures

Table 3-11: Mitigation measures for potential tree impacts

Potential Impact	Mitigation Measures
Accidental damage to trees that are to be retained	• Prominently sign posted with 300 mm x 450 mm boards stating, "NO ACCESS - TREE PROTECTION ZONE". • Protective cyclone chain wire link fence to be erected around the TPZ to protect and isolate retained trees from the construction works. Existing boundary fencing may be used. • Where required, crown protection may include the installation of a physical barrier, pruning selected branches to establish clearance, or the tying/bracing of branches. • When fencing is not practical or prior to any activities within the TPZ, trunk protection is required and consist of a layer geotextile fabric or similar followed by 1.8 m lengths of softwood timbers spaced evenly around the trunk and secured with a galvanised hoop strap. • Install and maintain 100 mm thick layer of mulch around tree in TPZ. For machine or vehicle access within TPZ geotextile fabric beneath crushed rock or rumble boards may be required. • Soil moisture levels should be regularly monitored by the Project Arborist. Temporary irrigation or watering may be required within TPZ. • If incursions/excavation within the TPZ are unavoidable, root investigation may be needed to determine the extent and location of roots within the area of construction activity using non-destructive excavation (NDE) methods. • All underground services should be routed outside of the TPZ. If underground services need to be installed within the TPZ, they should be installed using horizontal directional drilling (HDD), non-destructive excavation (NDE) methods such as hydro-vacuum, Air Spade or manually excavated trenches.
Pre-construction briefing	• Prior to any construction, an onsite meeting should be conducted with attendee's subject but not limited to the Project Arborist (AQF Level 5 Consulting Arborist), site manager and construction personnel team to walkthrough the tree protection measures requirements. Any trees, if approved for removal (see below), are to be indicated clearly with spray paint on trunks. • Prior to removing any trees in relation to the proposed works, permission is to be granted by the relevant consent authority.
During construction	• Regular inspection of trees by the Project Arborist (or other timing as agreed with the Project Arborist) is recommended to be completed on trees to be retained. The Project Arborist is to supervise all works to be completed within the TPZ of trees to be retained and protected, and provide advice regarding tree protection and monitor compliance.
Post-construction	• A final inspection of trees should be undertaken by Project Arborist after all major construction has ceased and following the removal of tree protection measures.
PTA Recommendations	**Design considerations** • It is recommended to either undertake root mapping prior to final design works or alternatively use root mapping to guide installation works for the retaining wall and other project elements within a TPZ. **Minimise impacts from root severance:** • Avoid pruning roots that are larger than 5 cm in diameter. • Where there is a choice between an impact on an older tree (DBH > 50 cm) and a younger tree (DBH < 50 cm) within in a TPZ. A younger tree is more likely to be resilient to impacts. • Whenever possible avoid excavation works. If materials can be supported on top of existing soil grade within TPZs, impacts on tree roots will be reduced.

Potential Impact	Mitigation Measures
	• Impacts to trees within their TPZ but outside their SRZ may have a negative impact on their vitality, but those impacts are unlikely to increase risk in the short term. **Minimise soil compaction:** • Avoid traversing the site with vehicles when soils are moist (during and after rainfall). • Use of relatively light weight excavators, namely skid shift excavators no greater than five (5) tonnes that use rubber tracks will minimise soil compaction. These types of excavators are used in forestry work. Ensure that use of the skid shift excavator is supervised by an arborist (AQF Level 5) and ensure the twisting and sliding is minimised. Turning is to be undertaken using large turning circles where possible to minimise soil disturbance. • Use of the existing access track with a lightweight vehicle will reduce impacts extending beyond areas that have previously experienced soil compaction. • Use of rumble boards and similar materials as described in the Australian Standard 4970 will assist in mitigating the impacts from soil compaction. • Use cranes to transfer materials down to the swimming area wherever feasible. **Assist trees in recovering once works are complete:** • Addition of mulch significantly improves soil moisture retention and consequently assists in tree recovery. • Maintaining good health potentially though additional watering or irrigation during warmer months when required will assist in tree recovery.

3.5 Aboriginal Heritage

3.5.1 Existing Environment

The following section regarding Aboriginal heritage has been conducted in accordance with *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (hereafter referred to as 'CoP') (DECCW 2010).

This due diligence process aims to determine whether Aboriginal objects will be harmed by the proposed works, as required under Part 6 of the NPW Act. The CoP sets out the reasonable and practicable steps which individuals and organisations need to take 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); and,
- Determine whether an Aboriginal Heritage Impact Permit (AHIP) from the Heritage NSW or further assessment is required.

The methodology of this Aboriginal heritage due diligence assessment is to:

- Undertake a search of the AHIMS register maintained by Heritage NSW to establish if there are any previously recorded Aboriginal objects or places within the study area;
- Undertake a search of the NSW State Heritage Inventory, the Australian Heritage Database, and the Parramatta LEP 2011 Schedule 5 (Environmental Heritage) in order to determine if there are any sites of Aboriginal significance or sensitivity located within the study area.
- Undertake a desktop review of relevant previous archaeological assessments to understand the local archaeological context and assist in predicting the likely occurrence of unrecorded archaeological sites or objects.
- Undertake a site inspection to assess landscape features and survey the potential for previously unidentified archaeological items and sites.

Consultation with Aboriginal people was not undertaken as part of this assessment. The Local Aboriginal Land Council and other stakeholder groups can provide a cultural assessment for the area if required.

3.5.1.1 Heritage Database Search

Searches of the Australian Heritage Database, the Parramatta LEP 2011 and the State Heritage Inventory utilising the term 'Lake Parramatta' were conducted on the 6 December 2022 to determine if any places of archaeological significance were located within the study area.

No Aboriginal archaeological sites or heritage items were recorded on these databases as being within the study area.

The study area is located within the curtilage of 'Lake Paramatta Reserve' (item number I335 on the LEP). 'Lake Parramatta Dam' is State Heritage listed (item number 01879) and locally listed (item number I304 on the Parramatta LEP) and is located approximately 120m to the east of the study area (Figure 3-39). This is summarised in Section 3.6 and contained in the SoHI (ELA 2023c) in Appendix F.

3.5.1.2 AHIMS Search

An extensive search of the AHIMS database, which is maintained by Heritage NSW and regulated under Section 90Q of the NPW Act, was conducted on 9 November 2022 to identify if any registered Aboriginal sites were present within, or adjacent to, the study area (Appendix E). The AHIMS search represents 1 km around the study area and was conducted within the following coordinates: GDA Zone 56, Eastings 313579-317579, Northings 6257267-6261267, with a buffer of 0 m.

The search resulted in the identification of 56 Aboriginal sites within the vicinity of the study area. AHIMS ID 45-5-4630 is listed as 'not a site'.

No sites have previously been recorded as being within the study area (Figure 3-23). AHIMS ID 45-6-2805, an artefact site, is located approximately 100 m to the south of the study area and will not be impacted by the proposed works (Figure 3-23).

According to the Parramatta Development Control Plan (DCP) 2011, the study area is located within an area of 'high archaeological sensitivity' (Figure 3-24).

Figure 3-23: AHIMS sites within the vicinity of the study area

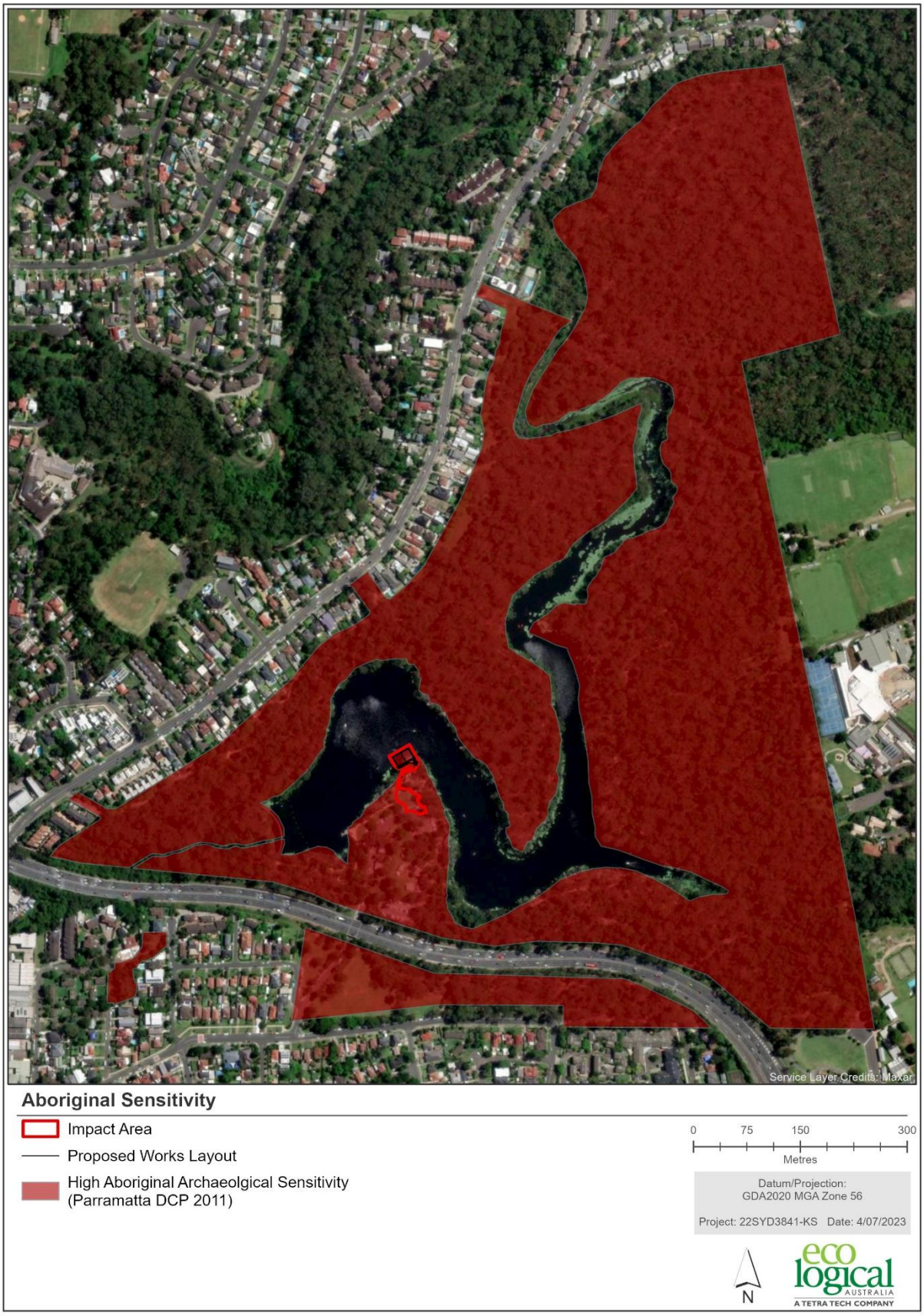

Figure 3-24: Aboriginal sensitivity mapping within the study area (Paramatta DCP 2011)

3.5.1.3 Previous Archaeological Assessments

Archaeology and Heritage Consultants, 2006. Lake Parramatta Reserve Playground – Aboriginal Archaeological Excavation Report. Prepared for Parramatta City Council.

Archaeology and Heritage Consultants (AHMS) were previously engaged by Parramatta City Council to undertake an Aboriginal archaeological excavation to support the proposed development of a playground within Lake Parramatta Reserve. The excavation was undertaken approximately 100m to the south of the current study area.

The assessment was undertaken within part of AHIMS ID 45-6-2805, an Aboriginal artefact scatter comprising of two stone artefacts, one silcrete primary flake and one red silcrete flake with no cortex, identified on the surface of a recently deposited slope wash.

A total of twelve 1 x 1 m trenches were excavated. The excavation revealed that the original topsoils had been removed from all twelve trenches in relation to the road and carpark construction within the reserve. Nine of the twelve trenches contained remnants of the original topsoil, and the other three comprised of fill overlaying bedrock. One stone artefact, a tuff primary flake, was recovered within the topsoil deposits during the excavation.

The excavation identified that the proposed study area had undergone past disturbance in the form of vegetation clearance, sheet erosion and development adjacent to the proposed playground area and within the reserve. The single stone artefact identified during the excavation represented a low-density background scatter. As a result, the study area was assessed as having a low to nil scientific and archaeological significance, and no further work was recommended.

3.5.1.4 Visual Inspection

A visual inspection of the study area was undertaken by ELA Archaeologists Kate Storan and Jessica Horton on the 11th of November 2022. The visual inspection aimed to identify Aboriginal objects if present and assess the archaeological potential of the study area.

The study area was situated on a moderate south-north orientated slope down towards the lake (Figure 3-28 – Figure 3-30). The visual inspection revealed that the majority of the study area had undergone prior ground disturbance related to the construction of and continued recreational use of Lake Parramatta Reserve as a swimming and picnic area (Figure 3-25 – Figure 3-30). The existing disturbance included the clearance of vegetation and associated landscaping, the construction of picnic structures, park benches, and concrete footpaths, as well as a concrete staircase that lead towards the road and carpark (Figure 3-26 – Figure 3-30), all of which had modified the original landform (Figure 3-29).

Surface visibility was limited due to grass cover, footpaths, and the existing structures, and in areas of exposure, mixed deposits of gravel, leaf litter and yellow-grey sand and loams were observed (Figure 3-27). No surface artefacts were identified in any exposures. Native vegetation and exposed sandstone bedrock surrounded the lake (Figure 3-25), and no cultural markings were observed on any areas of exposed bedrock.

Overall, the majority of the study area had previously been disturbed by the construction of and recreational use of the reserve, and no surface artefacts or areas of potential were identified during the visual inspection.

Figure 3-25: View north-east towards existing swimming area showing vegetation and exposed sandstone bedrock surrounding the lake

Figure 3-26: View east towards swimming area showing landscaped picnic area, moderate south-north slope and existing pathway

Figure 3-27: View north showing existing swimming area, with picnic tables and exposed sand

Figure 3-28: View south-west showing concrete steps leading towards the carpark

Figure 3-29: View west of road and parking area (modification of original landform)

Figure 3-30: View south-west towards Lake Paramatta Dam showing moderate slope towards lake and existing concrete path

3.5.2 Impact Assessment

The proposed works will not impact upon any known Aboriginal sites or objects and no Aboriginal sites are located within the study area. The study area has previously been mapped by the Parramatta DCP 2011 as being in an area of 'high archaeological sensitivity' (Figure 3-24), however, the visual inspection

identified that the majority of the study area has previously been disturbed in relation to the construction of and continued recreational use of the reserve.

The existing disturbance and low density of artefacts recovered during the excavation of AHIMS ID 45-6-2805 to the south indicates that there is a low potential for *intact* subsurface archaeological deposits to remain within the study area. As such, works can proceed with caution and no further investigation is required. A standard unexpected finds policy should be implemented as a mitigation measure (see Table 3-12 and Section 5).

3.5.3 Mitigation Measures

Table 3-12: Mitigation measures for Aboriginal heritage

Potential Impact	Mitigation Measures
Discovery of unexpected Aboriginal objects	• Brief all contractors undertaking works on site on the protection of Aboriginal heritage objects under the NPW Act, and the penalties for damage to these items. • If an item (or suspected item) of Aboriginal heritage significance is discovered, cease works in the immediate vicinity of the find and fence off the area with suitable markers (star pickets, flagging or barrier mesh). Notify the council project manager and engage an archaeologist to assess the finds. If they are found to be Aboriginal objects, Heritage NSW must be notified under Section 89A of the NPW, and appropriate management sought. Depending on the proposed works in relation to the finds, further assessment and an AHIP may be required. Works may not recommence unless council has provided written approval to do so.
Discovery of human remains	• Stop work if human remains are found and contact NSW Police. If remains are suspected to be Aboriginal, Heritage NSW must be notified as well.

3.6 Historic Heritage

A Statement of Heritage Impact Statement (SoHI) has been prepared by ELA as a standalone report Appendix F). This section provides a summary of the assessment.

The SoHI been prepared in accordance with the NSW Heritage Manual *Statements of Heritage Impact* (2002) and *Assessing Heritage Significance* (2001) guidelines. The philosophy and process adopted is that guided by the *Australia ICOMOS Burra Charter* 1999.

The subject proposal has been assessed in relation to the Parramatta LEP 2023 and the Parramatta DCP 2011.

3.6.1 Existing Environment

The study area is located within the curtilage of one local heritage item listed on Schedule 5 of the Parramatta LEP 2023, being Lake Parramatta Reserve (LEP Item No. I305). The study area is also within the vicinity (200 m) of one SHR item (Lake Parramatta Dam SHR listing No. 01879 / PLEP 2023 Item No. I304) (Figure 3-39).

Under Section 5.10 of the Parramatta LEP 2023, submission of a SoHI is required for works to heritage listed items, items, in conservation areas and in the vicinity of heritage items.

At point of European settlement, the study area fell within dense native bushland, utilised for public recreation as early as 1804. Parish maps indicate that the study area was included within land dedicated for the public water supply by 1870 and the land encompassing the study area was dedicated as public reserve in 1927 and recognised as 'Lake Parramatta Reserve' from the c1920s. Lake Parramatta Reserve was a popular swimming spot by the 1930s, however, this historic swimming area is located outside the study area.

There is no documentary evidence of substantial building development having taken place within the study area. Aerial imagery from between 1943 and present-day indicates that the study area has largely remained in its current configuration. Minor changes to tree plantings, tracks and pathways have occurred over time, as well as the addition of picnic shelters and parking.

3.6.1.1 Site description

A site visit was conducted by ELA Heritage Consultant Kate Storan and ELA Senior Heritage Consultant Jessica Horton on 11 November 2022.

The study area is located within Lake Parramatta Reserve, defined by an extensive lake system surrounded by remnant bushland interspersed with recreational facilities. The proposed construction compound area would be located within an existing carpark with adjoining grassed picnic area (Figure 3-33 and Figure 3-36), whilst the construction access track would traverse bushland to Lake Parramatta's shoreline. This bushland is interspersed with existing access tracks, and a sandstone culvert and sandstone pathway edging were encountered here during the site inspection (Figure 3-34 - Figure 3-35).

The newly accessible swimming area will be located within an existing designated swimming area along Lake Parramatta's shoreline (Figure 3-31 - Figure 3-32). This swimming area is defined by sandstone outcrops and native bushland. The setting of the place is largely regarded natural, with limited modification having occurred.

Lake Parramatta Dam lies to the west of the study area (Figure 3-38). It is a cylindrical masonry arch dam with vertical water face, considered to be in good condition with little evidence of weathering or spalling.

The Dam is constructed from solid sandstone blocks quarried from Hunts Creek, bonded together with Roman and Portland cement mortar. The dam wall is visible from the study area and is considered to contribute to the overall setting of the Reserve (Figure 3-37).

Figure 3-31: View northeast within Lake Parramatta Reserve towards study area

Figure 3-32: View north within Lake Parramatta Reserve towards study area

Figure 3-33: View of existing carpark within Lake Parramatta Reserve towards proposed compound area

Figure 3-34: View of existing sandstone culvert structure within proposed construction access track

Figure 3-35: View of existing sandstone pathway edging within proposed construction access track

Figure 3-36: View of existing grassed area within Lake Parramatta Reserve towards proposed compound area

Figure 3-37: View towards Parramatta Dam from study area

Figure 3-38: View of Parramatta Dam within Lake Parramatta Reserve (outside study area)

3.6.1.2 Archaeological assessment

Archaeology is assessed in two ways, the potential for the site to retain an archaeological resource and the significance of that resource. The significance of the resource then determines the management and approvals required. Archaeological Potential is defined as:

The degree of physical evidence present on an archaeological site is usually assessed on the basis of physical evaluation and historical research. Common units for describing archaeological potential are:

- known archaeological features/sites (high archaeological potential)
- potential archaeological features/sites (medium archaeological potential)
- no archaeological features/sites (low archaeological potential) (Heritage Office 1996).

To be considered a 'relic' under the Heritage Act, an item must have either local or State significance. A site or resource is said to be scientifically significant when its further study may be expected to help answer questions (Bickford and Sullivan, 1984 pp 23–24). For example, can the site contribute knowledge and is this knowledge relevant to general questions about associations with individuals, groups, or events of historical or social importance? While a site may have archaeological potential, the resource may not be significant if it does not have the ability to provide important information regarding a range of questions concerning way of life, taste, function, custom or process, location, setting, design, materials, and workmanship etc (Kerr 2000:8). An archaeological resource should therefore add to the knowledge of the past in an important way, rather than merely duplicating known information or information that might be more readily available from other sources such as documentary records or oral history.

An archaeological resource will form in areas where activity is concentrated. At point of European settlement, the study area fell within native bushland along the banks of Hunts Creek. Documentary evidence suggests that the study area has been utilised for public recreation purposes as early as 1804. Following the construction of the Parramatta Dam in 1856 (west of the study area), the study area was dedicated for the public water supply (1870) and later dedicated as public reserve (1927), becoming recognised as Lake Parramatta Reserve during the circa 1920s.

There is no evidence to suggest any archaeological resources associated with the Lake Parramatta Dam wall or its construction would be remnant within the study area. In addition, there is no documentary or aerial imagery evidence to suggest that substantial development occurred within the study area.

Documentary evidence attests that Lake Parramatta Reserve was, and continues to be, a popular swimming area, with minor infrastructure such as a sandstone pontoon/jetty, timber shed, timber benches, a kiosk and signage introduced. However, this historic swimming area is located outside the study area.

As such, archaeological resources associated with the study area's use for public recreation would be limited to twentieth century use including: evidence of former pathways or plantings, post holes from previous picnic facilities, and minor refuse material left by visitors. Archaeological potential within the study area is therefore considered to be low and would not reach the threshold for local significance, nor be considered 'relics.'

An unexpected finds procedure would be implemented ahead of works commencement as a mitigation for impacts to potential archaeological resources as outlined in Section 3.6.3.

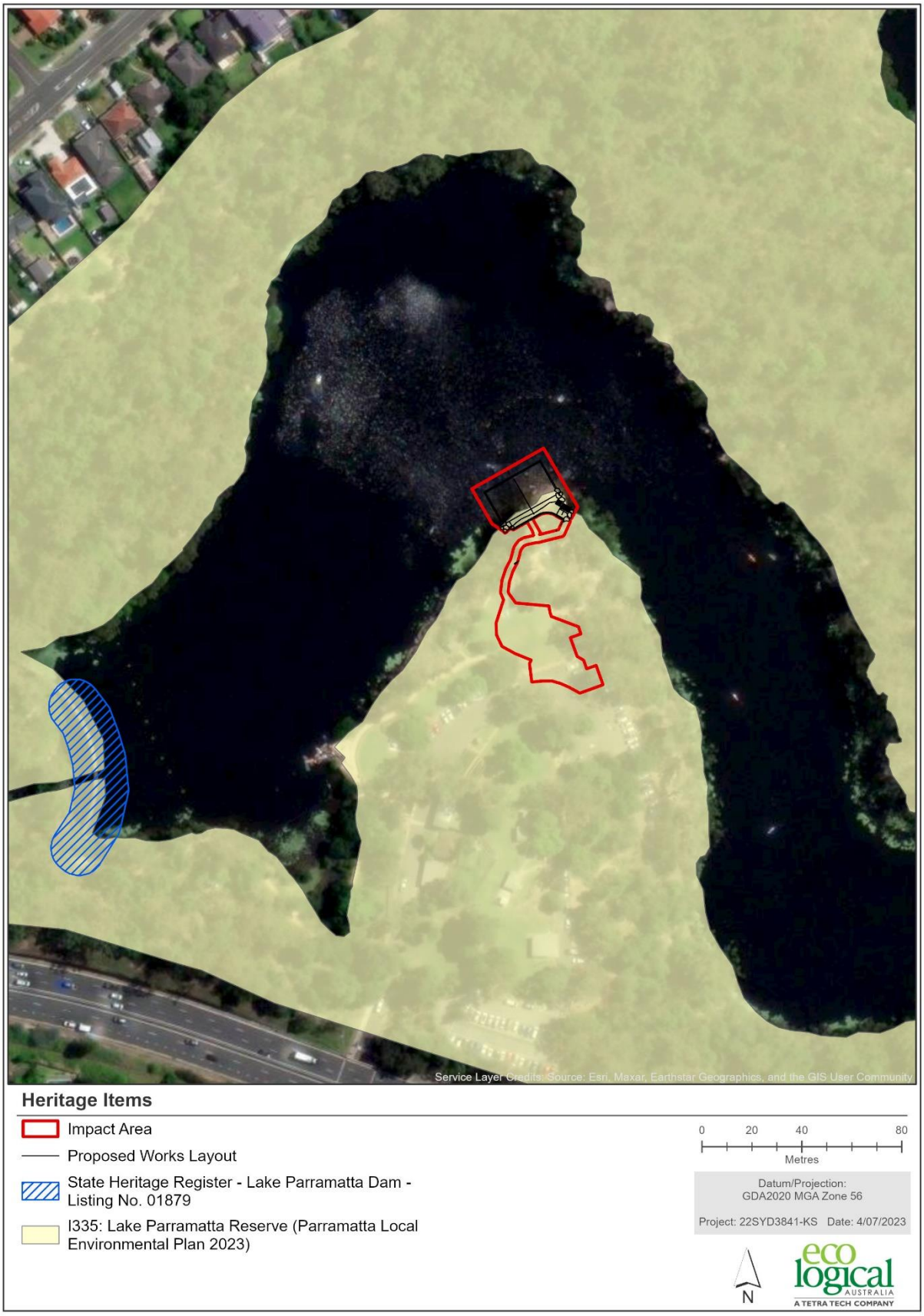

Figure 3-39: Listed heritage items within the study area

3.6.2 Impact Assessment

The study area is located directly within a local heritage item, Lake Parramatta Reserve, listed for its historic and research significance. The place is the first wildlife refuge within the Sydney region and demonstrates the heritage values of a public amenity of the past. Lake Parramatta Reserve contains a large population of intact remnant bushland and continues to operate as a popular recreational area. New elements to be introduced within the heritage curtilage would include: an underwater retaining wall, a raised mod-wood lifeguard platform, access ways, seating, and a coarse sand 'beach' with sandstone rock outcrops / boulders.

Whilst the proposed works would occur directly (physically) within the curtilage of the heritage item, these works would occur outside the original historic swimming area. In addition, no significant remnant bushland is expected to be removed as part of the works, whilst bush regeneration would occur, improving the amenity and outlook of the place. The works would ensure the ongoing historic use of the place as a swimming and recreational place, accessible to all local residents. The proposed works would not incur a direct (physical) impact level above negligible within the Lake Parramatta Reserve heritage curtilage.

The proposed works would introduce new visual elements within the Lake Parramatta Reserve heritage curtilage. The works are concerned with access and amenity improvements only and would ensure the ongoing historic use of the place. In addition, careful consideration has been taken in material and colouring choices including the use of sandstone and concrete, in-keeping with the existing setting of the place. Bush regeneration would occur, further improving the visual setting of the Reserve and shielding the proposed works from various points, whilst several proposed elements would be situated underwater and therefore not visible. The proposed works would not incur an indirect (visual) impact level above negligible within the Lake Parramatta Reserve heritage curtilage.

The study area is located within the vicinity of Lake Parramatta Dam (SHR Listing No. 01879 / PLEP 2023 Item No. I304). The Dam is considered significant for its historic, associative, aesthetic, social, research potential, rarity, and representative value. As the Dam is located outside the study area, the proposed works would have no direct (physical) impact on the place or its curtilage. The Dam is located some distance from the proposed works, which would be partially obscured by vegetation, screening views to and from the proposed works. As such, the proposed works would have no indirect (visual) impact on the heritage item.

The study area has been assessed as maintaining low potential for archaeological resources to be present. These resources would not reach the threshold for local significance, nor be considered 'relics.' As such, an unexpected finds procedure would be implemented ahead of works commencement as a mitigation for potential impacts to archaeological resources.

3.6.3 Mitigation Measures

Table 3-13: Mitigation measures for historic heritage

Potential Impact	Mitigation Measures
Impacts to Heritage items	• A heritage toolbox talk should be provided to all contractors working on the project to ensure no inadvertent damage to heritage significant places should occur. The toolbox talk should also relay the unexpected finds procedure to all contractors (outlined below).

Potential Impact	Mitigation Measures
	• Sandstone culverts and access track edging is present within or within close proximity to the study area. These sandstone elements should be avoided during the proposed works and included within the heritage toolbox to avoid inadvertent damage. • Any sandstone blocks or elements removed during the works should be reused. • If changes are made to the design plans assessed within this report, this SoHI would require updating to reflect these changes.
Unexpected finds	A standard unexpected finds procedure should be adopted during works associated with the Project as a mitigation measure. Should any unexpected historical archaeology be uncovered during any future excavation works, the following procedure must be adhered to: • Stop all work in the immediate area of the item and notify the Project Manager. • Establish a 'no-go zone' around the item. Use high visibility fencing, where practical. Inform all site personnel about the no-go zone. • No work is to be undertaken within this zone until further investigations are completed. • Engage a suitably qualified and experienced Archaeologist to assess the finds. • The Heritage Council must be notified if the finds are of local or state significance. Additional approvals will be required before works can recommence on site. • If the item is assessed as not a 'relic', a 'heritage item' or an 'Aboriginal object' by the Archaeologist, work can proceed with advice provided in writing.

3.7 Noise and Vibration

3.7.1 Existing Environment

Existing noise levels in the vicinity of the study area are variable and impacted by surrounding uses. The study area's surrounds are predominately residential in nature to the west and south. There are large tracts of bushland surrounding Lake Parramatta, extending to the east and further to the north. The area is also serviced by State Road, James Ruse Drive, in addition to other local roads. It can be assumed that the study area is at least partially impacted by road noise.

3.7.2 Impact Assessment

3.7.2.1 Construction

Noise impacts associated with increased heavy vehicle traffic for the transport and materials and machinery is expected to occur. Construction noise associated with use of heavy machinery (e.g., excavators) is also expected. Machinery noise will be minimised wherever possible through the use of hand tools, such as for the trimming of any vegetation if required and hand-digging in some locations.

Work hours will be in accordance with *Draft Construction Noise Guideline* (EPA 2020) standard daytime work times, which will minimise impacts to residents, fauna, and other sensitive receivers in proximity to the works:

- Monday to Friday 7.00 am to 6.00 pm
- Saturday 8.00 am to 1.00 pm
- No works on Sundays or Public Holidays.

Mitigation measures are provided in Table 3-14 below and Section 5 to further minimise noise impact. Overall, noise impacts are considered to be minimal.

3.7.2.2 Operation

Noise impacts associated with the ongoing use of the Lake Parramatta reserve are expected to be minimal, compared with the existing conditions and similar to noise levels already experienced within the study area.

3.7.3 Mitigation Measures

Table 3-14: Mitigation measures for noise and vibration

Potential Impact	Mitigation Measures

Noise impacts on sensitive receivers in proximity	• Avoid simultaneous operation of noisy plant wherever possible.
	• Works will only occur during the following times:
	  ○ Monday to Friday 7:00 am to 6:00 pm
	  ○ Saturday 8:00 am to 1:00 pm
	  ○ No works on Sundays or Public Holidays
	• Maximise the distance between noisy plant items and nearby residential receivers and potential fauna habitat.
	• Use slow start-up hammering for any in-water equipment to allow fauna to move away from impact area

3.8 Air Quality

3.8.1 Existing Environment

The study area is in a vegetated bushland reserve with varying degrees of native canopy and ground cover covering an area of approximately 60 ha. The area surrounding the park is primarily utilised for residential activities. Approximately 3 km south of the study area is the Parramatta CBD. The existing air quality is typical of a Sydney suburban area. Potentially affected receivers near the study area include residential properties and schools, notably The Kings School adjacent to the Lake Parramatta Reserve on the eastern boundary. Several residences are near the study area. The study area is near the following streets:

- Byrnes Street
- Bourke Street
- Bristol Street
- Lackey Street
- North Rocks Road

The elderly and children are the most at risk of adverse air quality impacts of the proposed works. Sensitive receivers within proximity to the works include, but are not limited to, the Kings Private School, which is < 600 m from the study area. Residents, particularly those located within the streets mentioned above and located near the proposed construction vehicle access points, may be sensitive to air quality impacts from the works.

3.8.2 Impact Assessment

Minor dust emissions may occur because of any earthworks within the impact area. Dust can be managed by timing works appropriately (e.g., outside of high wind periods) and using appropriate dust suppression techniques as required. The impacts resulting from dust emissions are considered minor and are unlikely to cause measurable adverse impacts to nearby sensitive receivers.

Fumes may be produced from heavy vehicles or machinery. This impact is expected to be minimal, if the recommended mitigation measures (Table 3-15) are implemented. Mitigation measures are provided in Table 3-15 below and Section 5.

3.8.3 Mitigation Measures

Table 3-15: Mitigation measures for air quality

Potential impact	Mitigation Measures
Dust, fumes and greenhouse gas generation from ground disturbing works and use of machinery	• Works are to be minimised during high wind periods. • Dust suppression techniques (e.g. water sprays) should be applied as required to limit excessive dust generation. • Plant and equipment must be regularly inspected. • Plant and equipment must be maintained in accordance with manufacturer's specifications to ensure that it is in a proper and efficient condition. • Do not leave machinery running while not in use. • Vehicles to maintain recommended speed. • Look for excessive dust generation and slow down if needed. • Carry out works during standard daytime working hours (EPA 2020).

3.9 Waste Management

3.9.1 Impact Assessment

Waste is expected to be generated in the form of organic waste (from any trimmed vegetation or removed groundcovers), general waste (produced by construction contractors) and excess soil (generated by earthworks or leftover materials). Potential impacts resulting from the generation of waste include reduced aesthetics value, minor spills from hazardous fuel and chemical use that may harm waterways, and pollution of the environment.

Any excess spoil from any minor earthworks is proposed to be classified in accordance with waste classification guidelines and disposed of at an appropriately licenced waste facility. No waste is to be imported into the site.

Potential for minor spills or leaks will be managed through mitigation measures described in Table 3-16 below. Removal and appropriate disposal of general waste generated by the contractors during the proposed works is the responsibility of the contractors unless advised differently by Council.

No impacts are anticipated with the management of waste if the mitigation measures recommended in Table 3-16 below, and Section 5, are implemented.

3.9.2 Mitigation Measures

Table 3-16: Mitigation measures for waste management

Potential impact	Mitigation Measures
Excess spoil produced by earthworks	• Any excess sediment or waste material must be kept on in a designated stockpile during construction works. • All waste must be removed from the site on completion of the works. • Upon completion of waste disposal, all original weighbridge / disposal receipts issued by the receiving waste facility must be retained in a waste register as evidence of proper disposal.
General waste	• An adequate number of bins must be placed at the site for workers and all litter will be placed in these bins. Work areas of the project site would be kept clean and free of litter, including cigarette butts, at all times.
Minor spills or leaks of fuels or chemicals	• Store all chemicals (e.g., fuel, oil) offsite and if required to be stored onsite, chemicals should be stored in appropriate bunding/storage systems and only for short periods. • Ensure appropriate spill kits are present onsite. • Ensure all equipment is in good working order. • Carry associated Safety Data Sheets (SDS) for all chemicals. • Refuel away from any drainage lines and waterways.

3.10 Traffic and Access

3.10.1 Existing Environment

The study area is principally accessed via the vehicle access point along Illawong Drive via Bourke Street, North Parramatta. A carpark of approximately 80 vehicles is provided by the parking facilities within the Lake Parramatta Reserve, approximately 50 m from the study area. The closest street to the study area with traffic data is James Ruse Drive with an approximate vehicle per day rate of 78,960 in 2018. It is noted however that James Ruse Drive is classified as an urban freeway in close proximity to the study area and is not indicative of average vehicle usage into Lake Parramatta Reserve. Additionally, a permanent vehicle counter located on Pennant Hills Road, approximately 750 m southeast of the study area recorded an average daily vehicle rate of 14,100 (TfNSW, 2022). These higher vehicle rates are due to their road classifications and are not representative of the residential road access to the study area via Bourke Street.

The study area is accessible through pedestrian pathways that connect to the wider Lake Parramatta Reserve via access points along North Rocks Road, Tallwood Drive and Plymouth Ave, as well as via the vehicle access point along Illawong Drive. The study area is approximately 350 m from the nearest bus stop on Bourke Street, Stop ID 2151131. This is the closest public transport to the study area and is serviced by the 609 service, Parramatta to North Parramatta (Loop Service).

3.10.2 Impact Assessment

3.10.2.1 Construction

There will be minor impacts to traffic associated with construction of the Project. This will be associated to the movement of vehicles required for construction purposes including construction workers cars, delivery of materials, delivery of plant, removal of spoils and demolition materials. A site compound is to be located within Lake Parramatta Reserve, in an existing carpark. It is not anticipated that road closures will be required to facilitate vehicle and machinery access or storage.

Access for contractors and machinery will be available as described in Figure 1-2. No trees are required to be cleared because of site access. Some groundcover lawn may be disturbed, however will be reinstated on completion of the proposed works.

3.10.2.2 Operation

The Project is likely to attract an increase in visitors to the park, primarily looking to utilise the recreational facilities along Lake Parramatta. It is considered that the proposed works will not have adverse effects in terms of road network capacity or off-street parking, servicing, or site access requirements given the existing nearby parking facilities and major road network adjacent.

Mitigation measures have been recommended in Table 3-17 and Section 5 to minimise potential traffic and access impacts.

3.10.3 Mitigation Measures

Table 3-17: Mitigation measures for traffic

Potential Impact	Mitigation Measures
Disruption to traffic flows	• Clearly delineate and sign post all alternative pedestrian routes that are obstructed because of the works • Position vehicles, materials, and equipment to minimise impacts to public access and parking • Restrict heavy vehicles to specified routes • Maintain a project complaint register in relation to traffic and other access impacts.
Impacts to vegetation as a result of machinery access routes	• No trees are to be removed for site access • Some minor trimming of branches may be required, and will be limited to only what is essential for access • Groundcover (lawn) will be disturbed for site access. Groundcover will be reinstated on completion of works.

3.11 Landscape and Visual Amenity

3.11.1 Existing Environment

The study area is situated within a largely natural landscape, though partly modified for its recreational uses. It offers significant visual amenity and is popular among the community and visitors for its scenic swimming, kayaking, bushwalking, and other recreational opportunities. Local blogs and tourism websites describe the lake as a "hidden, beautiful treasure" (ParraParents 2019), "one of the most beautiful places in Western Sydney" (Sydney Point).

3.11.2 Impact Assessment

The proposed works will result in short-term impacts on visual amenity, during the construction period. This is a result of any fencing, machinery storage, compound and temporary loss of access or impeded views to the reserve and lake. Any changes required during construction will be ameliorated on completion, including reinstating disturbed groundcover and removal of any ancillary items including fencing, compound, and signage.

Impacts to visual amenity for the life of the project are considered minor. The overall visual change to the swimming area will be minimal. Original designs included a pontoon on the water, which was removed as a response to community feedback and to reduce visual impacts on the natural waterway.

Mitigation measures have been recommended in Table 3-18 and Section 5 to minimise potential visual amenity impacts.

3.11.3 Mitigation Measures

Table 3-18: Mitigation measures for visual and landscape

Potential Impact	Mitigation Measures
Reduction in the aesthetic quality of the study area	• Vegetation maintenance (e.g. trimming of branches) is to be undertaken using hand tools and only as required. • Maintain exclusion zones to avoid incidental vegetation impacts • All disturbed areas will be reinstated on completion of works.

3.12 Social and Economic

3.12.1 Existing Environment

The Lake Parramatta swimming area is an existing open space recreation opportunity, which is visited by Parramatta locals and tourists alike. The lake attracts an average of 60,000 – 70,000 visitors every year. Currently, the entrance to the swimming area is very steep, there is considered a potential hazard and is not very accessible for people with disabilities.

Community engagement was held via Council's project feedback website, Participate Parramatta, available at https://participate.cityofparramatta.nsw.gov.au/swim-area-upgrade. Engagement closed on 23 December 2022. During this time, the draft concept plan was viewed 3,413 times on Participate Parramatta. A total of 370 submissions were received which found that:

- 233 people were happy with the draft concept plan.
- 25 supporting comments were received.
- 51 submissions indicated a strong opposition to the Project, including 31 comments.
- 22 submissions requested changes to the draft concept plan.
- 27 neutral comments and requests were received.

The main themes raised during community engagement were the preservation of the lake's natural quality, suitability of the pontoon and parking and congestion at the site and surrounding local roads. As a result, feedback informed the final Concept Plan (City of Parramatta 2023, Appendix A). Notably, the opposition to the pontoon was noted and subsequently removed from the final Concept Plan. The draft also proposed a ramp into the water to improve accessibility, however the suitability of this was questioned and subsequently removed from the final plan. Alternate accessibility features have been included in the final concept plan. Ancillary items raised, namely parking and congestion, are outside the scope of works for the proposed swimming area improvement and are not addressed in the Concept Plan.

An additional round of community consultation was held on a revised draft Concept Plan (City of Parramatta 2023), which considered the community feedback. During round two of consultation, 128 contributions were received. A total of 69 contributors (53.91%) supported the revised plan and a further 37 (28.91%) supported the plan to an extent. Eighteen (18) contributors opposed the plan.

More than 100 comments were received which established key issues or concerns such as:

- Protection and regeneration of existing Blackbutt trees (*Eucalyptus pilularis*)
- Safety concerns (snags, overhanging rocks)
- Protection of the peaceful, scenic environment and native bushland
- Environmental impact of adding beach and retaining wall features
- Accessibility

Additional feedback or concerns were raised in relation to parking and additional amenities (such as showers and change rooms), which is not included as part of the current scope of works.

Supportive feedback was received primarily on the following matters:

- Upgrades are overdue and welcomed
- User-friendliness
- Cohesiveness with the natural environment

Some contributions stated that accessibility for limited mobility users appeared better, while others raised concerns around accessibility. Overall, the safety and usage of the swimming area has been increased as much as possible while considering the natural environment and prioritising the avoidance of impacts to native vegetation and visual amenity.

3.12.2 Impact Assessment

The current economic impact of the swimming area amounts to $17,000 per year. This is required for ongoing maintenance of the foreshore sand and gravel which maintains safe entry and exit to the swimming area. The project is expected to deliver positive economic benefits, reducing the financial burden of the swimming area on Council by approximately $17,000 per year. The works eliminate the need for ongoing maintenance of the sand and gravel for safe access by providing more permanent safety solutions that do not require this level of upkeep.

The project will partly be delivered through the Places to Swim grant application, submitted by Council to DPE in March 2022 and finalised through contractual agreement in June 2022. As such, much of the project funding is secured to alleviate the economic burden on Council and the local taxpaying community. The project has been divided into 'Area A' and 'Area B' shown in Appendix A to align with the different funding streams. Additional grant funding may be obtained by Council to complement the Place to Swim grant.

Community concerns were raised around the retention of trees to protect and maintain the scenic and natural amenity of the swimming area. One comment specified that an Arboricultural Impact Assessment (AIA) must be completed to determine the retention of trees. It is noted that due to significant site constraints (including steep topography, variation in bedrock and soils) many impacts are unable to be determined until specific site conditions are determined by the construction contractor. As such a PTA has been prepared by ELA (2023b), providing detailed tree protection measures. Further, a qualified AQF Level 5 Arborist must be on site to delineate TPZs and supervise all site access and excavation works. This has been addressed in Section 3.4 and Appendix D.

Accessibility will be increased by creating an even 'beach' surface making it easier to enter and exit the water. It will also provide an optional entry point with steps and handrails. Long-term social benefits are expected as a result of increased swimming area size and improved safety and accessibility.

Potential short-term impacts may occur to the local community during construction. Access to the swimming area and surrounds will be limited or excluded entirely for the duration of works, which may have flow-on effects for tourism to nearby areas and local businesses.

Mitigation measures are provided in Table 3-19 and Section 5 to minimise the potential social and economic impacts associated with the project.

3.12.3 Mitigation Measures

Table 3-19: Mitigation measures for social and economic impacts

Potential impact	Mitigation Measures
Potential impacts to private residents and businesses	• Notify nearby residents and/or businesses within prior to the commencement of proposed works. • Clearly communicate construction timeframes and access to the lake during the time via Council website, letterbox drops and/or signage at the construction site.

3.13 Cumulative Impacts

In accordance with Clause 171 of the EP&A Regulation, any cumulative environmental effects of the project associated with other existing and likely future activities must be considered in determining the potential impacts of the project on the environment.

3.13.1 Impact Assessment

The works will have a low cumulative impact on the area. There are no other works known to be co-occurring in the Lake Parramatta area that would cause cumulative impacts. Some cumulative impacts may occur if works in the Parramatta LGA or other nearby suburbs are to occur in relation to other outdoor recreation facilities, reducing the community's ability to access these areas. Mitigation measures are provided in Table 3-20 and Section 5 to minimise the potential cumulative effect of the works.

3.13.2 Mitigation Measures

Table 3-20: Mitigation measures for cumulative impacts

Potential Impact	Mitigation Measures
Community notification	• Ensure a plan for community consultation is developed which outlines the dissemination of information to the community via letterbox drops, websites, and/or newsletters. • Where multiple projects are occurring within the same vicinity at the same time, undertake communication between construction contractors to ensure that potentially noisy or disruptive activities are not undertaken at the same time.

3.14 Matters of National Environmental Significance

Under the environmental assessment provisions of the EPBC Act, the following MNES and impacts on Commonwealth land are required to be considered to assist in determining whether the Project should be referred to the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW). Table 3-21 addresses the MNES for the Project.

Table 3-21: Consideration of MNES

MNES Aspect	Impact
Any environmental impact on a World Heritage property?	No
Any environmental impact on National heritage places?	No
Any environmental impact on RAMSAR wetlands?	No
Any environmental impact on Commonwealth listed threatened species or ecological communities?	Non-significant impact
Any environmental impact on Commonwealth listed migratory species?	No
Does any part of the project involve nuclear action?	No
Any environmental impact on a Commonwealth marine area?	No
Any impact on Commonwealth land?	No

3.15 Licences and Permits

All relevant environmental impacts have been assessed in this REF. A lease, license, permit or other right to work must be obtained from Crown Land to proceed with works.

The Project is not required to obtain a Part 7 Permit under Section 200 of the FM Act, given that the works are on Crown Land and will be undertaken in accordance with the Crown Land Management Act. It is recommended that Council consult with DPI Fisheries regardless. The works are to implement any recommendations issued by DPI Fisheries as a result of consultation.

SECTION 4

Consultation

4. Consultation

4.1 Consultation Requirements under the Transport and Infrastructure SEPP

Division 1 of the Transport and Infrastructure SEPP provides guidance on consultation with stakeholders. These requirements are addressed in Table 4-1 below.

Table 4-1: Transport and Infrastructure SEPP consultation requirements

SEPP Clause	Description	Consultation Undertaken
Section 2.10	Consultation with councils – development with impacts on council-related infrastructure or services Consultation is required if the development: (a) will have a substantial impact on stormwater management services provided by a council, or (b) is likely to generate traffic to an extent that will strain the capacity of the road system in a local government area, or (c) involves connection to, and a substantial impact on the capacity of, any part of a sewerage system owned by a council, or (d) involves connection to, and use of a substantial volume of water from, any part of a water supply system owned by a council, or (e) involves the installation of a temporary structure on, or the enclosing of, a public place that is under a council's management or control that is likely to cause a disruption to pedestrian or vehicular traffic that is not minor or inconsequential, or (f) involves excavation that is not minor or inconsequential of the surface of, or a footpath adjacent to, a road for which a council is the roads authority under the Roads Act 1993 (if the public authority that is carrying out the development, or on whose behalf it is being carried out, is not responsible for the maintenance of the road or footpath).	No, Council is the proponent.
Section 2.11	Consultation with councils – development with impacts on local heritage Consultation is required if the development: (a) is likely to affect the heritage significance of a local heritage item, or of a heritage conservation area, that is not also a State heritage item, in a way that is more than minor or inconsequential, and (b) is development that this Chapter provides may be carried out without consent	No, Council is the proponent.
Section 2.12	Consultation with councils – development with impacts on flood liable land In this section, flood liable land means land that is susceptible to flooding by the probable maximum flood event, identified in accordance with the principles set out in the manual entitled Floodplain Development Manual: the management of flood liable land published by the New South Wales Government and as in force from time to time. A public authority, or a person acting on behalf of a public authority, must not carry out, on flood liable land, development that this Chapter provides may be carried out without consent and that will change flood patterns other than to a minor extent unless the authority or person has – (a) given written notice of the intention to carry out the development (together with a scope of works) to the council for the area in which the land is located, and	No, Council is the proponent.

SEPP Clause	Description	Consultation Undertaken
	(b) taken into consideration any response to the notice that is received from the council within 21 days after the notice is given.	
Section 2.13	Consultation with State Emergency Service – development with impacts on flood liable land A public authority, or a person acting on behalf of a public authority, must not carry out development on flood liable land that may be carried out without development consent under a relevant provision unless the authority or person has— (a) given written notice of the intention to carry out the development (together with a scope of works) to the State Emergency Service, and (b) taken into consideration any response to the notice that is received from the State Emergency Service within 21 days after the notice is given.	No, the site is not mapped under the Flood Planning Map as flood liable land.
Section 2.14	Consultation with councils – development with impacts on certain land within the coastal zone (1) This section applies to development on land that is within a coastal vulnerability area and is inconsistent with a certified coastal management program that applies to that land.	No, Council is the proponent
Clause 2.15	Consultation with Public Authorities other than Councils Consultation is required if the development is: (a) development adjacent to land reserved under the National Parks and Wildlife Act 1974 or to land acquired under Part 11 of that Act — Department of Planning and Environment (DPE) / Biodiversity Conservation Division (BCD), (b) development on land in Zone E1 National Parks and Nature Reserves or in a land use zone that is equivalent to that zone, other than land reserved under the National Parks and Wildlife Act 1974 — DPE/BCD, (c) development comprising a fixed or floating structure in or over navigable waters—Transport for NSW, (d) development that may increase the amount of artificial light in the night sky and that is on land within the dark sky region as identified on the dark sky region map—the Director of the Observatory (e) development on defence communications facility buffer land within the meaning of clause 5.15 of the Standard Instrument—the Secretary of the Commonwealth Department of Defence, (f) development on land in a mine subsidence district within the meaning of the Mine Subsidence Compensation Act 1961—the Mine Subsidence Board.	N/A
Clause 2.16	Consideration of Planning for Bushfire Protection Consultation is required if the development is for: • health services facilities • correctional centres • residential accommodation A public authority, or a person acting on behalf of a public authority, must consider *Planning for Bush Fire Protection* before carrying out the development in an area that is bush fire prone land	No, the proposed works are not the specified development

4.2 Land Owner Consultation

The works are proposed wholly within NSW Crown Land, with the Council managing the park areas of Lake Parramatta Reserve as trustee. The following reservations apply:

- Reserve 59927 (the land portion of the study area)
- Reserve 77695 (waterway)

Council, in its capacity as Crown land Manager (CLM) is a public authority for the purposes of the EP&A Act. As CLM, Council may submit a development or other application without the need for consent of the Crown (the landowner) provided that notice of intention to make the application is served upon the Crown for comment prior to lodgement. The final construction documentation, along with this REF, will be provided to Crown Lands for comment prior to the commencement of works.

4.3 Publishing the REF – FM Act Permit

Section 171(4) of the EP&A Regulation sets out requirements in relation to the publishing of an REF if it meets criteria. One of these criteria is for works requiring a permit under the FM Act. As no permit is required given the Crown Land and CLM context, publication of the REF is not required on this basis.

Consultation with DPI Fisheries is still recommended.

4.4 Community Consultation

The draft Concept Plan (City of Parramatta, 2022) for upgrading the Lake Parramatta swimming area was publicly exhibited on the City of Parramatta 'Parramatta Participates' website from the 22nd of July 2022 – 15th of August 2022. The public was invited to share feedback through online feedback forms, mail, phone, and email. As a result of feedback, the draft Concept Plan (City of Parramatta, 2022) was revised and another round of community consultation was undertaken. This consultation has been summarised and addressed in the social and economic section of this report (Section 3.11).

SECTION 5

Mitigation Measures

5. Mitigation Measures

Table 5-1: Recommended mitigation measures and responsibility

Environmental Aspect	Potential Impact	Mitigation Measures	Responsibility	Timing
Soils and Erosion	Sediment and erosion	• Prepare a CEMP prior to any construction works to address measures to be adopted to minimise impacts on the environment as a result of the construction works, including erosion and sedimentation. • Prepare a Sediment and Erosion Control Plan (SEMP) in accordance with *The Blue Book – Managing Urban Stormwater: Soils and Construction* (Landcom, 2004) and implement prior to works. • Install appropriate soil and erosion control measures such as sediment fencing and local batters prior to commencing works. • Inspect controls regularly (weekly), and more frequently during rain periods to ensure structures are in proper working order. • Prior to forecast heavy rain, cease work, and remove accumulated material from sediment controls. • Schedule major earthworks outside of predicted heavy rain periods. • Stop work during and following heavy rainfall to reduce risk of mobilising sediment. • Monitor sedimentation down slope of excavated areas. • Leave erosion and sediment controls in place until after the works are completed	Project Manager Contractor	Before construction During construction
	Geotechnical recommendations (JKG 2023)	• Seek advice from a coastal engineer on the effect of raising the lakebed and subsequent hydrological alterations. • Engage a professional scuba diver to check the perimeter outside the retaining walls for hazards. Appropriate warnings are to be signposted on the outer edge of the beach following completion of works. • Design should include the most appropriate retaining wall solutions, being most suitable retaining walls are mass gravity boulder walls and mass gravity concrete block walls. • Any obvious deleterious or contaminated existing fill should be removed. These stripped materials should be taken offsite as they are not suitable for reuse as engineered fill. • Topsoil may be stockpiled and used for landscaping purposes if not deemed contaminated. Stockpiling recommendations are provided below.	Project Manager Contractor	Before construction During construction

Environmental Aspect	Potential Impact	Mitigation Measures	Responsibility	Timing
		• Excavation works are to be undertaken with reference to the *Code of Practice – Excavation Works* (NSW Government 2020) and geotechnical findings (JKG 2023). • Appropriate excavation support in the form of temporary batter slopes, per specifications by JKG 2023 are recommended. • Contractor is to make provisions for sandbagging of batter slopes in case it is required for instability or seepage. • Construct retaining walls with reference to geotechnical recommendations in JKG 2023.		

	Stockpiling of material	• Excavated soil and approved, imported materials must be stockpiled within a designated stockpile area.
		• During site establishment, stockpile areas must be prepared and managed using the following methods:
		  ○ Establishing stockpiles on existing paved surfaces wherever possible
		  ○ Construction of diversion drains and bunds around the perimeter of the stockpile areas. Installation of sediment and erosion control measures, where necessary
		  ○ Erection of signs at the entrance to the stockpile areas and at locations around the stockpile specifying individual stockpile number and the type of materials stored
		  ○ Limit stockpile height to no more than 2 m
		• All stockpiles must be maintained in a tidy and safe condition with stable batter slopes.
			Contractor	During construction

	Imported fill or illegal dumping on site	• Develop and implement an unexpected finds protocol for the site to ensure any material which is potentially contaminated is identified and appropriately assessed and managed.	Project Manager Contractor	During construction
	Contamination	• If contaminants are identified prior to or during works, further assessment is required before proceeding with excavation.	Project Manager Contractor	During construction
	Pollution of soils from chemical spills (e.g., fuel or oil from machinery).	• For any excess spoil material which requires offsite disposal, formally classify waste before being taken to an appropriately licensed landfill in accordance with the *Waste Classification Guidelines* (EPA 2014). • Store all chemicals (e.g., fuel, oil) in appropriate bunding/storage systems within the approved storage facility. • Ensure appropriate spill kits are available on site.	Project Manager Contractor	During construction

Environmental Aspect	Potential Impact	Mitigation Measures	Responsibility	Timing
		• Establish dedicated refuelling areas outside environmentally sensitive areas and away from creek lines. These areas are to be bunded to ensure any spills do not enter sensitive areas or waterways.		
Waterways and Aquatic Habitat	Excess sediment input into waterway	• A sediment and erosion control plan must be prepared in accordance *with Managing Urban Stormwater: Soils and construction - Volume 1* (Landcom 2004). • A sediment curtain must be installed around the in-reservoir works. • Weather forecasts will be checked daily to ensure that work is not carried out before or during high rainfall.	Project Manager Contractor	During construction
	Pollution of foreshore from chemical spills (e.g., fuel or oil)	• Store all chemicals (e.g., fuel, oil) offsite and if required to be stored onsite, chemicals should be stored in appropriate bunding/storage systems and only for short periods. • Ensure appropriate spill kits are present onsite. • Ensure all equipment is in good working order. • Carry associated Safety Data Sheets (SDS) for all chemicals.	Project Manager Contractor	During construction
	Impacts to Key Fish Habitat	• Consultation with DPI Fisheries is recommended prior to construction. Implement any recommendations provided by DPI Fisheries into the design and/or construction methodology. • Protect KFH wherever possible during construction. Allow for the restoration of any impacted fish habitat as part of the Project design.	Project Manager	Before construction After construction
	Introduction of invasive species	• Adhere to the Saving our Species Hygiene guidelines (DPIE 2020b) at all times. In particularly: o Wash down equipment and vehicles (including boats, boat trailers and barges) prior to entering the site, to manage the introduction and spread of pathogens. Pay particular attention to cleaning mud flaps and tyres. o Thoroughly clean all equipment of soil and vegetation debris prior to entry into the study area. o Use a solution of 70% ethanol or methylated spirits in 30% water for wash down and equipment cleaning to effectively disinfect areas. o Wash down on a hard, well-drained surface, for example a road, and on ramps if possible. Do not allow wash-down water to drain into native bushland or waterways. o Machinery and equipment must also be cleaned when leaving site.	Project Manager Contractor	During construction

Environmental Aspect	Potential Impact	Mitigation Measures	Responsibility	Timing
		Wash down protocols are required to control multiple impacts including, pathogens, weeds, and contaminated soils. The CEMP should develop a single wash down process that addresses the requirements of all three potential environmental impacts.		
Biodiversity	Accidental damage / clearing	• Delineate no-go zones using high visibility bunting, fencing or similar. • Maintain temporary fencing to prevent access into the native vegetation. • Council staff are to undertake a pre-works briefing advising of sensitive areas and relevant safeguards for these areas. This includes vegetation to be retained, and stag/hollow-bearing tree outside the impact area which are to be retained. • Stop works if any previously undiscovered threatened species are discovered during works. An assessment of the impact and any required approvals must be obtained. Works must not recommence until Council has provided written approval to do so. • Ensure the site-specific CEMP includes instructions for dealing with orphaned or injured native animals and ensure the CEMP includes the contact details for the NSW Wildlife Information, Rescue and Education Service Inc (WIRES). • Install temporary barrier fencing to prevent entry into adjacent vegetation and appropriate 'no-go zone' signage. This must include areas of Council and any areas of Community bush regeneration activities. • Install tree protection measures around trees to be retained (i.e. all trees) in the study area. Structures should be adequate to prevent machinery from entering within the drip zone.	Project Manager Contractor	Before construction During construction
	Indirect lighting to adjacent vegetation and waterbody	• Manage artificial lights using motion sensors and timers. • Aim light onto the exact surface area requiring illumination. Use shielding on lights to prevent light spill into the atmosphere and outside the footprint of the target area. • Avoid lights containing short wavelength, violet / blue light, and white LEDs. • Avoid high intensity light of any colour.	Project Manager Contractor	During construction
	Spread of priority weeds	• Wash down equipment and vehicles prior to and after use, to manage the introduction and spread of weed propagules. • Thoroughly clean all equipment of soil and weed propagules prior to entry into the study area. • Remove Priority weeds using best management practices (including appropriate controls to prevent impacts to threatened species) prior to removal of native vegetation. Remove weed propagules offsite.	Project Manager Contractor	During construction

Environmental Aspect	Potential Impact	Mitigation Measures	Responsibility	Timing
		• Bag and remove all weed propagules offsite, preferably the same day and dispose of at designated green waste facility.		
	Introduction/ spread of pathogens	• Adhere to the *Saving our Species Hygiene* guidelines (DPIE 2020b) at all times. In particular: o Wash down equipment and vehicles prior to entering the site, to manage the introduction and spread of pathogens. Pay particular attention to cleaning mud flaps and tyres. o Thoroughly clean all equipment of soil and vegetation debris prior to entry into the study area. o Use a solution of 70% ethanol or methylated spirits in 30% water for wash down and equipment cleaning to effectively disinfect areas. o Wash down on a hard, well-drained surface, for example a road, and on ramps if possible. Do not allow wash-down water to drain into native bushland. o Machinery and equipment must also be cleaned when leaving site. • Wash down protocols are required to control multiple impacts including, pathogens, weeds, and contaminated soils. The CEMP should develop a single wash down process that addresses the requirements of all three potential environmental impacts.	Project Manager Contractor	During construction
Arboriculture	Accidental damage to trees that are to be retained	• Prominently sign posted with 300 mm x 450 mm boards stating, "NO ACCESS - TREE PROTECTION ZONE". • Protective cyclone chain wire link fence to be erected around the TPZ to protect and isolate retained trees from the construction works. Existing boundary fencing may be used. • Where required, crown protection may include the installation of a physical barrier, pruning selected branches to establish clearance, or the tying/bracing of branches. • When fencing is not practical or prior to any activities within the TPZ, trunk protection is required and consist of a layer geotextile fabric or similar followed by 1.8 m lengths of softwood timbers spaced evenly around the trunk and secured with a galvanised hoop strap. • Install and maintain 100 mm thick layer of mulch around tree in TPZ. For machine or vehicle access within TPZ geotextile fabric beneath crushed rock or rumble boards may be required. • Soil moisture levels should be regularly monitored by the Project Arborist. Temporary irrigation or watering may be required within TPZ.	Project Manager Contractor Project Arborist	Before construction During construction

Environmental Aspect	Potential Impact	Mitigation Measures	Responsibility	Timing
		• If incursions/excavation within the TPZ are unavoidable, root investigation may be needed to determine the extent and location of roots within the area of construction activity using non-destructive excavation (NDE) methods. • All underground services should be routed outside of the TPZ. If underground services need to be installed within the TPZ, they should be installed using horizontal directional drilling (HDD), non-destructive excavation (NDE) methods such as hydro-vacuum, Air Spade or manually excavated trenches.		
	Pre-construction briefing	• Prior to any construction, an onsite meeting should be conducted with attendee's subject but not limited to the Project Arborist (AQF Level 5 Consulting Arborist), site manager and construction personnel team to walkthrough the tree protection measures requirements. Any trees, if approved for removal (see below), are to be indicated clearly with spray paint on trunks. • Prior to removing any trees in relation to the proposed works, permission is to be granted by the relevant consent authority.	Project Manager Contractor Project Arborist	Before construction
	During construction	• The Project Arborist is to supervise all works to be completed within the TPZ of trees to be retained and provide advice regarding tree protection and retention, and monitor compliance.	Project Manager Project Arborist	During construction
	Post-construction	• A final inspection of trees should be undertaken by Project Arborist after all major construction has ceased and following the removal of tree protection measures.	Project Manager Project Arborist	After construction
	PTA Recommendations	**Design considerations** • It is recommended to either undertake root mapping prior to final design works or alternatively use root mapping to guide installation works for the retaining wall and other project elements within a TPZ. **Minimise impacts from root severance:** • Avoid pruning roots that are larger than 5 cm in diameter. • Where there is a choice between an impact on an older tree (DBH > 50 cm) and a younger tree (DBH < 50 cm) within in a TPZ. A younger tree is more likely to be resilient to impacts. • Whenever possible avoid excavation works. If materials can be supported on top of existing soil grade within TPZs, impacts on tree roots will be reduced.	Project Manager Project Arborist	All stages

Environmental Aspect	Potential Impact	Mitigation Measures	Responsibility	Timing
		• Impacts to trees within their TPZ but outside their SRZ may have a negative impact on their vitality, but those impacts are unlikely to increase risk in the short term. **Minimise soil compaction:** • Avoid traversing the site with vehicles when soils are moist (during and after rainfall). • Use of relatively light weight excavators, namely skid shift excavators no greater than five (5) tonnes that use rubber tracks will minimise soil compaction. These types of excavators are used in forestry work. Ensure that use of the skid shift excavator is supervised by an arborist (AQF Level 5) and ensure the twisting and sliding is minimised. Turning is to be undertaken using large turning circles where possible to minimise soil disturbance. • Use of the existing access track with a lightweight vehicle will reduce impacts extending beyond areas that have previously experienced soil compaction. • Use of rumble boards and similar materials as described in the Australian Standard 4970 will assist in mitigating the impacts from soil compaction. • Use cranes to transfer materials down to the swimming area wherever feasible. **Assist trees in recovering once works are complete:** • Addition of mulch significant improves soil moisture retention and consequently assists in tree recovery. • Maintaining good health potentially though additional watering or irrigation during warmer months when required will assist in tree recovery.		
Aboriginal Heritage	Discovery of unexpected Aboriginal objects	• Brief all contractors undertaking works on site on the protection of Aboriginal heritage objects under the NPW Act, and the penalties for damage to these items. • If an item (or suspected item) of Aboriginal heritage significance is discovered, cease works in the immediate vicinity of the find and fence off the area with suitable markers (star pickets, flagging or barrier mesh). Notify the council project manager and engage an Archaeologist to assess the finds. If they are found to be Aboriginal objects, Heritage NSW must be notified under Section 89A of the NPW, and appropriate management sought. Depending on the proposed works in relation to the finds, further assessment and an AHIP may be required. Works may not recommence unless council has provided written approval to do so.	Project Manager Contractor	Before construction
	Discovery of Human Remains	• Stop work if human remains are found and contact NSW Police. If remains are suspected to be Aboriginal, Heritage NSW must be notified as well.	Contractor	During construction

Environmental Aspect	Potential Impact	Mitigation Measures	Responsibility	Timing
Historic Heritage	Impacts to Heritage items	• A heritage toolbox talk should be provided to all contractors working on the project to ensure no inadvertent damage to heritage significant places should occur. The toolbox talk should also relay the unexpected finds procedure to all contractors (outlined below). • Sandstone culverts and access track edging is present within or within close proximity to the study area. These sandstone elements should be avoided during the proposed works and included within the heritage toolbox to avoid inadvertent damage. • Any sandstone blocks or elements removed during the works should be reused. • If changes are made to the design plans assessed within this report, this SoHI would require updating to reflect these changes.	Project Manager Contractor	Before construction
	Unexpected finds	A standard unexpected finds procedure should be adopted during works associated with the Project as a mitigation measure. Should any unexpected historical archaeology be uncovered during any future excavation works, the following procedure must be adhered to: • Stop all work in the immediate area of the item and notify the Project Manager. • Establish a 'no-go zone' around the item. Use high visibility fencing, where practical. Inform all site personnel about the no-go zone. • No work is to be undertaken within this zone until further investigations are completed. • Engage a suitably qualified and experienced Archaeologist to assess the finds. • The Heritage Council must be notified if the finds are of local or state significance. Additional approvals will be required before works can recommence on site. • If the item is assessed as not a 'relic', a 'heritage item' or an 'Aboriginal object' by the Archaeologist, work can proceed with advice provided in writing.	Project Manager Contractor	Before construction During construction

Noise and Vibration	Noise impacts on sensitive receivers in proximity	• Avoid simultaneous operation of noisy plant wherever possible.
		• Works will only occur during the following times:
		  ○ Monday to Friday 7:00 am to 6:00 pm
		  ○ Saturday 8:00 am to 1:00 pm
		  ○ No works on Sundays or Public Holidays
		• Maximise the distance between noisy plant items and nearby residential receivers and potential fauna habitat.
		• Use slow start-up hammering for any in-water equipment to allow fauna to move away from impact area
			Contractor	During construction

Environmental Aspect	Potential Impact	Mitigation Measures	Responsibility	Timing
Air Quality	Dust, fumes and greenhouse gas generation from ground disturbing works and use of machinery	• Works are to be minimised during high wind periods. • Dust suppression techniques (e.g. water sprays) should be applied as required to limit excessive dust generation. • Plant and equipment must be regularly inspected. • Plant and equipment must be maintained in accordance with manufacturer's specifications to ensure that it is in a proper and efficient condition. • Do not leave machinery running while not in use. • Vehicles to maintain recommended speed. • Look for excessive dust generation and slow down if needed. • Carry out works during standard daytime working hours (EPA 2020).	Contractor All staff	During construction
Waste Management	Excess spoil produced by earthworks	• Any excess sediment or waste material must be kept on in a designated stockpile during construction works. • All waste must be removed from the site on completion of the works. • Upon completion of waste disposal, all original weighbridge / disposal receipts issued by the receiving waste facility must be retained in a waste register as evidence of proper disposal.	Contractor All staff	During construction
	General waste	• An adequate number of bins must be placed at the site for workers and all litter will be placed in these bins. Work areas of the project site would be kept clean and free of litter, including cigarette butts, at all times.	Contractor All staff	During construction
	Minor spills or leaks of fuels or chemicals	• Store all chemicals (e.g., fuel, oil) offsite and if required to be stored onsite, chemicals should be stored in appropriate bunding/storage systems and only for short periods. • Ensure appropriate spill kits are present onsite. • Ensure all equipment is in good working order. • Carry associated Safety Data Sheets (SDS) for all chemicals. • Refuel away from any drainage lines and waterways.	Contractor All staff	During construction
Traffic and Access	Disruption to traffic flows	• Clearly delineate and sign post all alternative pedestrian routes that are obstructed because of the works • Position vehicles, materials, and equipment to minimise impacts to public access and parking • Restrict heavy vehicles to specified routes • Maintain a project complaint register in relation to traffic and other access impacts.	Project Manager Contractor	Before construction During construction

Environmental Aspect	Potential Impact	Mitigation Measures	Responsibility	Timing
	Impacts to vegetation as a result of machinery access routes	• No trees are to be removed for site access • Some minor trimming of branches may be required, and will be limited to only what is essential for access • Groundcover (lawn) will be disturbed for site access. Groundcover will be reinstated on completion of works.	Project Manager Contractor	During construction After construction
Landscape and Visual Amenity	Reduction in the aesthetic quality of the study area	• Vegetation maintenance (e.g. trimming of branches) is to be undertaken using hand tools and only as required. • Maintain exclusion zones to avoid incidental vegetation impacts • All disturbed areas will be reinstated on completion of works.	Project Manager Contractor	During construction After construction
Social and Economic	Potential impacts to private residents and businesses	• Notify nearby residents and/or businesses within prior to the commencement of proposed works. • Clearly communicate construction timeframes and access to the lake during the time via Council website, letterbox drops and/or signage at the construction site.	Project Manager	Before construction
Cumulative Impacts	Community notification	• Ensure a plan for community consultation is developed which outlines the dissemination of information to the community via letterbox drops, websites, and/or newsletters. • Where multiple projects are occurring within the same vicinity at the same time, undertake communication between construction contractors to ensure that potentially noisy or disruptive activities are not undertaken at the same time.	Project Manager	Before construction

Source: Sydney.com

SECTION 6

Conclusion

6. Conclusion

6.1 Section 171 of the EP&A Regulation

Section 171 of the EP&A Regulation sets out a non-exhaustive list of factors which must be considered when undertaking a Review of Environmental Factors under Part 5 of the EP&A Act. These factors have been addressed throughout this report and are summarised in Table 6-1 below.

Table 6-1: Section 171 Factors under the EP&A Regulation

Section 171 Factors		Impact
(a)	the environmental impact on the community,	Noise and other impacts on the community are anticipated to be minimal. The proposed works will result in a positive impact on the community through upgrading a public open space recreational asset to be safe and accessible.
(b)	the transformation of the locality,	No significant transformation of locality is likely as part of the works. The proposed works involve the upgrading of the existing swimming area with new recreational facilities in an area which has previously been modified. Vegetation removal will be minimised where possible.
(c)	the environmental impact on the ecosystems of the locality,	Impacts on ecosystems are anticipated to be non-significant if the recommended mitigation measures are followed.
(d)	reduction of the aesthetic, recreational, scientific, or other environmental quality or value of the locality,	The works involve the upgrading of the existing swimming area of recreational facilities in an area that has predominantly been previously modified. No impacts to any threatened ecological community were identified. Other impacts to ecology and biodiversity have been considered and either avoided or mitigated. Therefore, the works will not significantly reduce aesthetic, scientific, or other environmental quality or value of the locality. Rather, the proposed works are anticipated to improve the aesthetic, recreational and environmental quality, and value of the locality.
(e)	the effects on any locality, place or building that has— • aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or • social significance, or other special value for present or future generations,	The proposed works will not have an effect on any known Aboriginal sites and is there is a low likelihood for Aboriginal objects to be present within the site. The proposed works will not have any significant effect upon a place or building having aesthetic, architectural, cultural, historical, scientific, or social significance or any other special value for present or future generations if the recommended mitigation measures are implemented.
(f)	the impact on the habitat of protected animals, within the meaning of the Biodiversity Conservation Act 2016,	The impact on threatened fauna has been assessed and mitigated. The impact, if any, will not be significant. In addition, the impact resulting from the loss of general fauna habitat because of vegetation disturbance is not likely to result in the loss or reduction in the viability of more common fauna species.
(g)	the endangering of a species of animal, plant or other form of life, whether living on land, in water or in the air,	Potential impacts on flora and fauna have been considered as part of this REF. There will be no significant impact on any threatened species or other more common fauna species.

Section 171 Factors		Impact
(h)	long-term effects on the environment,	The Project will not result in long-term impact if mitigation procedures are followed. Maintenance following the completion of the works will be infrequent. The works will have a long-term positive impact on the community through providing a safe and usable recreational area.
(i)	degradation of the quality of the environment,	No significant impacts to the quality of the environment were found. No degradation to the quality of the environment should occur if mitigation measures are adhered to.
(j)	risk to the safety of the environment,	A low risk to the environment is associated with the works. Potential for contamination is possible if the relevant management plans and mitigation measures are not adhered to. There is a small potential for sedimentation from stockpiles, and water turbidity, to occur during construction of the works. The risk to the environment is considered minimal if the recommended mitigation measures are adopted.
(k)	reduction in the range of beneficial uses of the environment,	No reduction in the range of beneficial uses of the environment will result as part of the works. The works will not limit or modify any uses of the environment.
(l)	pollution of the environment,	No pollution of the environment is proposed or likely. The risk is minimal if the recommended mitigation measures are implemented.
(m)	environmental problems associated with the disposal of waste,	All waste is to be taken offsite and disposed of appropriately or as stipulated in the relevant remediation plan
(n)	Any increased demands on resources (natural or otherwise) that are or are likely to become in short supply?	No resources that are being utilised as part of this project are likely to become in short supply.
(o)	the cumulative environmental effect with other existing or likely future activities,	Minor to negligible cumulative environmental effect is likely to occur as a result of the works.
(p)	the impact on coastal processes and coastal hazards, including those under projected climate change conditions,	There are no impacts on coastal processes or hazards that will result as part of the works.
(q)	applicable local strategic planning statements, regional strategic plans or district strategic plans made under the Act, Division 3.1,	The Project is consistent with and supports the objectives of relevant local, regional and district level strategic plans.
(r)	other relevant environmental factors.	All relevant environmental factors have been assessed in Section 3 of this REF.

6.2 Evaluation

Through the process of this REF, the project has been subject to a comprehensive assessment under Part 5 of the EP&A Act. This REF has examined and fully considered all matters affecting or likely to affect the environment by reason of the proposed activity. This has included consideration of other environmental planning instruments as well as other NSW and Commonwealth legislation.

The project will aid in the delivery of multiple objectives identified both in the Central City District Plan and City of Parramatta LSPS such as providing improved social infrastructure, delivering high quality open space, and promoting the active health of community members.

Environmental impacts associated with the project would generally be limited to soils and erosion, water quality and biodiversity. Biodiversity impacts are largely minimised by avoiding the removal of trees, thereby retaining a large proportion of habitat within the study area. Appropriate mitigation measures have been recommended and should be implemented prior to, and during, construction as described in Section 5. This includes the recommendation for the following management plans:

- Construction Environmental Management Plan (CEMP)
- Sediment and Erosion Management Plan (SEMP)

Consultation with Crown Land and obtaining a lease, license, permit or other right to work in accordance with the Crown Land Management Act is required for the Project to proceed. A Part 7 Fisheries Permit under the FM Act is not required, however consultation with DPI Fisheries is recommended.

Based on the assessment contained in this REF, it is considered that the Project is not likely to have a significant impact upon the environment or any threatened species, populations, or communities. Accordingly, the preparation of an Environmental impact Statement (EIS) is not recommended.

The Project has also considered the principles of ecologically sustainable development and the objects of the EP&A Act. The Project would be delivered to the maximum benefit for the community, be cost effective and minimise any adverse impacts on the environment. On balance, the project is considered justified and in the public interest.

6.3 Determination

This REF provides a true and fair review of the activity in relation to its likely effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the Project and provides sufficient information to determine whether there is likely to be a significant impact on the environment as a result of the Project.

I have considered all environmental impacts and safeguards to the best of my knowledge and have sought advice where required.

Lake Parramatta Swimming Area REF	
Project Director Rebecca Ben-Haim Eco Logical Australia Level 3, 101 Sussex Street, Sydney 2000 Ph: 02 9259 3745	 Date: 21 July 2023
Project Manager Courtney Blick Eco Logical Australia Level 3, 101 Sussex Street, Sydney 2000 Ph: 02 9259 3754	 Date: 21 July 2023

SECTION 7

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7. References

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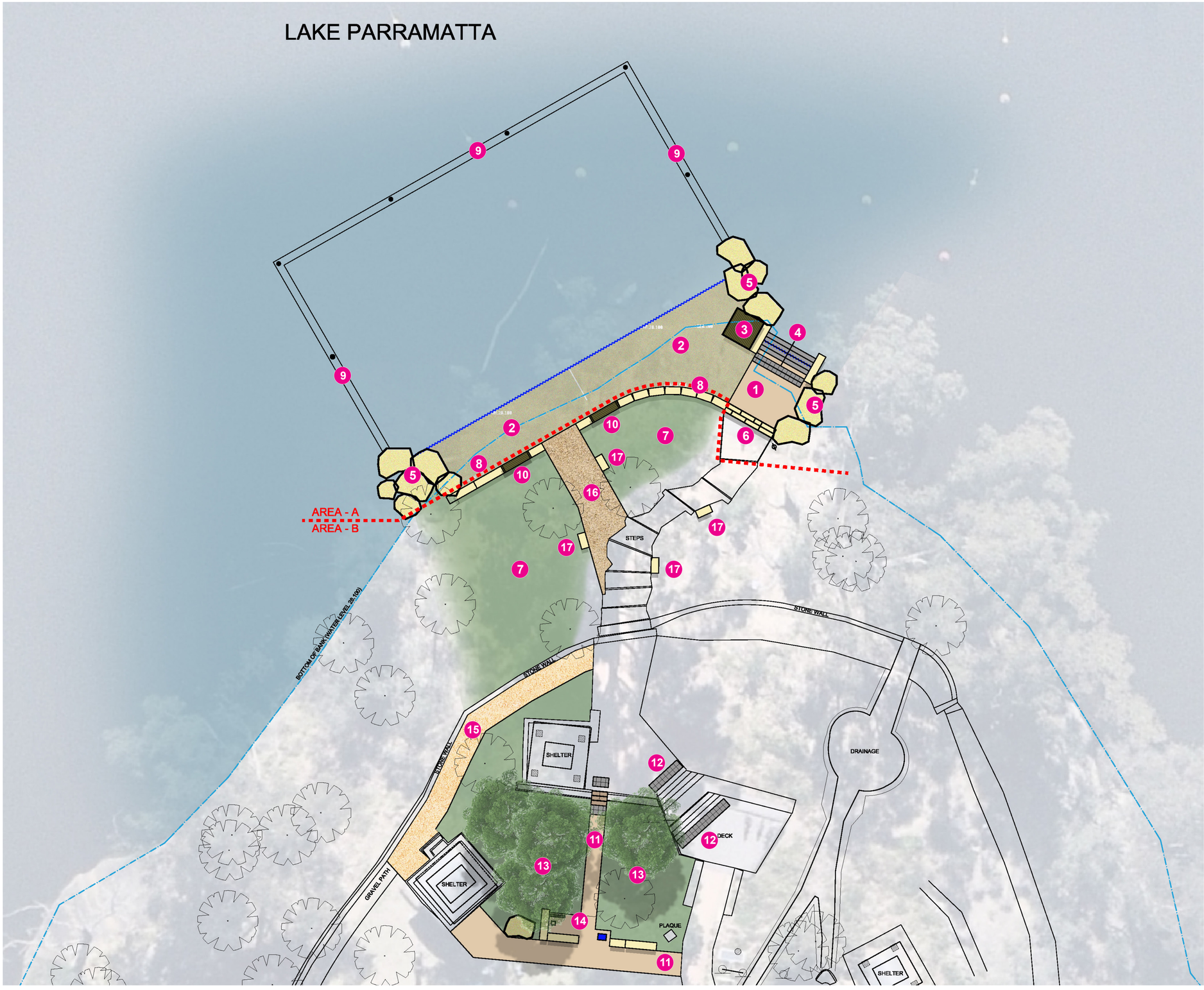
APPENDIX A

Lake Parramatta Concept Plan

City of Parramatta 2023



LEGEND

1 - Coloured concrete pavement to improve accessibility to waters edge

2 - Coarse river sand ‘beach’ for improved level water access

3 - 2.0 x 2.0m raised mod-wood lifeguard platform

4 - Concrete water access steps with central stainless steel handrail and tactile surface indicators

5 - Proposed sandstone rock outcrops / boulders

6 - Sandstone coloured concrete steps to match existing

7 - Planted native bush regeneration works

8 - Sandstone block seating / retaining wall

9 - Underwater retaining wall to 1.8m depth with depth markers to retain coarse river sand ‘beach’ material

10 - Backrest and armrests placed on sandstone block retaining wall

11 - Coloured concrete access pathway with steps and tactile surface indicators along pedestrian desire line improving accessibility to existing shelters and swimming area

12 - Tactile surface indicators placed at the top and bottom of existing deck steps for improved accessibility

13 - Planted native bush regeneration works including 75L pot sized endemic ‘Black Butt’ shade tree planting

14 - Water refill station and outdoor shower

15 - Improved access with widened decomposed granite pathway

16 - Informal crushed sandstone pathway and swimming area maintenance access

17 - Sandstone block bench seating rest spots

APPENDIX B

Geotechnical Investigation Report

GBG Group 2023

GBG Australia Pty Ltd
28/7 Salisbury Road,
Castle Hill, NSW. 2154.
Tel: (02) 9890 2122. Fax: (02) 9890 2922.
E-Mail: info@gbgoz.com.au
ABN 77 009 550 869

Report

LAKE PARRAMATTA - SWIMMING AREA GEOTECHNICAL INVESTIGATION REPORT

Date: 1 March 2023

Job Number: GBGA2603

SHALLOW

GEOPHYSICAL

INVESTIGATIONS

DETAILS

Project Number:	GBGA2603
Document Title:	Lake Parramatta Swimming Area Geotechnical Report
Site Address:	Lake Parramatta, Parramatta, NSW
Client Details:	John Graham Senior Landscape Architect City of Parramatta Council
Client Address:	316 Victoria Rd Rydalmere NSW 2116
Contact Information:	Tel: 02 9806 8223 Email: JGraham@cityofparramatta.nsw.gov.au

DOCUMENT HISTORY

Revision	Prepared by	Reviewed by	Date issued
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Final	Taylor Willick & Daniel Lee	Simon Williams	01/03/2023
2			
3			

DISTRIBUTION

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Final	1	0	John Graham, City of Parramatta Council	01/03/2023
2				
3				

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Appendix A: Bathymetry and Geophysical profile drawings

Appendix B: JK Geotechnical Investigation report including borehole logs and laboratory results

1 INTRODUCTION

At the request of City of Parramatta Council, GBG Australia Pty Ltd (part of GBG Group) carried out a geophysical and geotechnical investigation at Lake Parramatta. GBG engaged JK Geotechnics for the geotechnical works.

The investigation will provide information to facilitate the design for upgraded swimming area access improvements at the Lake.

The investigation comprised of:

- Land boreholes
- Grab samples of the lakebed sediments
- Single beam echo sounder bathymetry
- Static Marine Seismic Refraction

This report presents the findings.

2 GEOPHYSICAL INVESTIGATION SITE

The investigation area is pictured in figure 1 below.

Figure 1. Lake Parramatta investigation area (white polygon). The doted area within the white polygon represents the swimming area boundary. Image courtesy of SixMaps.

2.1.1 Location and Positioning

All GNSS data presented in this report is given in MGA2020 zone 56 (GDA2020) and AHD (AusGeoid2020). The coordinates were measured using an Emlid Reach RS2 or Trimble R10 multi-band, RTK-enabled GNSS receiver. RTK corrections were streamed from the closest AUSCORS reference station. The recorded horizontal and vertical RMS errors were 0.016 m and 0.016 m respectively Tables 1 and 2 summarise the coordinates of the measured lines.

The location of each test is summarised in table 1. BH = Borehole, GS = Grab Sample.

Table 1: Test Locations.

Point	Easting (m)	Northing (m)
Line 1: Start	315540.37	6259332.24
Line 1: End	315560.13	6259291.60
Line 2: Start	315569.84	6259344.17
Line 2: End	315564.11	6259298.62
Line 3: Start	315595.54	6259322.34
Line 3: End	315565.87	6259288.70
BH_1	315559.32	6259293.18
BH_2	315564.25	6259299.03
BH_3	315569.93	6259287.38
GS_4	315571.92	6259343.03
GS_5	315565.59	6259323.07
GS_6	315544.52	6259332.82
GS_7	315549.65	6259319.11
GS_8	315536.12	6259319.92
GS_9	315537.25	6259306.33

3 DATA ACQUISITION

The scope comprised of both geotechnical and geophysical investigations.

The geotechnical works were carried out over 2 days on 5th and 6th of December 2022.

The geophysical works were carried out over 2 days on the 5th and 13th of December 2022.

3.1 GEOPHYSICAL

3.1.1 Bathymetry

The Bathymetry data was acquired utilising a CEE HydroSystems CEESCOPE and dual frequency transducer. Positional information was obtained using a Trimble R10 directly mounted over the transducer therefore requiring no offset corrections.

The area represented by the white polygon was surveyed.

3.1.2 Marine Seismic Refraction (MSR)

Seismic refraction is a seismic method that relies on measured travel times over known distances of seismic waves generated from a seismic source. At an interface where there is a significant density contrast, the seismic wave will refract along the interface and return to the surface. The 'first arrival' time of the signal returning to the receivers (hydrophones or geophones) having travelled from the source through the sub-surface materials is picked at each receiver. Given the known distance from the source to the receivers and the arrival time of the returning signal, a velocity can be calculated. Seismic refraction measures compressional wave (P-wave) velocity. This process is repeated across multiple shot locations allowing for a P-wave velocity distribution profile of varying sub-surface layers (refractors) to be resolved.

For this investigation, some hydrophones were changed to geophones to allow for the 'transition zone' from the lake to land to be covered. This enabled the end of each MSR line to connect with the nearest geotechnical borehole. This was not possible for Line 3, and BH_3 as the borehole was drilled on an elevated rock platform which would result in an elevation profile not suitable for refraction modelling.

P wave velocity is directly relatable to material density / hardness the higher the velocity the stronger the rock is. Velocities above 1500mS in sandstone are the point at which sediments would move into slightly weathered sandstone. Transiting into medium to hard sandstone with velocities up to 2000mS.

The equipment utilised is summarised below:

- The receiving array was a 24 channel, 2 m spaced receiver array (46 m). This array length was the longest practical length that could be utilised on site. The length of the array is related to the maximum achievable depth of the method and was selected to increase the likelihood of capturing the bedrock refractor.
- Two seismic sources were utilised. The marine seismic source was a 20 cubic inch Bolt Airgun which uses compressed nitrogen that is released from a chamber by a solenoid-activated piston. The land seismic source was a sledgehammer impacting a metal plate.
- Geometrics Geode digital seismograph
- RTK GNSS
- Airgun source triggering system
- Panasonic Toughbook
- 1 vessel

- GISCO radio wireless triggering system.

The alignments were chosen based on the borehole locations. The land component of the array was first laid out. The remainder of the array was then laid out from the boat with a float then attached to the last hydrophone in the water to denote its location (also for retrieval). Hydrophones that were on the land were then substituted for spiked geophones. The seismic array therefore comprised of a combination of geophones and hydrophones.

The receiving equipment was setup on the land side. The airgun was setup on the small boat. Figure 2 shows the land equipment setup on the east side. The boat is moving into position for the first air gun shot.

Figure 2. MSR setup for Line 2. Picture taken from seismograph operator looking out towards air gun operators. Note the orange polyline representing the seismic array.

Seismic shots were then taken in the water, with the air gun lowered to the seabed and fired. The source firing is triggered and simultaneously, utilising the wireless trigger system, triggers the recording equipment close to zero time of the energy pulse. A GPS location was taken of the shot position for positioning during processing. This was repeated until the water was too shallow. At this point, land shots were completed as close to the waterline as practicable. This was repeated moving inland at suitable increments measured using a tape that was laid along the alignment.

4 DATA PROCESSING AND ANALYSIS

4.1 GEOPHYSICAL

4.1.1 Bathymetry

Bathymetry data was processed in CEEDATA to output an Isopach contour plan of depth in metres from AHD. No processing was required other than assessing positioning and height as part of the QA process. Corrections to AHD were undertaken during data collection using the Z axis output from the RTK corrected GNSS navigation stream.

4.1.2 MSR

Overall, the data quality of the MSR data was good determined by the ability to resolve first arrivals on all channels for each shot location. This included land based offset shots.

The following processing steps were applied during processing:

- The acquired GPS information for shot locations was used to calculate distances between shot points for each line.
- Utilising Rayfract 3.35 (Intelligent Resources Inc.), spreads and shot geometry were transformed into an HDR file. The HDR file enables unique geometry to be input in a batch process and assigned to each file.
- First arrivals for each file were then picked.
- As the method was surface towed, no elevation was input into the software prior to modelling. The resulting profile from the software is vertically shifted up or down to account for tide. A ‘Blanking file’ (.bln) in Surfer 22 (Golden Software 2021) is created from the SBES grid having been ‘sliced’ along the MSR line. The original resulting output from Rayfract is then ‘blanked’ to remove the water column and present data below the seabed.
- An initial layer model is generated from the picked data in Rayfract 3.35. This starting model is then utilised for Wavefront Eikonal Tomographic (WET) modelling which produces the grid files.
- Grid files are then imported into Surfer 22 for presentation.

5 RESULTS AND INTERPRETATION

The results of the geophysical investigation carried out for Paramatta Council have been provided in the following drawings attached in Appendix A of this report:

- GBGA2603-01 – Sitemap
- GBGA2603-02 - Bathymetry
- GBGA2603-03 – MSR Line 1
- GBGA2603-04 - MSR Line 2
- GBGA2603-05 - MSR Line 3

Drawing GBGA2603-01 (01) presents the site plan with cyan lines indicating the extents of the MSR profiles. Line chainage labels have been added to the start and end of each traverse to denote the length and orientation.

GBGA2603-02 displays the collected bathymetry of the area and is displayed in m AHD.

The remainder of the drawings display each MSR line respectively.

Boreholes have been added to the drawings where applicable, to aid in correlation with the geophysics. This allows for a simplified geological interpretation to be made on each MSR line. Appendix B of this report contains the Geotechnical report from J & K geotechnics who undertook the three land boreholes and some sediment sampling and probing in the lake.

5.1 Bathymetry

The bathymetry collected shows a reasonably steep slope running north off the point to a channel that is 7m deep. The North-western side of the point has a more gradual slope than the Eastern side which may have some bearing on the containment design for the proposed beach extension.

5.2 MSR

For each MSR drawing, two sections are displayed. All MSR lines have been corrected to the bathymetry data as well as land based topographic survey. The top section is the p-wave velocity distribution. The lower section is the simplified geological interpretation and is based on correlation with the boreholes. The geological interpretation is separated into three layers, the Fill layer 1 having velocities less than 1000m/s, extremely weathered sandstone as layer 2 with 1000-1500m/s, and slightly to low weathered sandstone as layer 3 with velocity values greater than 1500m/s.

The current beach material is clearly visible in the collected velocity profiles and appears to cover an area between 18 and 40m along the profiles (profile zero point is offshore). The effect of the sand beach material is to create a large low velocity zone that influences the depth to the harder material beneath it. The velocity zone appears to be 4 to 5m deep but in reality it is likely to be between 2 to 3m thick. This is just an anomaly caused by the software

and the physics where the presence of a thickish layer of soft material siting in a sloping profile with harder materials at either end of the profile.

The profiles actually align well with the results from the boreholes showing how the sandstone bedrock extends out into the lake. The typical incised creek topography in Hawksbury sandstone in the Sydney basin consists of ledges / platforms and then a step down or cliff drop to another ledge. This would appear to be the subsurface profile under the beach material and lake bed. The information gathered suggests that other than where the imported beach materials are there is minimal sediment build up on the lake floor with approximately 1m of weaker, weathered sandstone before higher strength material is encountered.

6 CONCLUSIONS

At the request of City of Parramatta Council, GBG Australia Pty Ltd (part of GBG Group) carried out a geophysical and geotechnical investigation at Lake Parramatta. GBG engaged JK Geotechnics for the geotechnical works.

The two reports are combined, and the geophysics and bathymetry complement the geotechnical report in that the refraction profiles confirm that reasonably hard sandstone bedrock is present under a thin layer of lake bed sediments and weaker weathered sandstone. And that the topography of the rock would appear to consist of steps and ledges or platforms dropping 7m from the water level to the creek north of the point. The ledges appear wider on the western side of the point which, from a geomorphic point of view makes sense, as this is the side where least erosion would have occurred as the creek was cut by water flow from east to west.

The stepper eastern side of the point may require more preparation to create a stable footing for any bund wall design if using blocks or large boulders to create the wall.

For and on behalf of

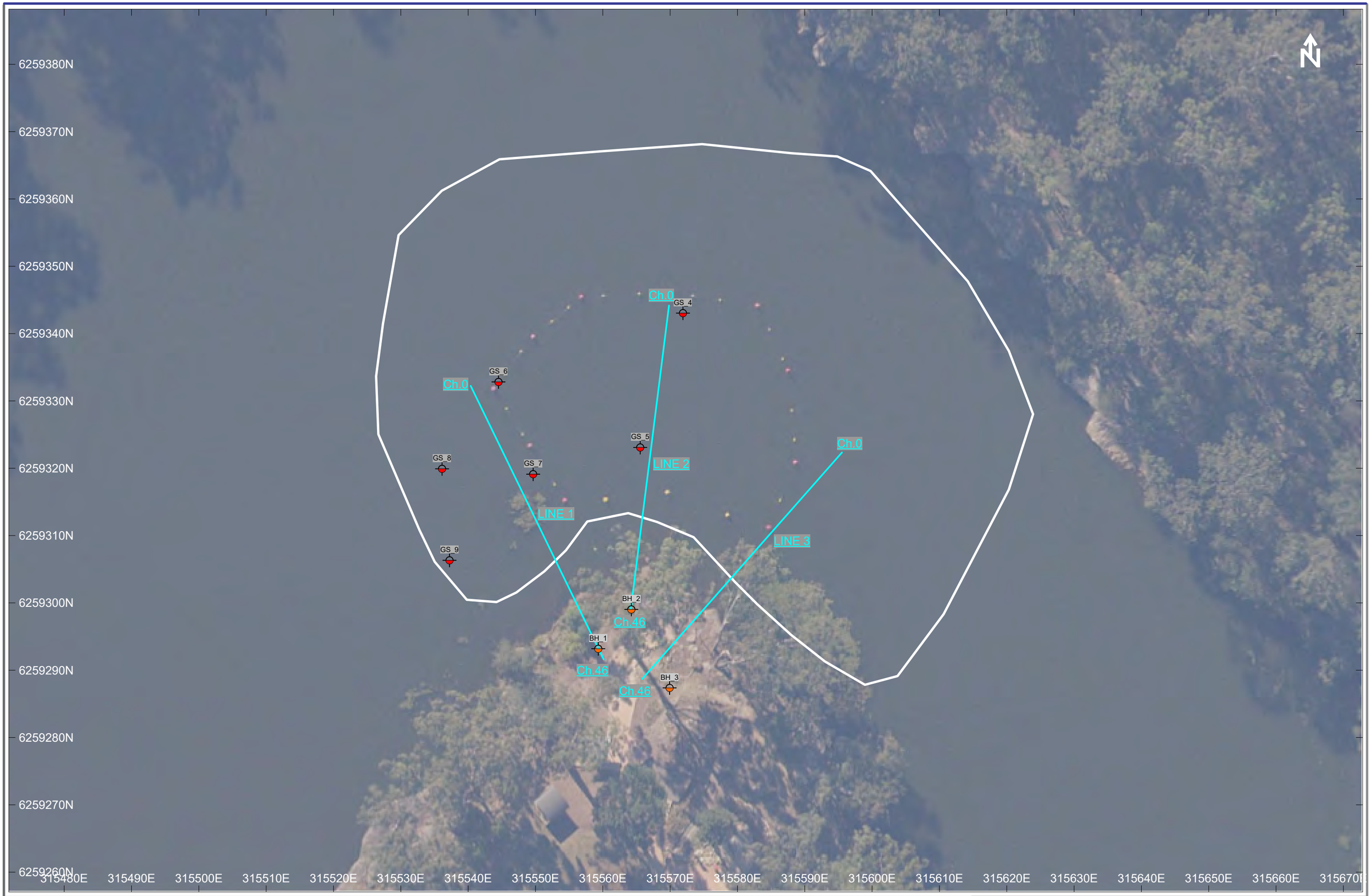
GBG Australia

Daniel Lee. B.Sc. Geophysics & Geology

Geophysicist

APPENDIX A. Drawings from Geophysical Investigation

APPENDIX B: JK Geotechnical investigation report



LEGEND:

- Geotechnical Borehole
- Grab Sample (Lakebed)
- MSR Line
- Survey Area Boundary
- Ch.0 Chainage Label (m)

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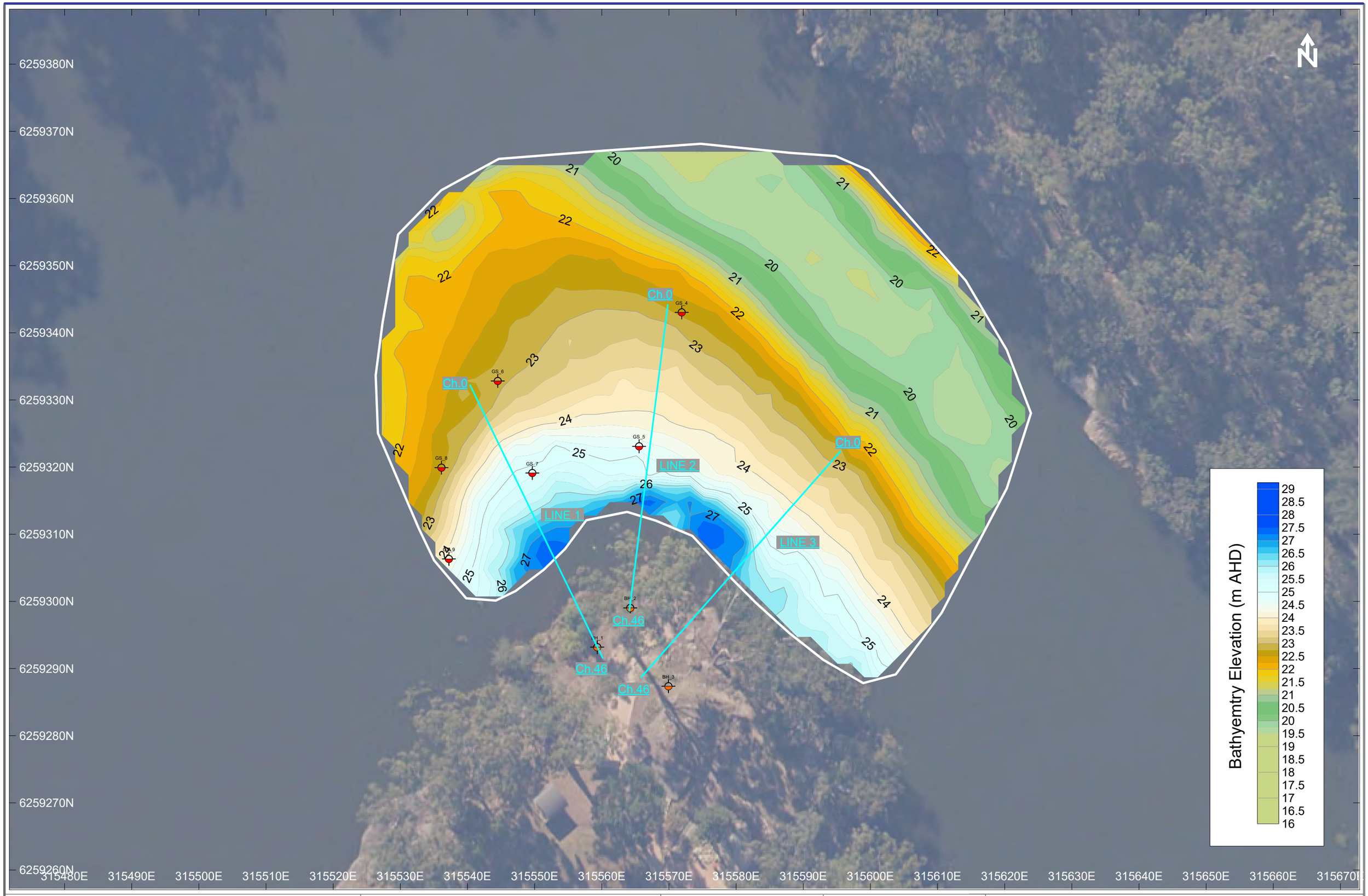
GBG Australia Pty. Ltd.
28/7 Salisbury Road,
Castle Hill, NSW 2154
Telephone: (02) 9890 2122
Email: info@gbgoz.com.au



LEGEND:

- Geotechnical Borehole
- Grab Sample (Lakebed)
- MSR Line
- Survey Area Boundary

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GBG Australia Pty. Ltd.
28/7 Salisbury Road,
Castle Hill, NSW 2154
Telephone: (02) 9890 2122
Email: info@gbgoz.com.au

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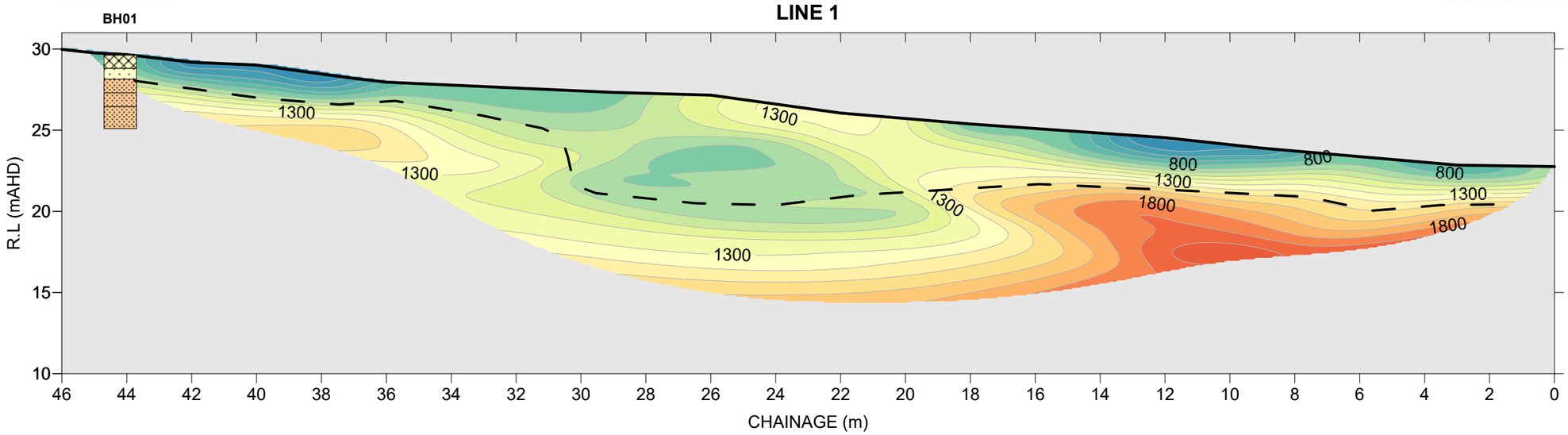
6259291.597N

N
315540.3763E
6259332.235N

LINE 1



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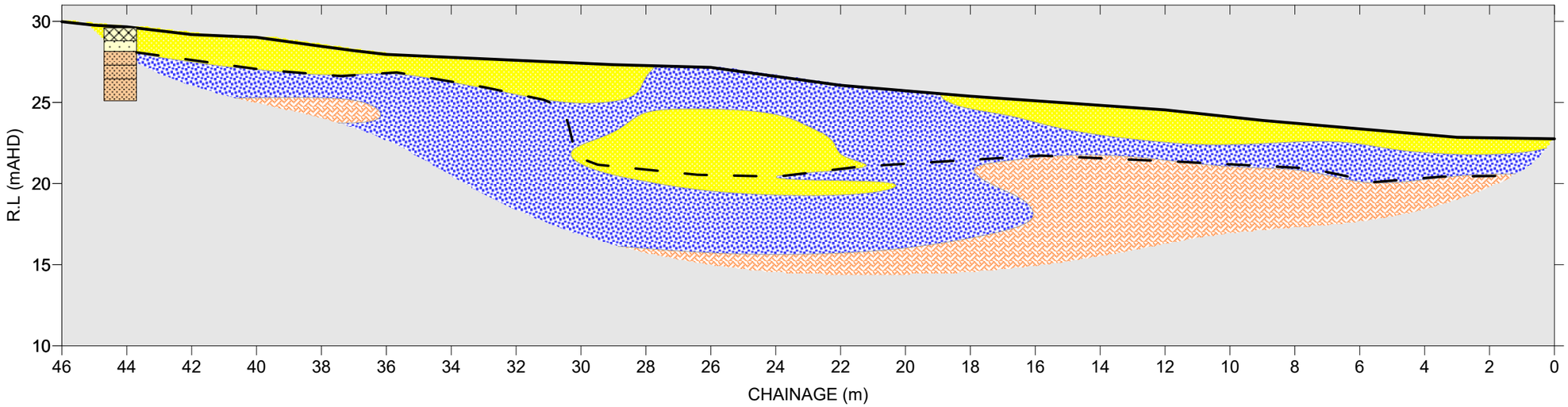

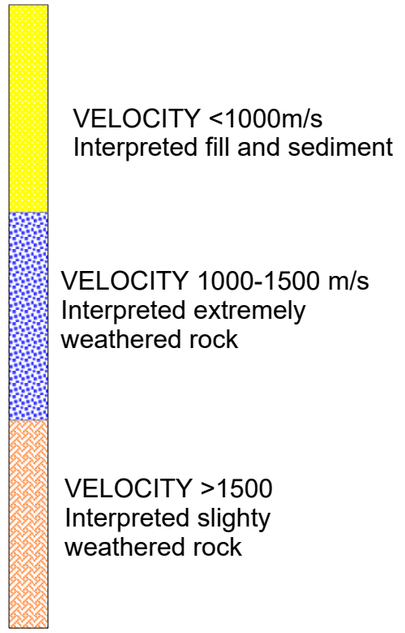

SIMPLIFIED BOREHOLE LITHOLOGY

- FILL: Silty sand, concrete fragments and root fibres.
- SANDSTONE: (Augered) Extremely weathered sandstone, clayey sand.
- SANDSTONE: (Cored) Moderately to Slightly Weathered Sandstone.

LEGEND:
= INTERPERETED ROCK BOUNDARY

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GBG Australia Pty. Ltd.
28/7 Salisbury Road,
Castle Hill, NSW 2154
Telephone: (02) 9890 2122
Email: info@gbgoz.com.au

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N
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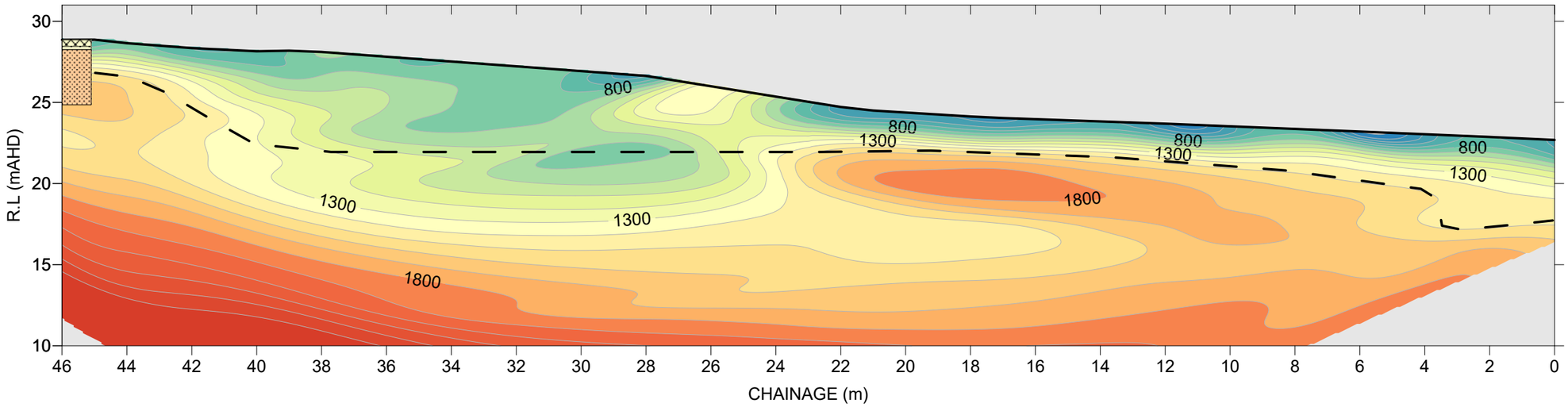
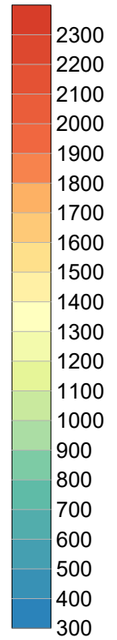
BH02

LINE 2





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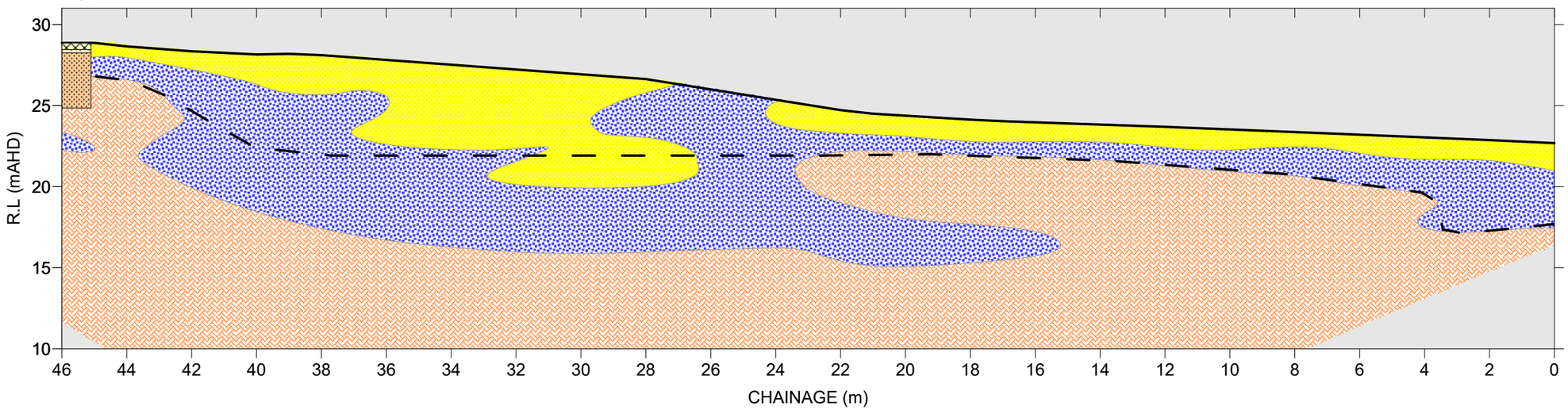

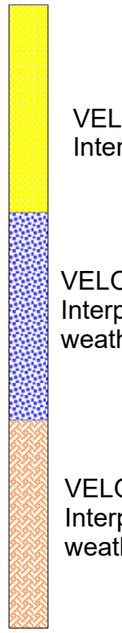

SIMPLIFIED BOREHOLE LITHOLOGY

- FILL: Silty sand, concrete fragments and root fibres.
- SANDSTONE: (Augered) Extremely weathered sandstone, clayey sand.
- SANDSTONE: (Cored) Moderately to Slightly Weathered Sandstone.

LEGEND:

= INTERPERETED ROCK BOUNDARY

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GBG Australia Pty. Ltd.
28/7 Salisbury Road,
Castle Hill, NSW 2154
Telephone: (02) 9890 2122
Email: info@gbgoz.com.au

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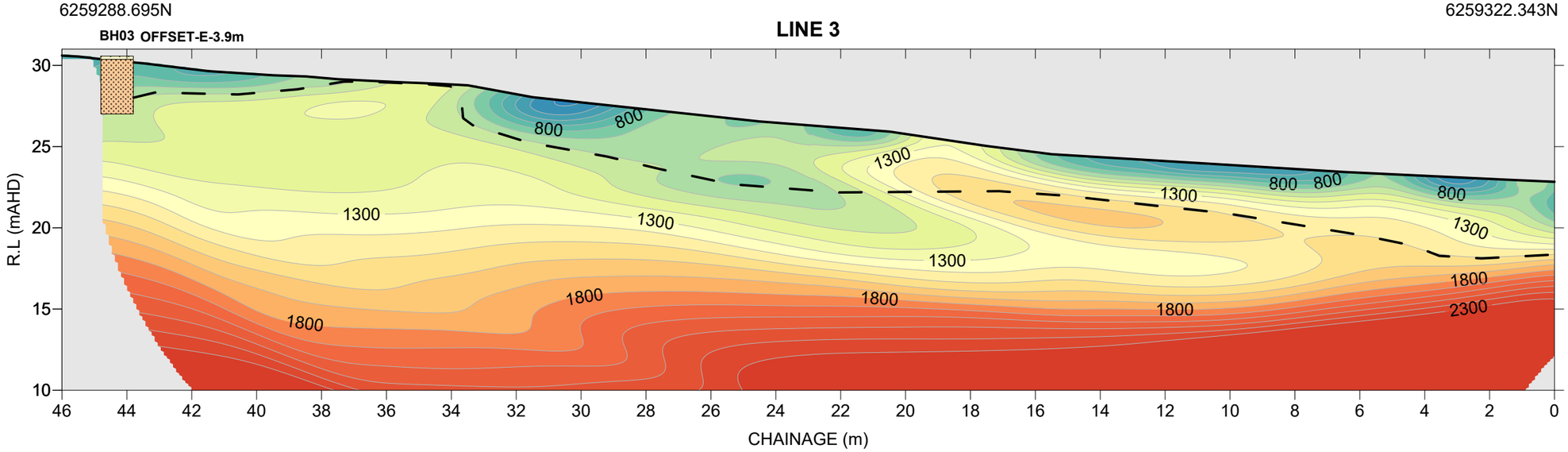

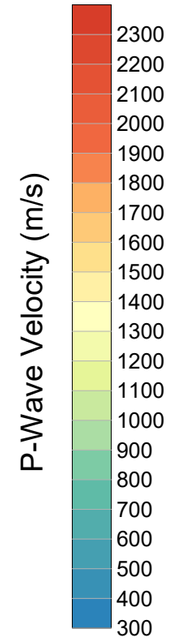

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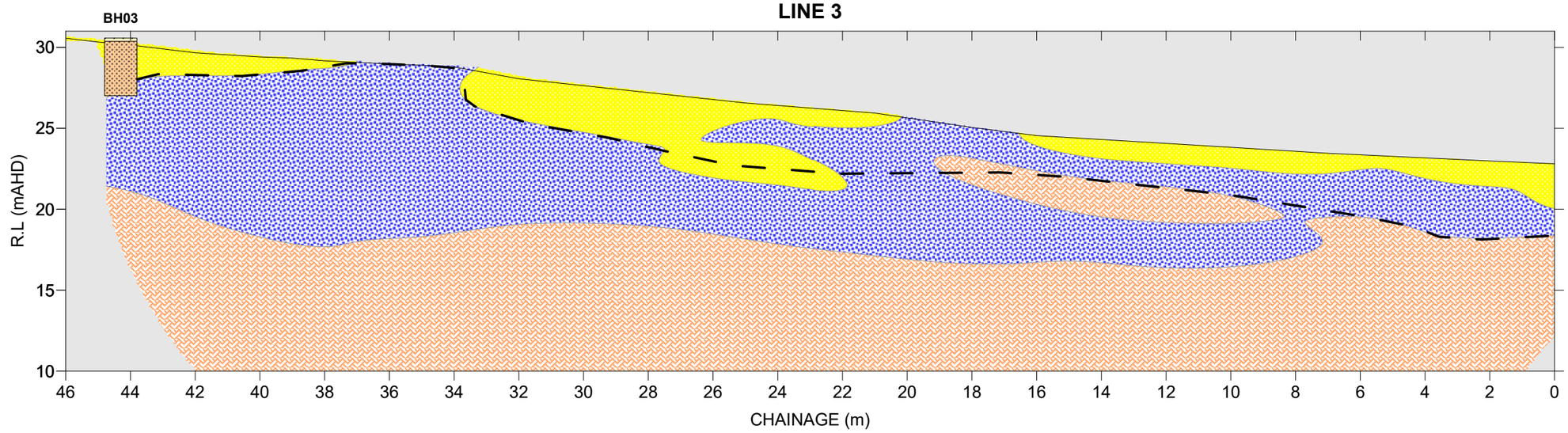
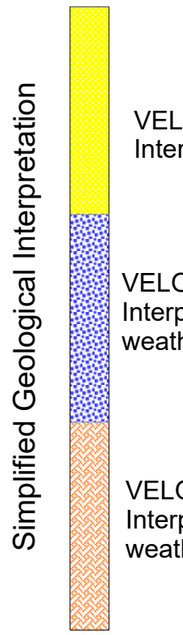
6259288.695N

N
315595.5284E
6259322.343N

LINE 3





SIMPLIFIED BOREHOLE LITHOLOGY

- FILL: Silty sand, concrete fragments and root fibres.
- SANDSTONE: (Augered) Extremely weathered sandstone, clayey sand.
- SANDSTONE: (Cored) Moderately to Slightly Weathered Sandstone.

LEGEND:
= INTERPERETED ROCK BOUNDARY

CLIENT: CITY OF PARRAMATTA COUNCIL		DATE: 01/03/23	DATUM: GDA2020 MGA56
TITLE: LAKE PARRAMATTA SWIMMING AREA GEOTECHNICAL INVESTIGATION - LINE 3		SCALE: 1:150	DRAWN: DL
		DRG No: GBGA2603_05	REV: 0

GBG Australia Pty. Ltd.
28/7 Salisbury Road,
Castle Hill, NSW 2154
Telephone: (02) 9890 2122
Email: info@gbgoz.com.au

REPORT TO

GBG GROUP PTY LTD

ON

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED LAKE PARRAMATTA SWIMMING AREA UPGRADE

AT

LAKE PARRAMATTA RESERVE,
NORTH PARAMATTA, NSW

Date: 22 February 2023
Ref: 35624SDrpt

JKGeotechnics
www.jkgeotechnics.com.au

T: +61 2 9888 5000
JK Geotechnics Pty Ltd
ABN 17 003 550 801

Report prepared by:

David Schwarzer
Associate | Geotechnical Engineer

Report reviewed by:

Paul Stubbs
Principal Consultant| Geotechnical Engineer

For and on behalf of
JK GEOTECHNICS
PO BOX 976
NORTH RYDE BC NSW 1670

DOCUMENT REVISION RECORD

Report Reference	Report Status	Report Date
35624SDrpt	Final Report	22 February 2023

Table of Contents

ATTACHMENTS

1 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed Lake Parramatta swimming area upgrade at Lake Parramatta Reserve, North Parramatta, NSW. The location of the site is shown in Figure 1. The investigation was commissioned by Simon Williams of GBG Group Pty Ltd by email dated 9 November 2022. The commission was on the basis of our fee proposal (Ref: P57551XD) dated 24 October 2022.

We have been provided with an unreferenced request for quotation (RFQ) prepare by John Graham of City of Parramatta and a Lake Parramatta swimming area concept design report, dated 20 August 2021, prepared by NewScape Design. We have also been provided with a bathymetry plan (Drawing No. GBGA2603_02, Revision 0, dated 30 January 2023) prepared by GBG Group.

Based on the provided information and our site meeting with representatives from NewScape Design and GBG Group on 15 November 2022, we understand that the proposed upgrade to the swimming area at Lake Parramatta will include the following:

- Construction of an artificial beach extending approximately 12m beyond the existing water's edge. The perimeter of the proposed beach will require the construction of underwater retaining walls which would be backfilled to raise the lakebed in this area. The graded shallow beach platform will be sloping down to the north-west at 1 Vertical (V) in 8 Horizontal (H), with an approximate maximum depth of about 1.5m below the water surface level. The outside edge of these retaining walls is to be graded downward to form a gradually decent into the deeper water beyond the beach.
- Installation of an over-water pontoon within the deeper water beyond the beach. The pontoon would be supported horizontally by two pylons at the longitudinal ends founded in the lakebed.
- Onshore, a paved area adjacent to the beach, bench seating and shaded canopies are proposed. Minor excavation to maximum depth of about 1m has been assumed.

The purpose of the investigation was to obtain geotechnical information on the subsurface conditions, and to use this as a basis for providing comments and recommendations on excavation conditions, excavation support, retaining wall options and design parameters, and footings.

2 INVESTIGATION PROCEDURE

Fieldwork for the investigation was carried out on 5 and 6 December 2022, and comprised the drilling of three boreholes (BH1 to BH3) to depth between 3.56m and 4.46m below the existing onshore surface levels using our track mounted JK205 drill rig. In addition to the onshore boreholes, six locations (BH4 to BH9) were investigated from our small boat using a 'piston sampler', which collected disturbed samples from lakebed. Each of the lakebed locations were probed with a Dynamic Cone Penetrometer (DCP) rod in an attempt to assess the depth of the lakebed sediment.

Our geotechnical engineers (Fraser Hall and Andrew Griffith) were present full-time during the fieldwork to set out the borehole locations, prepare the borehole logs, and nominate in-situ testing and sampling. The

borehole logs, which include the field test results are attached to this report, together with a set of explanatory notes, which describe the investigation techniques, and define the logging terms and symbols used.

The investigation locations are shown on the attached Figure 2 and were set out as close as practical to the nominated locations in the City of Parramatta RFQ. The grid coordinates (to MGA) and surface RL (to the Australian Height Datum [AHD]) of each borehole location were obtained using a differential GPS unit and are shown on the borehole logs. The accuracy of the survey system is about 50mm in all directions. Figure 2 is based on the provided survey plan.

The onshore boreholes (BH1 to BH3) were initially drilled using spiral flight augers and a tungsten carbide (TC) bit until competent bedrock was encountered. Each borehole was then extended into the bedrock by rotary diamond coring techniques, using an NMLC triple tube core barrel and water flush.

The strength of the underlying bedrock encountered within the augered portion of BH1 to BH3 was assessed by observation of auger penetration resistance, and examination of the rock chips recovered from the augers.

Where the bedrock was cored, the recovered core was returned JK Geotechnics for photographing and Point Load Strength Index ($I_{S(50)}$) testing. Using established correlations, the Unconfined Compressive Strength (UCS) of the bedrock was then calculated from the $I_{S(50)}$ results. The Point Load Strength Index test results are summarised in the attached STS Table B and are also shown graphically on the borehole logs. Copies of the photographs are presented with the cored borehole logs.

Groundwater observations were made in the boreholes, during and a short time following completion of auger drilling and after core drilling. We note that water is introduced into the borehole during core drilling, and therefore the water levels after coring are likely to be artificially high.

Further details of the techniques and procedures employed in the investigation are presented in the attached Report Explanation Notes.

Soil samples from the onshore and lakebed investigations were returned to a NATA registered analytical laboratory (Envirolab Services Pty Ltd) for soil pH, chloride content, sulphate content and resistivity testing. The results are summarised in the Envirolab Services Pty Ltd Certificate of Analysis 312614 which is attached to this report.

Selected soil samples were recovered from the boreholes and submitted to a NATA registered laboratory (Soil Test Services Pty Ltd), for particle size distribution testing. The test results are summarised in attached STS Table A.

3 RESULTS OF INVESTIGATION

3.1 Site Description

Site is located on the southern bank of the Lake Paramatta, near the tip of a local peninsula feature extending south to north and sloping down towards the lake at up to about 10°.

At the time of the fieldwork the site contained concrete and sandstone steps, concrete paths and scattered shaded seating. A swimming area just off the bank was marked with roped together buoys some of which displayed the approximate depth to the lakebed.

Sandstone bedrock and boulders occupied the majority of the ground surface and lined the lakes edge. A limited thickness of surficial sandy fill cover was present in some areas. The exposed sandstone was assessed to be predominately moderately weathered and of low and medium strength. Small shrubs and medium to large size trees were located near the water's edge.

3.2 Subsurface Conditions

The 1:100,000 geological map of Sydney indicates that the site is underlain by Hawkesbury Sandstone. The boreholes disclosed a generalised subsurface profile comprising sandy fill over weathered sandstone bedrock at shallow depth. A summary of some of the more pertinent subsurface conditions is outlined below.

Pavement

50mm thick concrete pavement was encounter at the surface of BH3.

Fill

Silty sand fill was encountered from the surface in BH1 and BH2 and extended to depths of about 0.8m and 0.4m, respectively. An approximately 0.4m thick sandstone boulder was encountered within the fill profile in BH1. Inclusions comprising sandstone and igneous gravel, concrete fragments and root fibres were present in the fill profile.

Lakebed Sediment

The lakebed sediments comprising high plasticity silty clay were encountered in the disturbed samples collected from BH4 to BH9. The silty clay sediment extended to the piston sampler refusal depths ranging between about 0.05m (BH7) and 0.4m (BH4 and BH9) below the lakebed surface. Probing of the lakebed using a DCP rod refused at similar depths.

Sandstone Bedrock

Weathered sandstone bedrock was encountered beneath the fill in BH1 and BH2 and directly underlying the concrete pavement in BH3. The sandstone bedrock extended to the borehole termination depths between 3.56m (BH3) and 4.46m (BH1). The majority of the sandstone bedrock was assessed to be distinctly to slightly weathered and of low to high strength, with occasional bands of extremely and highly weathered bedrock of

very low and lesser strength. Significant sandstone outcrops were present at the surface adjacent to the boreholes and were assessed to be predominately moderately weathered and of low and medium strength.

The bedrock contained numerous defects which were generally widely spaced with some defect clusters which were closely spaced within the upper portion of BH1 and towards the base of BH2. The defects comprised extremely weathered seams and clay seams, bedding partings and inclined (45° to 85°) joints.

Inferred Sandstone Bedrock

The refusal of the piston sampler and DCP probe investigations carried out from our boat may have occurred on the surface of weathered bedrock. However, as these tests cannot penetrate the bedrock and refusal may occur on other hard layers within the sediment, this could not be confirmed.

Groundwater

No groundwater was encountered during auger drilling. The water level in BH1 to BH3 on completion of coring was recorded on the attached borehole logs but in considered to be artificially high as a result of water being used in the coring process. No long-term groundwater monitoring was carried out.

3.3 Laboratory Test Results

The results of the laboratory particle size distribution tests confirmed our field classification of the soils.

The results of the point load strength test carried out on the recovered rock cores correlated well with our field assessment of rock strength. The estimated UCS's, based on the correlation provided in AS1726:2017 'Geotechnical Site Investigations' (ie. UCS = 20 x $IS_{(50)}$), was mostly between 14MPa and 24MPa with a couple of lower values at the top of BH1 and around 1.3m depth in BH3, and higher strengths up to 42MPa below 3.25m in BH1.

The soil aggression test results presented in the attached Envirolab Services Certificate of Analysis No. 312614, show a moderately acidic soils (pH of 6.2 and 6.6) to highly alkaline soils (pH of 11.1), very low sulfate contents (less than or equal to 120mg/kg) and chloride contents (less than or equal to 98mg/kg). Relatively high resistivity was measured (ranging between 2,000ohm.cm and 21,000ohm.cm).

4 COMMENTS AND RECOMMENDATIONS

4.1 Geotechnical Issues

- The construction of the proposed beach will raise the lakebed in this area and will influence the hydrology of the lake. We recommend that advice on the impacted of the altered lake hydrology be sought from a coastal engineer prior to finalising the design.
- The outer perimeter of the retaining walls supporting the beach are potentially a diving hazard. We recommend that directly following construction professional scuba divers check the perimeter outside

the retaining walls for hazards and appropriate warnings be signposted around the outer edge of the proposed beach.

- Based on the results of our investigation and with reference to the provided bathymetry plan the retaining walls around the perimeter of the proposed beach will need to retain a maximum backfilled height of about 2m. The retaining walls supporting the proposed beach will likely need to be constructed underwater, as such, we consider the most suitable retaining walls to comprise mass gravity boulder walls and mass gravity concrete block walls. The lakebed slopes down at a maximum of about 18° within the footprint of the proposed beach, steepest towards the north-eastern and north-western corners.

4.2 Excavation

4.2.1 Site Preparation

On-shore site preparation will require stripping of vegetation and topsoil. Following this, any obvious deleterious or contaminated existing fill should be removed. These stripped materials should be taken offsite as they are not suitable for reuse as engineered fill. The topsoil may, however, be separately stockpiled and used for subsequent landscaping purposes. Soil deemed to be unsuitable due to contamination (if any) should be treated or disposed of in the appropriate manner; refer to Section 5 of this report for comments regarding the assessment of soil for disposal.

4.2.2 Excavation Conditions

The excavation recommendations provided below should be complemented by reference to the NSW Government "Code of Practice 'Excavation Work", dated January 2020.

Based on the results of our investigation and assuming a maximum excavation depth of 1m, excavation for the proposed upgrade works will extend through the shallow fill profile and penetrate the underlying sandstone bedrock. While a limited thickness of very low or lesser strength bedrock may be encountered, the majority of the rock excavation is expected to be in bedrock of low to medium and higher strength.

The soil cover should be readily excavated using the bucket attachment on a conventional hydraulic excavator. Some of the underlying weathered sandstone of very low or lesser strength, if encountered, may also be excavated by bucket, possibly with some ripping. However, we expect excavation of low and higher strength sandstone would be most effectively excavated using hydraulic impact rock hammers and rock saws fitted to hydraulic excavators. This equipment would also be required for breaking up boulders or blocks, for trimming rock excavation faces and for detailed rock excavations such as for footings or buried services.

4.2.3 Excavation Support

Temporary batter slopes no steeper than 1 Vertical (V) in 1.5 Horizontal (H) through the soil profile and 1V:1H in the extremely weathered bedrock profile (if encountered) are considered to be appropriate. Based on our inspection of the site topography, the expected shallow soil cover and the assumed maximum 1m depth of

excavation, we expect the above temporary batter slopes should be able to be accommodated at the site. Surcharge loads from plant and equipment must be kept well away from the crest of the batters.

Some instability of temporary sand batters may occur at, or below, the level of any groundwater seepage, especially after rain periods, and sand bagging may be required to stabilise the batter should this occur. Conventional retaining walls may be constructed at the base of the batters and subsequently backfilled.

We expect that good quality sandstone of low or higher strength may be cut vertically. However, locally flatter batters may be necessary if adverse defects such as inclined joints or bedding are found. Clay seams occurring in permanently exposed sandstone slopes may also require localised removal and replacement with non-shrink cementitious mortar with weep holes. We therefore recommend that any rock faces should be inspected by a geotechnical engineer at bulk excavation level to identify adverse defects and to propose appropriate stabilisation measures.

4.2.4 Groundwater Seepage

Groundwater inflow may occur within the excavations, particularly after periods of heavy rain, within the sandy soil profile close to, or at, the contact with the underlying bedrock. We expect the inflows to be of small volume and managed by gravity drainage.

4.3 Retaining Walls

4.3.5 Onshore Retaining Walls

The onshore retaining walls are expected to comprise conventional cantilever walls founded in or on the underlying bedrock and supporting the soil and bedrock profiles.

Conventional free-standing cantilever walls which support areas where movement is not of concern (ie. landscape walls), may be designed using a triangular lateral earth pressure distribution with an 'active' earth pressure coefficient, Ka, of 0.35, for the soil profile, assuming a horizontal retained surface.

Cantilever walls which support movement sensitive elements, should be designed using a triangular lateral earth pressure distribution and an 'at rest' earth pressure coefficient, K_o, of 0.6, for the soil profile, assuming a horizontal retained surface.

A bulk unit weight of 20kN/m^3 for the soil profile and 22kN/m^3 for weathered bedrock of very low or lesser strength (if encountered) should be adopted.

All surcharge loads affecting the walls (eg. adjacent high level footings, construction loads, sloping retained surfaces etc) should be taken into account in the wall design using the appropriate earth pressure coefficient from above.

Retaining walls should be designed as drained and measures taken to provide permanent and effective drainage of the ground behind the walls. The drains must incorporate a non-woven geotextile fabric (eg. Bidim A34) to act as a filter against subsoil erosion.

For lateral toe restraint, retaining walls should be keyed or socketed into the sandstone bedrock below bulk excavation level. An allowable lateral stress 200kPa should be adopted for socket or key depth design.

4.4 Artificial Beach Walls

From the concept design, the results of our investigation and taking into account the sloping lakebed. we consider suitable methods for construction of the artificial beach is to place perimeter mass gravity boulder or concrete block retaining walls built up to a maximum height of about 2m above the lakebed and backfilling with imported sand. The internal sides of the retaining walls must be lined with a permeable non-woven geotextile such as 'Texcel' to restrict the migration of the imported sand into voids in the retaining walls while remaining permeable to the water movement.

Construction of a mass gravity sandstone or concrete block or boulder retaining wall would likely require some lakebed, excavation to remove the soft clay sediment layer so that the blocks sit directly on the bedrock. The placement of the sandstone or concrete blocks (depending on the type and size) could be carried out by a long arm excavator. Alternatively, a mobile crane and clamshell bucket setup adjacent to the shore could be considered.

The geotextile can be secured in place by embedding under the final layer of blocks at the crest.

Alternative retaining wall types such as contiguous pile wall, sandbag walls etc were disregarded as they were deemed, too expensive or to have limited durability in the expected environment and usage.

Mass Gravity Walls

Based on the above, we consider mass gravity boulder walls constructed around the perimeter of the proposed artificial beach to be the most suitable solution to retain the raised lakebed. The boulder walls should be constructed following stripping of the soft clay sediment from the lakebed. Once the basal layers of rock have been placed the walls should be formed with battered side slopes no steeper than 1.5V:1H and a minimum 1m wide level bench at the crest. The geotextile 'Texcel' should be placed to cover the internal face of the wall and extending about 1m along the lakebed from the base of the wall. The top of the geotextile should be tied into the crest of the wall below the final layer of blocks or layer of sand. Overlap widths between adjacent sheets of the geotextile should be as per the supplier's specification. A layer of blocks may be required at the base of the internal walls and on top of the geotextile to hold it in place while the beach is being backfilled. Care must be taken to maintain the geotextile rock cover and overlaps during backfilling.

A layer of sand or concrete capping could be placed over the level bench at the crest of the boulder walls as the exposed blocks are rough and could be a hazard for swimmers who stand on the crests of the walls.

We note the type of rock and block sizes to be used in the gravity wall must be recommended by a coastal engineer. The wall dimensions may need to be modified following the coastal engineers' recommendations.

Backfilling

Following construction of the mass gravity boulder walls and placement of the geotextile the artificial beach should be backfilled with imported 'beach' sand. The imported sand could be end dumped near the shore and spread out using the bucket on the long arm excavator. Care must be taken not to disturb the geotextile during spreading of the sand. As filling will be carried out underwater and beach will only be supporting pedestrian loads self-compaction/settlement of the placed backfill material is considered appropriate. Settlement of the backfilled sand is expected over time and topping up of the placed sand will be required.

4.5 Footings

4.5.1 High Level Footings

Based on the results of our investigation we consider that weathered sandstone bedrock will be present at or a shallow depth blow the proposed onshore structures, we therefore recommend that new footing for the proposed upgrade works be uniformly founded in the underlying sandstone bedrock. High level footings founded on the underlying sandstone bedrock may be designed for an allowable bearing pressure of 800kPa.

4.5.2 Pile Footings

The pylons for the proposed pontoon will need to resist lateral pressures from the flowing water in the lake, particularly during heavy rainfall periods, and will therefore need to be suitable socketed into the underlying bedrock to resist these lateral pressures. Piles for the proposed pontoon pylons socketed into the underlying bedrock below the lakebed may be designed for an allowable end bearing pressure of 800kPa, and allowable lateral stress of 200kPa.

We anticipate the proposed floating pontoon will most likely be supported by steel tube piles which are drilled into the underlying sandstone bedrock. However, depending on the depth of pile socket required into the bedrock, 'drilling out' of tube piles prior to concreting could also be considered. A specialist piling contractor with experience in installing marine piles should be consulted to assess suitable pile installation options for this project. We further expect that detail design of the piles will be on a D&C basis.

We expect that the piles for the proposed pontoons will be predominantly subjected to lateral loads, with very little, if any, vertical load on the piles. The estimated lateral loads on the piles from the flowing water in the lake must be provided by a coastal engineer.

The piling contractor must provide certification of the as-built piles. We can review the piling records if commissioned to do so.

Alternatively heavy concrete mooring blocks could be used to anchor the floating pontoon to the lakebed. This would be much quicker and more cost effective than piling. The coastal engineer could advise on the suitable block sizes.

4.6 Further Geotechnical Input

The following is a summary of the further geotechnical input which is required and which has been detailed in the preceding sections of this report:

- Coastal engineer (such as Royal Haskoning to provided recommendations on the suitable rock type, associated porosity and unit weight for the mass gravity boulder wall, an assessment of the altered lake hydrology due to construction of the proposed artificial beach and an estimate of the lateral pressure on the pontoon pylons from the flowing water in the lake.
- Topping up of the beach sand following self-compaction/settlement.
- Coastal engineer to advise on use of mooring blocks for pontoon.

5 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the design and construction phase of the project. In the event that any of the advice presented in this report is not implemented, the general recommendations may become inapplicable and JK Geotechnics accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

Occasionally, the subsurface conditions between the completed boreholes may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

A waste classification is required for any soil and/or bedrock excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), Excavated Natural Material (ENM), General Solid, Restricted Solid or Hazardous Waste. Analysis can take up to seven to ten working days to complete, therefore, an adequate allowance should be included in the construction program unless testing is completed prior to construction. If contamination is encountered, then substantial further testing (and associated delays) could be expected. We strongly recommend that this requirement is addressed prior to the commencement of excavation on site.

115 Wicks Road
Macquarie Park, NSW 2113
PO Box 976
North Ryde, Bc 1670
Telephone: 02 9888 5000
Facsimile: 02 9888 5001
Email: dtreweek@jkgroup.net.au

SOIL TEST SERVICES
ABN 43 002 145 173

TABLE A
PARTICLE SIZE DISTRIBUTION TEST REPORT

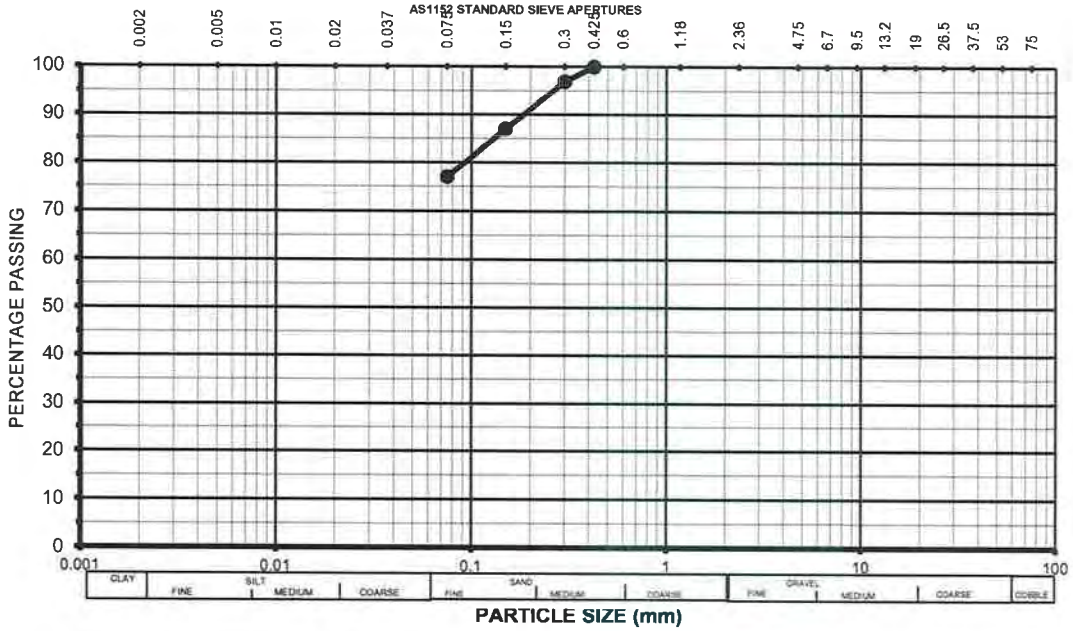
Client: JK Geotechnics
Project: Proposed Lake Parramatta Upgrade
Location: Parramatta Lake, Parramatta, NSW

Report No.: 35624XD - A
Report Date: 20/12/2022
Page 1 of 5

Borehole Number: 1
Depth (m): 0.0 - 0.4

SIEVE ANALYSIS RESULTS

SIEVE SIZE	% PASSING
425 µm	100
300 µm	97
150 µm	87
75 µm	77



Test Method: AS1289.3.6.1 & 3.6.3 Dry Sieve (washed)

- **Notes:** Sampled and supplied by client. Sample tested as received.
- Please refer to appropriate notes for soil descriptions
- Date of receipt of sample: 08/12/2022.

NATA Accredited Laboratory Number:1327

Approved Signatory / Date
(D. Treweek) 20/12/22

115 Wicks Road
Macquarie Park, NSW 2113
PO Box 976
North Ryde, Bc 1670
Telephone: 02 9888 5000
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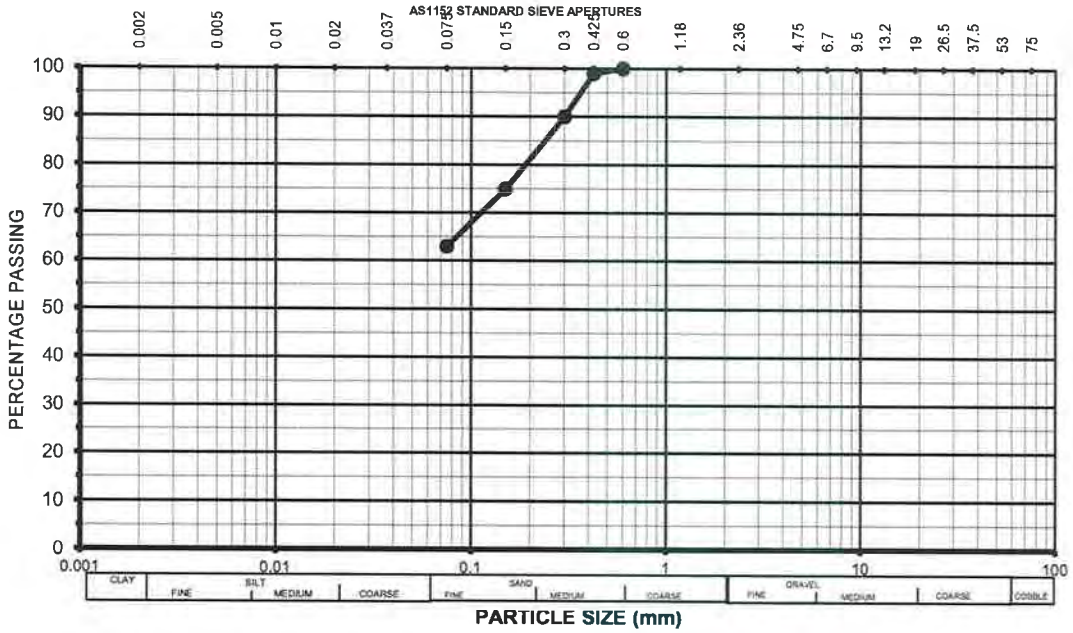
Location: Parramatta Lake, Parramatta, NSW

Report No.: 35624XD - A
Report Date: 20/12/2022
Page 2 of 5

Borehole Number: 5
Depth (m): 0.0 - 0.3

SIEVE ANALYSIS RESULTS

SIEVE SIZE	% PASSING
600 µm	100
425 µm	99
300 µm	90
150 µm	75
75 µm	63



Test Method: AS1289.3.6.1 & 3.6.3 Dry Sieve (washed)

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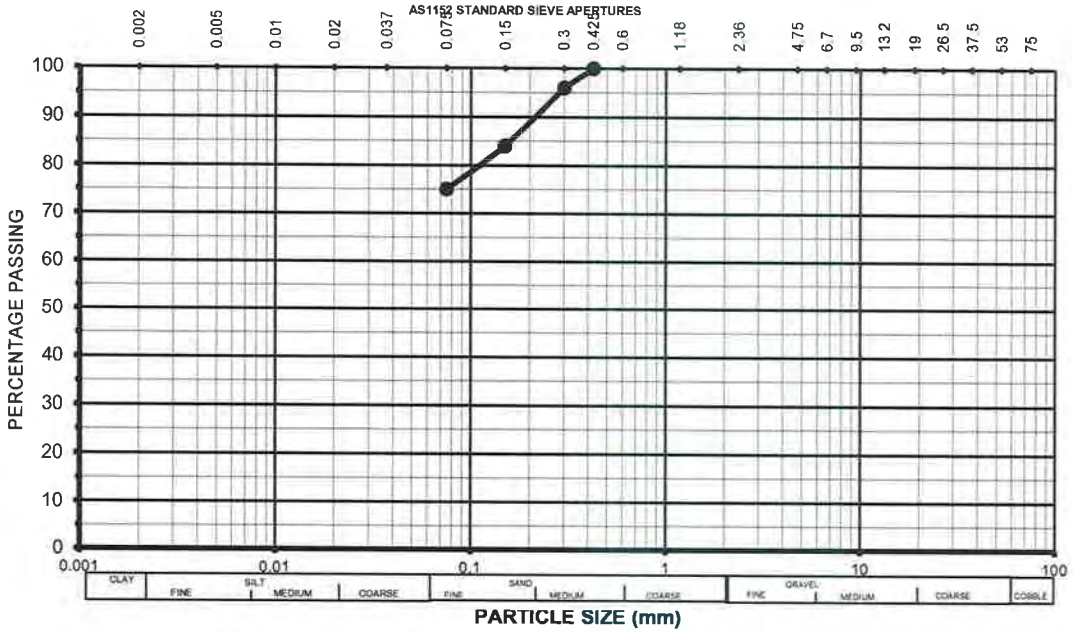
Client: JK Geotechnics
Project: Proposed Lake Parramatta Upgrade
Location: Parramatta Lake, Parramatta, NSW

Report No.: 35624XD - A
Report Date: 20/12/2022
Page 3 of 5

Borehole Number: 6
Depth (m): 0.0 - 0.3

SIEVE ANALYSIS RESULTS

SIEVE SIZE	% PASSING
425 µm	100
300 µm	96
150 µm	84
75 µm	75



Test Method: AS1289.3.6.1 & 3.6.3 Dry Sieve (washed)

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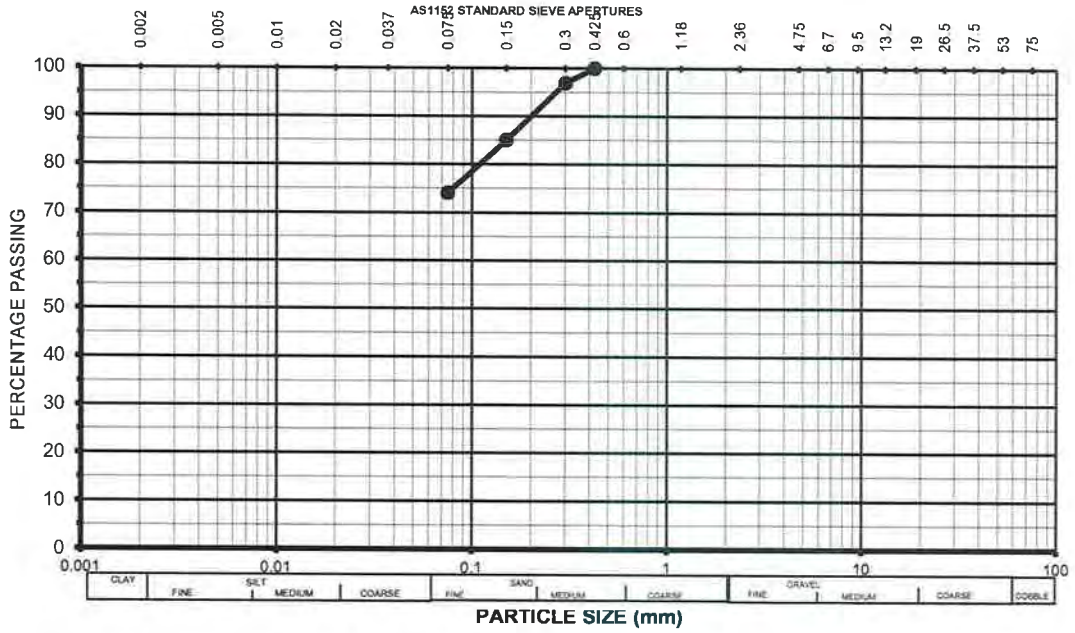
Location: Parramatta Lake, Parramatta, NSW

Report No.: 35624XD - A
Report Date: 20/12/2022
Page 4 of 5

Borehole Number: 8
Depth (m): 0.0 - 0.3

SIEVE ANALYSIS RESULTS

SIEVE SIZE	% PASSING
425 µm	100
300 µm	97
150 µm	85
75 µm	74



Test Method: AS1289.3.6.1 & 3.6.3 Dry Sieve (washed)

- **Notes:** Sampled and supplied by client. Sample tested as received.
- Please refer to appropriate notes for soil descriptions
- Date of receipt of sample: 08/12/2022.

NATA Accredited Laboratory Number:1327

Approved Signatory / Date
(D. Treweek)
20/12/22

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PARTICLE SIZE DISTRIBUTION TEST REPORT

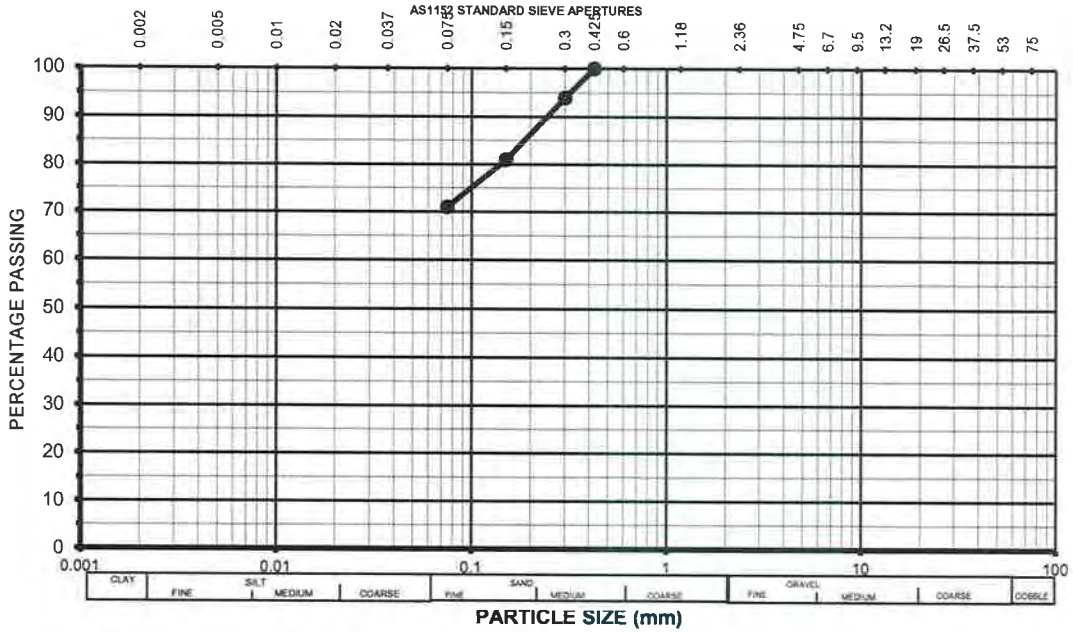
Client: JK Geotechnics
Project: Proposed Lake Parramatta Upgrade
Location: Parramatta Lake, Parramatta, NSW

Report No.: 35624XD - A
Report Date: 20/12/2022
Page 5 of 5

Borehole Number: 9
Depth (m): 0.0 - 0.4

SIEVE ANALYSIS RESULTS

SIEVE SIZE	% PASSING
425 µm	100
300 µm	94
150 µm	81
75 µm	71



Test Method: AS1289.3.6.1 & 3.6.3 Dry Sieve (washed)

- **Notes:** Sampled and supplied by client. Sample tested as received.
- Please refer to appropriate notes for soil descriptions
- Date of receipt of sample: 08/12/2022.

NATA Accredited Laboratory Number:1327

Approved Signatory / Date
(D. Treweek) 20/12/22

TABLE B
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	GBG Australia	**Ref No:**	35624XD
Project:	Proposed Lake Parramatta Upgrade	**Report:**	B
Location:	Parramatta Lake, PARRAMATTA, NSW	**Report Date:**	7/12/22

BOREHOLE NUMBER	DEPTH (m)	$I_{S\,(50)}$ (MPa)	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)	TEST DIRECTION
1	1.67 - 1.70	0.5	10	A
	2.23 - 2.27	0.2	4	A
	2.76 - 2.80	0.9	18	A
	3.25 - 3.30	2.1	42	A
	3.73 - 3.76	1	20	A
	4.30 - 4.34	1.1	22	A
2	0.63 - 0.67	1.2	24	A
	1.25 - 1.29	1.8	36	A
	1.76 - 1.80	1.6	32	A
	2.29 - 2.33	1.5	30	A
	2.79 - 2.83	1.2	24	A
	3.26 - 3.30	0.8	16	A
	3.87 - 3.91	0.8	16	A
3	0.38 - 0.41	0.7	14	A
	0.78 - 0.81	0.7	14	A
	1.10 - 1.13	0.7	14	A
	1.32 - 1.35	0.3	6	A
	1.89 - 1.92	1.2	24	A
	2.21 - 2.24	1.1	22	A
	2.75 - 2.78	0.8	16	A
	3.17 - 3.20	1	20	A
	3.46 - 3.50	1.5	30	A

NOTES

1. In the above table, testing was completed in test direction A for the axial direction, D for the diametral direction, B for the block test and L for the lump test.
2. The above strength tests were completed at the 'as received' moisture content.
3. Test Method: RMS T223.
4. For reporting purposes, the $I_{S(50)}$ has been rounded to the nearest 0.1MPa, or to one significant figure if less than 0.1MPa.
5. The estimated Unconfined Compressive Strength was calculated from the Point Load Strength Index based on the correlation provided in AS1726:2017 'Geotechnical Site Investigations' and rounded off to the nearest whole number: U.C.S. = 20 $I_{S(50)}$.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 312614

Client Details

Client	JK Geotechnics
Attention	Fraser Hall
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**35624XD, Parramatta, NSW**
Number of Samples	3 Soil
Date samples received	08/12/2022
Date completed instructions received	08/12/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	15/12/2022
Date of Issue	15/12/2022

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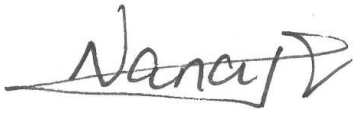
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Nick Sarlamis, Assistant Operation Manager

Authorised By



Nancy Zhang, Laboratory Manager

Misc Inorg - Soil				
Our Reference		312614-1	312614-2	312614-3
Your Reference	UNITS	BH1	BH2	BH3
Depth		0.1-0.3	0.1-0.3	0.1-0.2
Type of sample		Soil	Soil	Soil
Date prepared	-	14/12/2022	14/12/2022	14/12/2022
Date analysed	-	14/12/2022	14/12/2022	14/12/2022
pH 1:5 soil:water	pH Units	6.6	6.2	11.1
Chloride, Cl 1:5 soil:water	mg/kg	27	21	98
Sulphate, SO4 1:5 soil:water	mg/kg	27	10	120
Resistivity in soil*	ohm m	140	210	20

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			14/12/2022	2	14/12/2022	14/12/2022		14/12/2022	[NT]
Date analysed	-			14/12/2022	2	14/12/2022	14/12/2022		14/12/2022	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	2	6.2	6.1	2	98	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	21	25	17	90	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	10	10	0	95	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	<1	2	210	190	10	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

JKGeotechnics

BOREHOLE LOG

Borehole No. 1

Client: GBG AUSTRALIA

Project: PROPOSED LAKE PARRAMATTA UPGRADE

Location: PARRAMATTA LAKE, PARRAMATTA, NSW

Job No.: 35624XD **Method:** SPIRAL AUGER **R.L. Surface:** 29.60 m

Date: 5/12/22 **Datum:** AHD

Plant Type: JK205 **Logged/Checked By:** F.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING										FILL: Silty sand, fine to medium grained, brown, trace of fine to medium grained igneous and sandstone gravel, concrete fragments and root fibres.	D			
					N=SPT 2/ 0mm REFUSAL	29				FILL: Sandstone boulder, fine to medium grained, orange brown and light grey.	DW	L - M		MODERATE 'TC' BIT RESISTANCE
							1		-	Extremely Weathered sandstone: clayey SAND, fine to medium grained, orange brown.	XW			HAWKESBURY SANDSTONE
										SANDSTONE: fine to medium grained, orange brown and light grey.	DW	L		LOW TO MODERATE RESISTANCE
						28	2			REFER TO CORED BOREHOLE LOG		M - H		HIGH RESISTANCE GROUNDWATER AT 2.1m DEPTH ON COMPLETION
						27	3							
						26	4							
						25	5							
						24	6							
						23								

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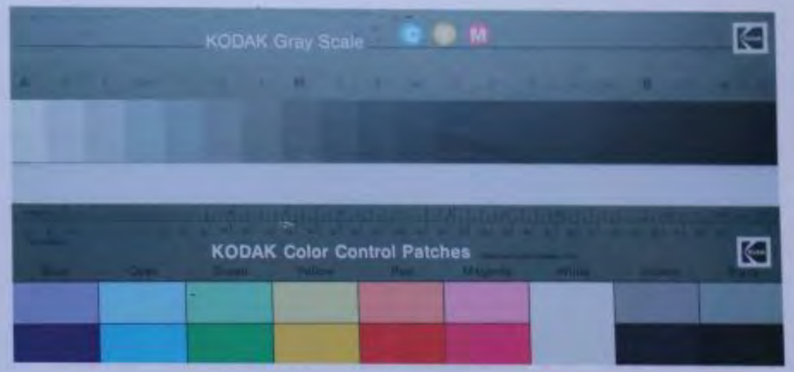
Job No: 35624XD
Borehole No: BH1
Depth: 1.46 - 4.46m



35624XD BH1 START CORING AT 1.46m

1 1.46m

2

3

4 END OF BOREHOLE AT 4.46m

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CORED BOREHOLE LOG

Borehole No. 1

Client: GBG AUSTRALIA

Project: PROPOSED LAKE PARRAMATTA UPGRADE

Location: PARRAMATTA LAKE, PARRAMATTA, NSW

Job No.: 35624XD | **Core Size:** NMLC | **R.L. Surface:** 29.60 m

Date: 5/12/22 | **Inclination:** VERTICAL | **Datum:** AHD

Plant Type: JK205 | **Bearing:** N/A | **Logged/Checked By:** F.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS: SPACING (mm)	DEFECT DETAILS: DESCRIPTION (Specific / General)	Formation
					START CORING AT 1.46m						
95% RETURN		28	2		SANDSTONE: fine to medium grained, light grey, orange brown and red brown, with ironstone bands up to 90mm.t, trace of grey laminae, bedded at 0-10°.	MW	M	0.50		(1.57m) J, 50°, P, R, Cn	Hawkesbury Sandstone
							L	0.20		(1.73m) Cr, 0°, 20 mm.t (1.81m) XWS, 5 - 10°, 15 mm.t (1.93m) CS, 8°, 10 mm.t (1.97m) CS, 0 - 20°, 5 mm.t (2.03m) CS, 0 - 20°, 15 mm.t (2.07m) CS, 0 - 15°, 10 mm.t GROUNDWATER AT 2.1m DEPTH ON COMPLETION	
		27	3		SANDSTONE: fine to medium grained, light grey, with grey laminae, bedded at 0-10°.	SW	M	0.90		(2.35m) CS, 0°, 3 mm.t (2.44m) CS, 0 - 5°, 10 mm.t (2.49m) CS, 0°, 20 mm.t (2.57m) J, 60 - 90°, C, R, Clay Ct (2.68m) J, 75°, C, R, Clay Ct	
		26	4		SANDSTONE: fine to medium grained, orange brown, red brown and light grey, with grey laminae, bedded at 0-10°.		H	2.1 1.0 1.1		(3.06m) Be, 5°, P, R, Clay Ct	
		25	5		END OF BOREHOLE AT 4.46 m						
		24	6								
		23	7								
		22									

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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BOREHOLE LOG

Borehole No. 2

Client: GBG AUSTRALIA

Project: PROPOSED LAKE PARRAMATTA UPGRADE

Location: PARRAMATTA LAKE, PARRAMATTA, NSW

Job No.: 35624XD **Method:** SPIRAL AUGER **R.L. Surface:** 28.93 m

Date: 5/12/22 **Datum:** AHD

Plant Type: JK205 **Logged/Checked By:** F.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING				■						FILL: Silty sand, fine to medium grained, brown, trace of fine to coarse grained igneous and sandstone gravel and root fibres.	D			
									-	SANDSTONE: fine to medium grained, orange brown and light grey.	DW	L		HAWKESBURY SANDSTONE
										REFER TO CORED BOREHOLE LOG				MODERATE 'TC' BIT RESISTANCE
						28	1							GROUNDWATER AT 1.9m DEPTH ON COMPLETION
						27	2							
						26	3							
						25	4							
						24	5							
						23	6							
						22								

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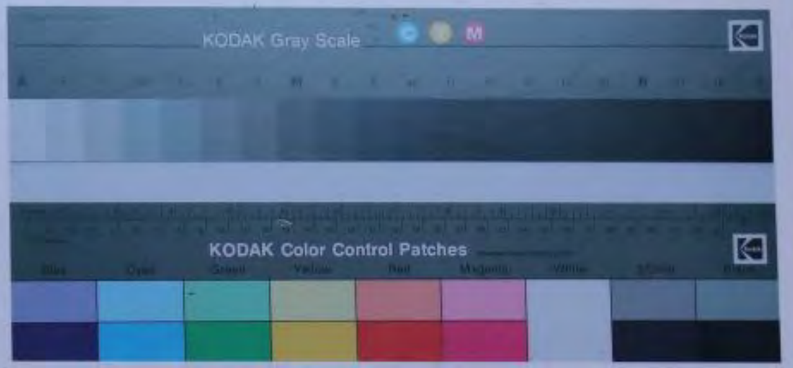
Job No: 35624XD
Borehole No: BH2
Depth: 0.63 - 4.00m



35624XD BH2 START CORING AT 0.63m

0

0.63m

CORE LOSS 0.18m

1

2

3

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CORED BOREHOLE LOG

Borehole No. 2

Client: GBG AUSTRALIA

Project: PROPOSED LAKE PARRAMATTA UPGRADE

Location: PARRAMATTA LAKE, PARRAMATTA, NSW

Job No.: 35624XD | **Core Size:** NMLC | **R.L. Surface:** 28.93 m

Date: 5/12/22 | **Inclination:** VERTICAL | **Datum:** AHD

Plant Type: JK205 | **Bearing:** N/A | **Logged/Checked By:** F.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS: SPACING (mm)	DEFECT DETAILS: DESCRIPTION (Specific / General)	Formation
					START CORING AT 0.63m			1.2			
		28	1		SANDSTONE: fine to medium grained, light grey and orange brown.	MW	H				
					NO CORE 0.18m	MW	H			(0.91m) Cr, 0 - 20°, 30 mm.t (1.04m) J, 75 - 80°, C, R, Cn	
					SANDSTONE: fine to medium grained, light grey and orange brown, with ironstone bands up to 110mm.t, trace of grey laminae, bedded at 0-15°.	SW		1.8 1.6			
▽ 95% RETURN		27	2					1.5		GROUNDWATER AT 1.9m DEPTH ON COMPLETION (2.21m) Be, 0°, P, R, Clay Sn	
		26	3				M	1.2 0.80		(2.51m) J, 45 - 85°, C, R, Cn	Hawkesbury Sandstone
		25	4					0.80		(3.72m) Be, 10°, P, R, Clay Ct (3.75m) Be, 5°, P, R, Clay Ct (3.83m) Be, 2°, P, R, Clay Ct (3.94m) Be, 10°, P, R, Clay Ct	
					END OF BOREHOLE AT 4.00 m						
		24	5								
		23	6								
		22									

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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BOREHOLE LOG

Borehole No. 3

Client: GBG AUSTRALIA

Project: PROPOSED LAKE PARRAMATTA UPGRADE

Location: PARRAMATTA LAKE, PARRAMATTA, NSW

Job No.: 35624XD **Method:** SPIRAL AUGER **R.L. Surface:** 30.57 m

Date: 5/12/22 **Datum:** AHD

Plant Type: JK205 **Logged/Checked By:** F.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING				■					-	CONCRETE: 50mm.t	DW	M		NO REINFORCEMENT OBSERVED
										SANDSTONE: fine to medium grained, light grey.				HAWKESBURY SANDSTONE
										REFER TO CORED BOREHOLE LOG				MODERATE TO HIGH 'TC' BIT RESISTANCE
						30								GROUNDWATER AT 1.4m DEPTH ON COMPLETION
							1							
						29								
							2							
						28								
							3							
						27								
							4							
						26								
							5							
						25								
							6							
						24								

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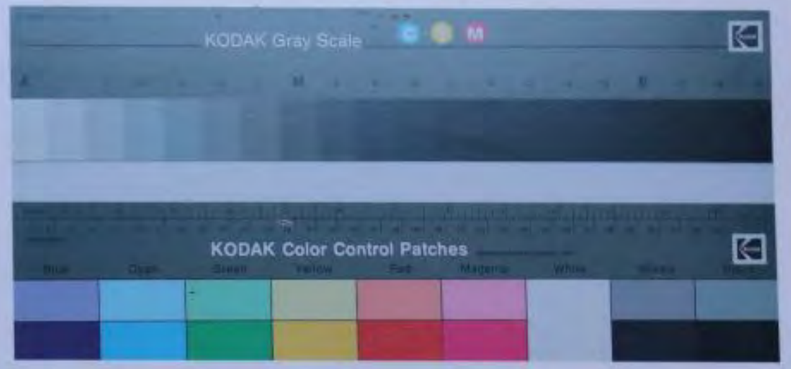
Job No: 35624XD
Borehole No: BH3
Depth: 0.22 - 3.56m



35624XD BH3 START CORING AT 0.22m

0 0.22m

CORE LOSS 0.25m

END OF BOREHOLE AT 3.56m

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CORED BOREHOLE LOG

Borehole No. 3 **2 / 2**

Client: GBG AUSTRALIA

Project: PROPOSED LAKE PARRAMATTA UPGRADE

Location: PARRAMATTA LAKE, PARRAMATTA, NSW

Job No.: 35624XD **Core Size:** NMLC **R.L. Surface:** 30.57 m

Date: 5/12/22 **Inclination:** VERTICAL **Datum:** AHD

Plant Type: JK205 **Bearing:** N/A **Logged/Checked By:** F.H./

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS: SPACING (mm)	DEFECT DETAILS: DESCRIPTION (Specific / General)	Formation
					START CORING AT 0.22m						
		30	1		SANDSTONE: fine to medium grained, light grey, orange brown and red brown, with ironstone bands up to 80mm.t.	SW	M	0.70, 0.70			Hawkesbury Sandstone
						MW		0.70, 0.30		(0.87m) Be, 2°, P, R, Fe Sn; (0.99m) Cr, 0°, 20 mm.t; (1.29m) XWS, 0°, 5 mm.t	
▽					NO CORE 0.25m					GROUNDWATER AT 1.4m DEPTH ON COMPLETION	
95% RETURN		29	2		SANDSTONE: fine to medium grained, light grey, orange brown and red brown, with clay seams up to 100mm.t and ironstone bands up to 40mm.t, trace of grey laminae bedded at 0-15°.	HW	VL			(1.63m) XWS, 0 - 10°, 30 mm.t; (1.75m) CS, 0 - 5°, 100 mm.t	Hawkesbury Sandstone
						MW	M - H	1.2, 1.1		(1.94m) J, 80°, C, R, Cn; (2.05m) CS, 0 - 10°, 15 mm.t	
		28	3			SW		0.80, 1.0, 1.5		(2.58m) Be, 7°, P, R, Clay Ct	
		27	4		END OF BOREHOLE AT 3.56 m						
		26	5								
		25	6								
		24									

POINT LOAD STRENGTH INDEX $I_s(50)$: VL -0.1, L -0.3, M -1, H -3, VH -10, EH

SPACING (mm): 600, 200, 60, 20

JK 9.02.4 LIB:GLB Log JK CORED BOREHOLE - MASTER 35624XD PARRAMATTA.GPJ <<DrawingFile>> 07/12/2022 15:39 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

BOREHOLE LOG

Borehole No. 4

Client: GBG AUSTRALIA

Project: PROPOSED LAKE PARRAMATTA UPGRADE

Location: PARRAMATTA LAKE, PARRAMATTA, NSW

Job No.: 35624XD **Method:** PISTON SAMPLER **R.L. Surface:** 22.6 m

Date: 6/12/22 **Datum:** AHD

Plant Type: **Logged/Checked By:** F.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
SUBMERGED				■					ML	Clayey SILT: low plasticity, dark grey, with clay nodules.	w>PL			(RAN OUT OF PISTON RODS)
						22	0			END OF BOREHOLE AT 0.40 m				
							1							
						21								
							2							
						20								
							3							
						19								
							4							
						18								
							5							
						17								
							6							
						16								

JKGeotechnics

BOREHOLE LOG

Borehole No. 5

1 / 1

Client: GBG AUSTRALIA

Project: PROPOSED LAKE PARRAMATTA UPGRADE

Location: PARRAMATTA LAKE, PARRAMATTA, NSW

Job No.: 35624XD **Method:** PISTON SAMPLER **R.L. Surface:** ~25.0 m

Date: 6/12/22 **Datum:** AHD

Plant Type: **Logged/Checked By:** F.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
SUBMERGED				■					ML	Clayey SILT: low plasticity, dark grey.	w>PL			
						24	1			END OF BOREHOLE AT 0.30 m				REFUSAL ON HARD LAYER
						23	2							
						22	3							
						21	4							
						20	5							
						19	6							

JKGeotechnics

BOREHOLE LOG

Borehole No. 6

Client: GBG AUSTRALIA

Project: PROPOSED LAKE PARRAMATTA UPGRADE

Location: PARRAMATTA LAKE, PARRAMATTA, NSW

Job No.: 35624XD **Method:** PISTON SAMPLER **R.L. Surface:** ~23.5 m

Date: 6/12/22 **Datum:** AHD

Plant Type: **Logged/Checked By:** F.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
SUBMERGED				■					ML	Clayey SILT: low plasticity, dark grey, trace of fine to medium grained sand.	w>PL			
						23	0			END OF BOREHOLE AT 0.30 m				REFUSAL ON HARD LAYER
						22	1							
						21	2							
						20	3							
						19	4							
						18	5							
						17	6							

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BOREHOLE LOG

Borehole No. 7

1 / 1

Client: GBG AUSTRALIA

Project: PROPOSED LAKE PARRAMATTA UPGRADE

Location: PARRAMATTA LAKE, PARRAMATTA, NSW

Job No.: 35624XD **Method:** PISTON SAMPLER **R.L. Surface:** ~25.8 m

Date: 6/12/22 **Datum:** AHD

Plant Type: **Logged/Checked By:** F.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
SUBMERGED						25	0		ML	Clayey SILT: low plasticity, dark grey, trace of fine to coarse grained sand.	w>PL			REFUSAL ON HARD LAYER
										END OF BOREHOLE AT 0.05 m				(ALMOST CERTAINLY SANDSTONE BEDROCK)
						24	1							
						23	2							
						22	3							
						21	4							
						20	5							
						19	6							

JKGeotechnics

BOREHOLE LOG

Borehole No. 8

1 / 1

Client: GBG AUSTRALIA

Project: PROPOSED LAKE PARRAMATTA UPGRADE

Location: PARRAMATTA LAKE, PARRAMATTA, NSW

Job No.: 35624XD **Method:** PISTON SAMPLER **R.L. Surface:** ~22.5 m

Date: 6/12/22 **Datum:** AHD

Plant Type: **Logged/Checked By:** F.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
SUBMERGED				■					ML	Clayey SILT: low plasticity, dark grey, with clay nodules.	w>PL			(RAN OUT OF PISTON RODS)
						22	0			END OF BOREHOLE AT 0.30 m				
							1							
						21								
							2							
						20								
							3							
						19								
							4							
						18								
							5							
						17								
							6							
						16								

JKGeotechnics

BOREHOLE LOG

Borehole No. 9

1 / 1

Client: GBG AUSTRALIA

Project: PROPOSED LAKE PARRAMATTA UPGRADE

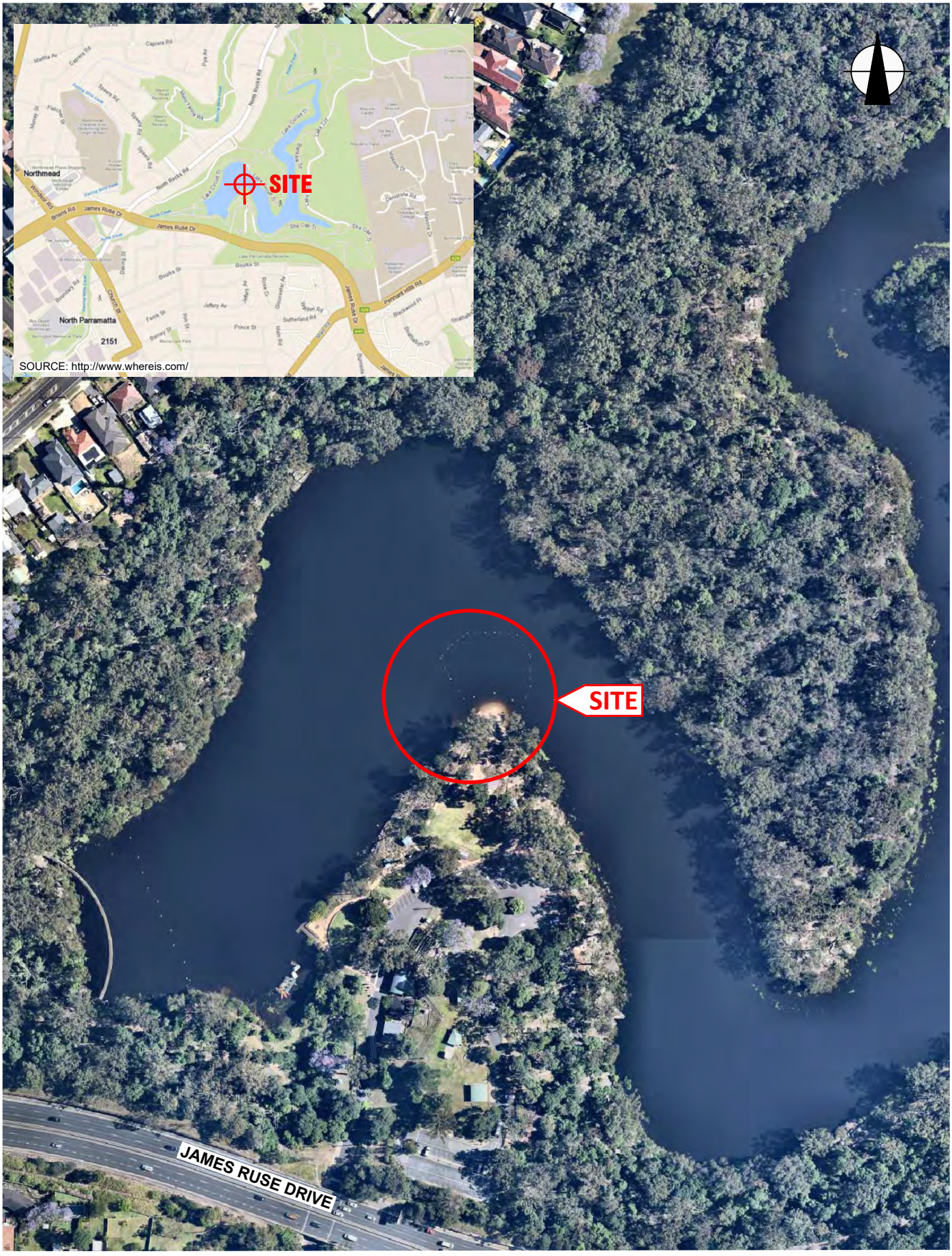
Location: PARRAMATTA LAKE, PARRAMATTA, NSW

Job No.: 35624XD **Method:** PISTON SAMPLER **R.L. Surface:** ~26.3 m

Date: 6/12/22 **Datum:** AHD

Plant Type: **Logged/Checked By:** F.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
SUBMERGED				■		26			ML	Clayey SILT: low plasticity, dark grey, with clay nodules, trace of root fibres.	w>PL			
										END OF BOREHOLE AT 0.40 m				REFUSAL ON HARD LAYER
						25	1							
						24	2							
						23	3							
						22	4							
						21	5							
						20	6							



AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

This plan should be read in conjunction with the JK Geotechnics report.

Title: **SITE LOCATION PLAN**

Location: LAKE PARRAMATTA SWIMMING AREA, NORTH PARRAMATTA, NSW

Report No: 35624XD

Figure No: 1

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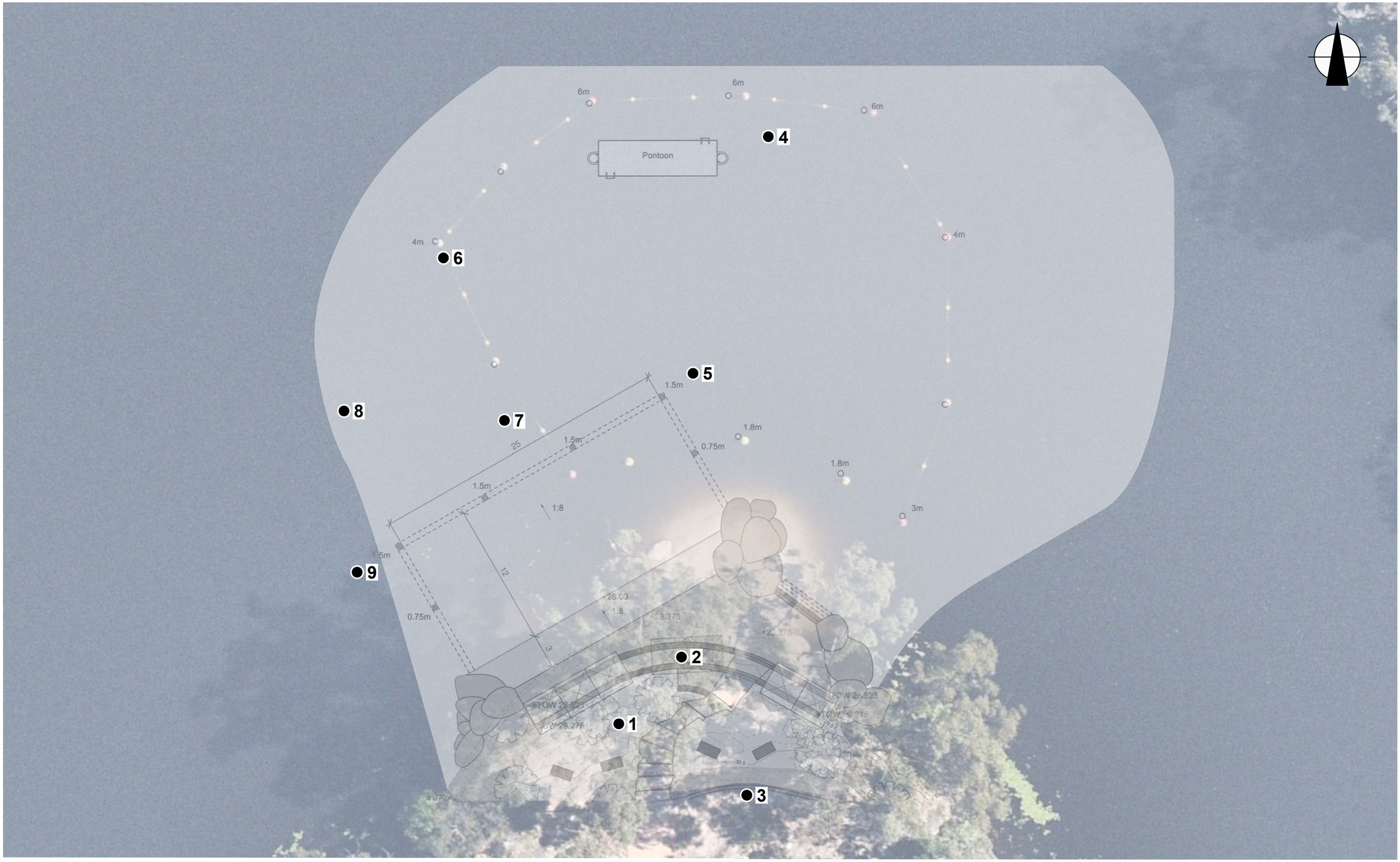
PLOT DATE: 7/12/2022 3:52:53 PM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\35000'S\35624XD PARRAMATTA\CAD\35624XD.DWG



AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

0 3 6 9 12 15

SCALE 1:300 @A3 METRES

This plan should be read in conjunction with the JK Geotechnics report.

Title: **BOREHOLE LOCATION PLAN**

Location: LAKE PARRAMATTA SWIMMING AREA, NORTH PARRAMATTA, NSW

Report No: 35624XD

Figure No: 2

JKGeotechnics

PLOT DATE: 7/12/2022 3:53:04 PM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\35000'S\35624XD PARRAMATTA\CAD\35624XD.DWG

REPORT EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726:2017 *'Geotechnical Site Investigations'*. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached soil classification table qualified by the grading of other particles present (eg. sandy clay) as set out below:

Soil Classification	Particle Size
Clay	< 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2.36mm
Gravel	2.36 to 63mm
Cobbles	63 to 200mm
Boulders	> 200mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose (VL)	< 4
Loose (L)	4 to 10
Medium dense (MD)	10 to 30
Dense (D)	30 to 50
Very Dense (VD)	> 50

Cohesive soils are classified on the basis of strength (consistency) either by use of a hand penetrometer, vane shear, laboratory testing and/or tactile engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength (kPa)	Indicative Undrained Shear Strength (kPa)
Very Soft (VS)	≤ 25	≤ 12
Soft (S)	> 25 and ≤ 50	> 12 and ≤ 25
Firm (F)	> 50 and ≤ 100	> 25 and ≤ 50
Stiff (St)	> 100 and ≤ 200	> 50 and ≤ 100
Very Stiff (VSt)	> 200 and ≤ 400	> 100 and ≤ 200
Hard (Hd)	> 400	> 200
Friable (Fr)	Strength not attainable – soil crumbles	

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'shale' is used to describe fissile mudstone, with a weakness parallel to bedding. Rocks with alternating inter-laminations of different grain size (eg. siltstone/claystone and siltstone/fine grained sandstone) is referred to as 'laminite'.

SAMPLING

Sampling is carried out during drilling or from other excavations to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shrink-swell behaviour, strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All methods except test pits, hand auger drilling and portable Dynamic Cone Penetrometers require the use of a mechanical rig which is commonly mounted on a truck chassis or track base.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils and 'weaker' bedrock if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for a large excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Refusal of the hand auger can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of limited reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock cuttings. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be assessed from the cuttings, together with some information from "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, NMLC or HQ triple tube core barrels, which give a core of about 50mm and 61mm diameter, respectively, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as NO CORE. The location of NO CORE recovery is determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the bottom of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils, as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289.6.3.1–2004 (R2016) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – Standard Penetration Test (SPT)'*.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63.5kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In the case where full penetration is obtained with successive blow counts for each 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as

  N > 30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

A modification to the SPT is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as 'N_c' on the borehole logs, together with the number of blows per 150mm penetration.

Cone Penetrometer Testing (CPT) and Interpretation: The cone penetrometer is sometimes referred to as a Dutch Cone. The test is described in Australian Standard 1289.6.5.1–1999 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Static Cone Penetration Resistance of a Soil – Field Test using a Mechanical and Electrical Cone or Friction-Cone Penetrometer'*.

In the tests, a 35mm or 44mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm or 165mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck. The CPT does not provide soil sample recovery.

As penetration occurs (at a rate of approximately 20mm per second), the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa. There are two scales presented for the cone resistance. The lower scale has a range of 0 to 5MPa and the main scale has a range of 0 to 50MPa. For cone resistance values less than 5MPa, the plot will appear on both scales.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

  The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between CPT and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of CPT values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

There are limitations when using the CPT in that it may not penetrate obstructions within any fill, thick layers of hard clay and very dense sand, gravel and weathered bedrock. Normally a 'dummy' cone is pushed through fill to protect the equipment. No information is recorded by the 'dummy' probe.

Flat Dilatometer Test: The flat dilatometer (DMT), also known as the Marchetti Dilometer comprises a stainless steel blade having a flat, circular steel membrane mounted flush on one side.

The blade is connected to a control unit at ground surface by a pneumatic-electrical tube running through the insertion rods. A gas tank, connected to the control unit by a pneumatic cable, supplies the gas pressure required to expand the membrane. The control unit is equipped with a pressure regulator, pressure gauges, an audio-visual signal and vent valves.

The blade is advanced into the ground using our CPT rig or one of our drilling rigs, and can be driven into the ground using an SPT hammer. As soon as the blade is in place, the membrane is inflated, and the pressure required to lift the membrane (approximately 0.1mm) is recorded. The pressure then required to lift the centre of the membrane by an additional 1mm is recorded. The membrane is then deflated before pushing to the next depth increment, usually 200mm down. The pressure readings are corrected for membrane stiffness.

The DMT is used to measure material index (I_D), horizontal stress index (K_D), and dilatometer modulus (E_D). Using established correlations, the DMT results can also be used to assess the 'at rest' earth pressure coefficient (K_o), over-consolidation ratio (OCR), undrained shear strength (C_u), friction angle (ϕ), coefficient of consolidation (C_h), coefficient of permeability (K_h), unit weight (γ), and vertical drained constrained modulus (M).

The seismic dilatometer (SDMT) is the combination of the DMT with an add-on seismic module for the measurement of shear wave velocity (V_s). Using established correlations, the SDMT results can also be used to assess the small strain modulus (G_o).

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a 16mm diameter rod with a 20mm diameter cone end with a 9kg hammer dropping 510mm. The test is described in Australian Standard 1289.6.3.2–1997 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – 9kg Dynamic Cone Penetrometer Test'*.

The results are used to assess the relative compaction of fill, the relative density of granular soils, and the strength of cohesive soils. Using established correlations, the DCP test results can also be used to assess California Bearing Ratio (CBR).

Refusal of the DCP can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

Vane Shear Test: The vane shear test is used to measure the undrained shear strength (C_u) of typically very soft to firm fine grained cohesive soils. The vane shear is normally performed in the bottom of a borehole, but can be completed from surface level, the bottom and sides of test pits, and on recovered undisturbed tube samples (when using a hand vane).

The vane comprises four rectangular blades arranged in the form of a cross on the end of a thin rod, which is coupled to the bottom of a drill rod string when used in a borehole. The size of the vane is dependent on the strength of the fine grained cohesive soils; that is, larger vanes are normally used for very low strength soils. For borehole testing, the size of the vane can be limited by the size of the casing that is used.

For testing inside a borehole, a device is used at the top of the casing, which suspends the vane and rods so that they do not sink under self-weight into the 'soft' soils beyond the depth at which the test is to be carried out. A calibrated torque head is used to rotate the rods and vane and to measure the resistance of the vane to rotation.

With the vane in position, torque is applied to cause rotation of the vane at a constant rate. A rate of 6° per minute is the common rotation rate. Rotation is continued until the soil is sheared and the maximum torque has been recorded. This value is then used to calculate the undrained shear strength. The vane is then rotated rapidly a number of times and the operation repeated until a constant torque reading is obtained. This torque value is used to calculate the remoulded shear strength. Where appropriate, friction on the vane rods is measured and taken into account in the shear strength calculation.

LOGS

The borehole or test pit logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will enable the most reliable assessment, but is not always practicable or possible to justify on economic grounds. In any case, the boreholes or test pits represent only a very small sample of the total subsurface conditions.

The terms and symbols used in preparation of the logs are defined in the following pages.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than 'straight line' variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

Where groundwater levels are measured in boreholes, there are several potential problems:

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole or 'reverted' chemically if reliable water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after the groundwater level has stabilised at intervals ranging from several days to perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg. bricks, steel, etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably assess the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soils for Engineering Purposes'* or appropriate NSW Government Roads & Maritime Services (RMS) test methods. Details of the test procedure used are given on the individual report forms.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

Reasonable care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.
- Details of the development that the Company could not reasonably be expected to anticipate.

If these occur, the Company will be pleased to assist with investigation or advice to resolve any problems occurring.

SITE ANOMALIES

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Copyright in all documents (such as drawings, borehole or test pit logs, reports and specifications) provided by the Company shall remain the property of Jeffery and Katauskas Pty Ltd. Subject to the payment of all fees due, the Client alone shall have a licence to use the documents provided for the sole purpose of completing the project to which they relate. Licence to use the documents may be revoked without notice if the Client is in breach of any obligation to make a payment to us.

REVIEW OF DESIGN

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/constraints are quite complex, it is prudent to have a joint design review which involves an experienced geotechnical engineer/engineering geologist.

SITE INSPECTION

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types and appropriate footing or pile founding depths, or

iii) full time engineering presence on site.

SYMBOL LEGENDS

SOIL


FILL


TOPSOIL


CLAY (CL, CI, CH)


SILT (ML, MH)


SAND (SP, SW)


GRAVEL (GP, GW)


SANDY CLAY (CL, CI, CH)


SILTY CLAY (CL, CI, CH)


CLAYEY SAND (SC)


SILTY SAND (SM)


GRAVELLY CLAY (CL, CI, CH)


CLAYEY GRAVEL (GC)


SANDY SILT (ML, MH)


PEAT AND HIGHLY ORGANIC SOILS (Pt)

ROCK


CONGLOMERATE


SANDSTONE


SHALE/MUDSTONE


SILTSTONE


CLAYSTONE


COAL


LAMINITE


LIMESTONE


PHYLLITE, SCHIST


TUFF


GRANITE, GABBRO


DOLERITE, DIORITE


BASALT, ANDESITE


QUARTZITE

OTHER MATERIALS


BRICKS OR PAVERS


CONCRETE


ASPHALTIC CONCRETE

CLASSIFICATION OF COARSE AND FINE GRAINED SOILS

Major Divisions		Group Symbol	Typical Names	Field Classification of Sand and Gravel	Laboratory Classification	
Coarse grained soil (more than 65% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL (more than half of coarse fraction is larger than 2.36mm	GW	Gravel and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 4$ $1 < C_c < 3$
		GP	Gravel and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		GM	Gravel-silt mixtures and gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	Fines behave as silt
		GC	Gravel-clay mixtures and gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	Fines behave as clay
	SAND (more than half of coarse fraction is smaller than 2.36mm)	SW	Sand and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 6$ $1 < C_c < 3$
		SP	Sand and gravel-sand mixtures, little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		SM	Sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	N/A
		SC	Sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	

Major Divisions		Group Symbol	Typical Names	Field Classification of Silt and Clay			Laboratory Classification
				Dry Strength	Dilatancy	Toughness	% < 0.075mm
Fine grained soils (more than 35% of soil excluding oversize fraction is less than 0.075mm)	SILT and CLAY (low to medium plasticity)	ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity	None to low	Slow to rapid	Low	Below A line
		CL, CI	Inorganic clay of low to medium plasticity, gravelly clay, sandy clay	Medium to high	None to slow	Medium	Above A line
		OL	Organic silt	Low to medium	Slow	Low	Below A line
	SILT and CLAY (high plasticity)	MH	Inorganic silt	Low to medium	None to slow	Low to medium	Below A line
		CH	Inorganic clay of high plasticity	High to very high	None	High	Above A line
		OH	Organic clay of medium to high plasticity, organic silt	Medium to high	None to very slow	Low to medium	Below A line
	Highly organic soil	Pt	Peat, highly organic soil	–	–	–	–

Laboratory Classification Criteria

A well graded coarse grained soil is one for which the coefficient of uniformity $Cu > 4$ and the coefficient of curvature $1 < C_c < 3$. Otherwise, the soil is poorly graded. These coefficients are given by:

$$C_U = \frac{D_{60}}{D_{10}} \qquad and \qquad C_C = \frac{(D_{30})^2}{D_{10}\, D_{60}}$$

Where D_{10}, D_{30} and D_{60} are those grain sizes for which 10%, 30% and 60% of the soil grains, respectively, are smaller.

NOTES:

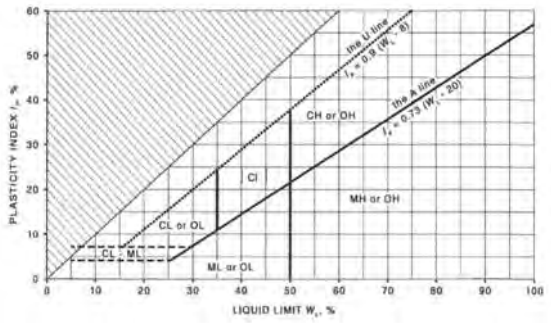
1 For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.

2 Where the grading is determined from laboratory tests, it is defined by coefficients of curvature (C_c) and uniformity (C_u) derived from the particle size distribution curve.

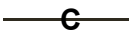
3 Clay soils with liquid limits > 35% and ≤ 50% may be classified as being of medium plasticity.

4 The U line on the Modified Casagrande Chart is an approximate upper bound for most natural soils.

Modified Casagrande Chart for Classifying Silts and Clays according to their Behaviour



LOG SYMBOLS

Log Column	Symbol	Definition
Groundwater Record		Standing water level. Time delay following completion of drilling/excavation may be shown.
		Extent of borehole/test pit collapse shortly after drilling/excavation.
		Groundwater seepage into borehole or test pit noted during drilling or excavation.
Samples	ES	Sample taken over depth indicated, for environmental analysis.
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.
	DB	Bulk disturbed sample taken over depth indicated.
	DS	Small disturbed bag sample taken over depth indicated.
	ASB	Soil sample taken over depth indicated, for asbestos analysis.
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.
	SAL	Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'Refusal' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60° solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of undrained shear strength.
	PID = 100	Photoionisation detector reading in ppm (soil sample headspace test).
Moisture Condition (Fine Grained Soils)	w > PL	Moisture content estimated to be greater than plastic limit.
	$w \approx$ PL	Moisture content estimated to be approximately equal to plastic limit.
	w < PL	Moisture content estimated to be less than plastic limit.
	$w \approx$ LL	Moisture content estimated to be near liquid limit.
	w > LL	Moisture content estimated to be wet of liquid limit.
(Coarse Grained Soils)	D	DRY – runs freely through fingers.
	M	MOIST – does not run freely but no free water visible on soil surface.
	W	WET – free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS	VERY SOFT – unconfined compressive strength ≤ 25kPa.
	S	SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa.
	F	FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa.
	St	STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa.
	VSt	VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa.
	Hd	HARD – unconfined compressive strength > 400kPa.
	Fr	FRIABLE – strength not attainable, soil crumbles.
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other assessment.
Density Index/ Relative Density (Cohesionless Soils)		**Density Index (I_D) Range (%)** / **SPT 'N' Value Range (Blows/300mm)**: VERY LOOSE ≤ 15 / 0 – 4; LOOSE > 15 and ≤ 35 / 4 – 10; MEDIUM DENSE > 35 and ≤ 65 / 10 – 30; DENSE > 65 and ≤ 85 / 30 – 50; VERY DENSE > 85 / > 50
	VL	
	L	
	MD	
	D	
	VD	
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other assessment.
Hand Penetrometer Readings	300 250	Measures reading in kPa of unconfined compressive strength. Numbers indicate individual test results on representative undisturbed material unless noted otherwise.

Log Column	Symbol	Definition
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Twin pronged tungsten carbide bit.
	T_{60}	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.
	Soil Origin	The geological origin of the soil can generally be described as: RESIDUAL – soil formed directly from insitu weathering of the underlying rock. No visible structure or fabric of the parent rock. EXTREMELY WEATHERED – soil formed directly from insitu weathering of the underlying rock. Material is of soil strength but retains the structure and/or fabric of the parent rock. ALLUVIAL – soil deposited by creeks and rivers. ESTUARINE – soil deposited in coastal estuaries, including sediments caused by inflowing creeks and rivers, and tidal currents. MARINE – soil deposited in a marine environment. AEOLIAN – soil carried and deposited by wind. COLLUVIAL – soil and rock debris transported downslope by gravity, with or without the assistance of flowing water. Colluvium is usually a thick deposit formed from a landslide. The description 'slopewash' is used for thinner surficial deposits. LITTORAL – beach deposited soil.

Classification of Material Weathering

Term		Abbreviation		Definition
Residual Soil		RS		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely Weathered		XW		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.
Highly Weathered	Distinctly Weathered (Note 1)	HW	DW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately Weathered		MW		The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly Weathered		SW		Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh		FR		Rock shows no sign of decomposition of individual minerals or colour changes.

NOTE 1: The term 'Distinctly Weathered' is used where it is not practicable to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock. 'Distinctly Weathered' is defined as follows: *'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores'*. There is some change in rock strength.

Rock Material Strength Classification

Term	Abbreviation	Uniaxial Compressive Strength (MPa)	Guide to Strength	
			Point Load Strength Index $Is_{(50)}$ (MPa)	Field Assessment
Very Low Strength	VL	0.6 to 2	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low Strength	L	2 to 6	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium Strength	M	6 to 20	0.3 to 1	Scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High Strength	H	20 to 60	1 to 3	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High Strength	VH	60 to 200	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High Strength	EH	> 200	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Abbreviations Used in Defect Description

Cored Borehole Log Column		Symbol Abbreviation	Description
Point Load Strength Index		• 0.6	Axial point load strength index test result (MPa)
		x 0.6	Diametral point load strength index test result (MPa)
Defect Details	– Type	Be	Parting – bedding or cleavage
		CS	Clay seam
		Cr	Crushed/sheared seam or zone
		J	Joint
		Jh	Healed joint
		Ji	Incipient joint
		XWS	Extremely weathered seam
	– Orientation	Degrees	Defect orientation is measured relative to normal to the core axis (ie. relative to the horizontal for a vertical borehole)
	– Shape	P	Planar
		C	Curved
		Un	Undulating
		St	Stepped
		Ir	Irregular
	– Roughness	Vr	Very rough
		R	Rough
		S	Smooth
		Po	Polished
		Sl	Slickensided
	– Infill Material	Ca	Calcite
		Cb	Carbonaceous
		Clay	Clay
		Fe	Iron
		Qz	Quartz
		Py	Pyrite
	– Coatings	Cn	Clean
		Sn	Stained – no visible coating, surface is discoloured
		Vn	Veneer – visible, too thin to measure, may be patchy
		Ct	Coating ≤ 1mm thick
		Filled	Coating > 1mm thick
	– Thickness	mm.t	Defect thickness measured in millimetres

APPENDIX C

Biodiversity Appendices

C1 Likelihood of Occurrence

An assessment of likelihood of occurrence was made for threatened and migratory species identified from the database search. Five terms for the likelihood of occurrence of species are used in this report. This assessment was based on database or other records, presence or absence of suitable habitat, features of the Project site, results of the site inspection and professional judgement. Some Migratory or Marine species identified from the Commonwealth database search have been excluded from the assessment, due to lack of habitat. The terms for likelihood of occurrence are defined below:

- "known" = the species was or has been observed on the site
- "likely" = a medium to high probability that a species uses the site
- "potential" = suitable habitat for a species occurs on the site, but there is insufficient information to categorise the species as likely to occur, or unlikely to occur
- "unlikely" = a very low to low probability that a species uses the site
- "no" = habitat on site and in the vicinity is unsuitable for the species.

Tests of Significance (Appendix C2) and Assessments of Significance (C3) were conducted for threatened species or ecological communities that were likely or had potential to occur within the study area. It is noted that some threatened fauna species that are highly mobile, wide ranging and vagrant may use portions of the study area intermittently for foraging. For these fauna species, the habitat present and likely to be impacted is not considered to be important to the threatened species, particularly in relation to the amount of similar habitat remaining in the surrounding landscape. As such, a test of significance in reference to State or Commonwealth legislation was not considered necessary.

The records column refers to the number of records occurring within 5 km of the study area, as provided by the Atlas of NSW Wildlife (BioNet) and Protected Matters Search Tool database search.

Information provided in the habitat associations' column has primarily been extracted (and modified) from the Commonwealth Species Profile and Threats Database and the NSW Threatened Species Profiles.

Table 7-1: Likelihood of occurrence of threatened ecological communities within the study area

Scientific Name	BC Act Status	EPBC Act Status	Distribution and Habitat	Likelihood of Occurrence	Impact Assessment Required
Shale Sandstone Transition Forest of the Sydney Basin Bioregion	CE	CE	To the west of Sydney, on the edges of the Cumberland Plain (particularly the southern edge), as well as on the sandstone-dominated Hornsby, Woronora, and Lower Blue Mountains Plateaux. Intergrade between clay soils from the shale rock and earthy and sandy soils from sandstone, or where shale caps overlay sandstone.	No - this community was not identified during field survey.	No
Turpentine-Ironbark Forest of the Sydney Basin Bioregion	E	CE	Cumberland Lowlands, with remnants also occurring to the west on shale-capped ridges in the Blue Mountains. Restricted to areas with clay soil derived from Wianamatta Shale in an area that generally has an annual rainfall of more than 950 mm.	No - this community was not identified during field survey.	No
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	-	E	Occurs in sub-tropical, sub-humid and temperate climatic zones from Curtis Island, north of Gladstone, in Queensland to Bermagui in southern New South Wales. Typically found where groundwater is saline or brackish, but can occur in areas where groundwater is relatively fresh.	No - this community was not identified during field survey.	No
Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion	V/CE	E	Sydney Basin Bioregion, mostly in the Cumberland IBRA sub-region, with small occurrences in the Sydney Cataract, Wollemi and Burragorang sub-regions. It occurs primarily in the Castlereagh area in the north-west of the Cumberland Plain with other known occurrences near Holsworthy, Kemps Creek and Longneck Lagoon. "Occurs primarily on Tertiary sands and gravels of the Hawkesbury-Nepean river system. At Agnes Banks it primarily occurs on aeolian (wind-blown) sands overlying Tertiary alluvium. Found on flat or gently undulating terrain in rain shadow areas typically receiving 700–900 mm annual rainfall. The ecological community occurs primarily at low elevations up to 80 m above sea level (ASL), including old ridges, dunes and terraces.	No - this community was not identified during field survey.	No
Blue Gum High Forest of the Sydney Basin Bioregion	CE	CE	The Blue Gum High Forest ecological community listed under the EPBC Act is limited to the Ku-ring-gai, Hornsby and Baulkham Hills local government areas. Occurs mainly in areas with deep clay soil derived from shale, generally at altitudes greater than 100 m above sea level, and that have an annual rainfall of more than 1050 mm. Also known to occur in isolated valleys on soils associated with localised volcanic intrusions.	No - this community was not identified during field survey.	No

Scientific Name	BC Act Status	EPBC Act Status	Distribution and Habitat	Likelihood of Occurrence	Impact Assessment Required
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest	CE	CE	Endemic to the shale hills and plains of the Sydney Basin Bioregion in NSW, occurring primarily in, but not limited to, the Cumberland Sub-region. Flat to undulating or hilly terrain, at elevations up to approximately 350 metres above sea level. Predominantly associated with clay soils, that are derived from Wianamatta Shale geology. Minor occurrences may be present on other soil groups, notably Holocene Alluvium and soils derived from the Mittagong Formation.	No - this community was not identified during field survey.	No
River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria	E	CE	Found on the river flats of the coastal floodplains. Known from parts of the Local Government Areas of Port Stephens, Maitland, Singleton, Cessnock, Lake Macquarie, Wyong, Gosford, Hawkesbury, Baulkham Hills, Blacktown, Parramatta, Penrith, Blue Mountains, Fairfield, Holroyd, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Sutherland, Wollongong, Shellharbour, Kiama, Shoalhaven, Palerang, Eurobodalla and Bega Valley. Associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains.	No - this community was not identified during field survey.	No
Coastal Upland Swamps in the Sydney Basin Bioregion	E	E	Endemic to NSW and confined to the Sydney Basin Bioregion. It occurs in the eastern Sydney Basin from the Somersby district in the north (Somersby-Hornsby plateaux) to the Robertson district in the south (n the Woronora plateau). Occur primarily on impermeable sandstone plateaux with shallow groundwater aquifers in the headwaters and impeded drainage lines of streams, and on sandstone benches with abundant seepage moisture. Generally associated with acidic soils.	No - this community was not identified during field survey.	No
Subtropical and Temperate Coastal Saltmarsh	-	V	Within a relatively narrow margin of the Australian coastline, within the subtropical and temperate climatic zones south of the South-east Queensland IBRA bioregion. "Typically restricted to the upper intertidal environment; mainly associated with the soft substrate shores of estuaries and embayments (sandy and/or muddy) and on some open, low wave energy coasts).	No - this community was not identified during field survey.	No
Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion	E	CE	Occurs in western Sydney, with the most extensive stands occurring in the Castlereagh and Holsworthy areas. Smaller remnants occur in the Kemps Creek area and in the eastern section of the Cumberland Plain. Mainly occurs on clay soils	No - this community was not identified during field survey.	No

Scientific Name	BC Act Status	EPBC Act Status	Distribution and Habitat	Likelihood of Occurrence	Impact Assessment Required
			derived from the deposits of ancient river systems (alluvium), or on shale soils of the Wianamatta Shales.		
Western Sydney Dry Rainforest and Moist Woodland on Shale	E	CE	Cumberland Plain Sub-region of the Sydney Basin Bioregion. "It generally occurs in rugged terrain and other patches may occur on undulating terrain, with dry rainforest patches typically occupying steep lower slopes and gullies, and moist woodland patches typically occupying upper sections of the slope Occurs almost exclusively on clay soils derived from Wiannamatta Group shales.	No - this community was not identified during field survey.	No
Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland	E	E	Occurs on the mainland and islands near to the coast (within 20 km) within the following IBRA2 Bioregions: South East Queensland (SEQ); NSW North Coast (NNC); Sydney Basin (SYB); and the Bateman subregion of the South East Corner (SEC2). typically occurs in low-lying coastal alluvial areas with minimal relief, such as swamps, floodplain pockets, depressions, alluvial flats, back-barrier flats, fans, terraces, and behind fore-dunes.	No - this community was not identified during field survey.	No

KEY: V = VULNERABLE, E = ENDANGERED, CE = CRITICALLY ENDANGERED

Table 7-2: Likelihood of occurrence of threatened fauna species within the study area

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
Actitis hypoleucos	Common Sandpiper	-	M	Summer migrant. In NSW, widespread along coastline and also occurs in many areas inland.	Coastal wetlands and some inland wetlands, especially muddy margins or rocky shores. Also estuaries and deltas, lakes, pools, billabongs, reservoirs, dams and claypans, mangroves.	-	Unlikely – habitat marginal (lake), but no records of species within 5 km	No
Anthochaera phrygia	Regent Honeyeater	E4A	CE	Inland slopes of south-east Australia, and less frequently in coastal areas. In NSW, most records are from the North-West Plains, North-West and South-West Slopes, Northern Tablelands, Central Tablelands and Southern Tablelands regions; also recorded in the Central Coast and Hunter Valley regions.	Eucalypt woodland and open forest, wooded farmland and urban areas with mature eucalypts, and riparian forests of Casuarina cunninghamiana (River Oak).	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Apus pacificus	Fork-tailed Swift	-	M	Recorded in all regions of NSW.	Riparian woodland., swamps, low scrub, heathland, saltmarsh, grassland, Spinifex sandplains, open farmland and inland and coastal sand-dunes.	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	-	Occurs throughout most of New South Wales, but is sparsely scattered in, or largely absent from, much of the upper western region.	Primarily inhabit dry, open eucalypt forests and woodlands, including mallee associations.	1	Unlikely – habitat marginal (PCT 3592), but no records of	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
							species within 5 km	
Botaurus poiciloptilus	Australasian Bittern	E1	E	Found over most of NSW except for the far north-west.	Permanent freshwater wetlands with tall, dense vegetation, particularly Typha spp. (bullrushes) and Eleocharis spp. (spikerushes).	1	Unlikely – habitat marginal (lake), but minimal records of species within 5 km	No
Calidris acuminata	Sharp-tailed Sandpiper	-	M	Summer migrant. Widespread in most regions of NSW, especially in coastal areas, but sparse in the south-central Western Plain and east Lower Western Regions.	Shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation.	-	Unlikely – habitat marginal (lake), but no records of species within 5 km	No
Calidris ferruginea	Curlew Sandpiper	E1	CE, M	Occurs along the entire coast of NSW, and sometimes in freshwater wetlands in the Murray-Darling Basin.	Littoral and estuarine habitats, including intertidal mudflats, non-tidal swamps, lakes and lagoons on the coast and sometimes inland.	-	Unlikely – habitat marginal (lake), but no records of species within 5 km	No
Calidris melanotos	Pectoral Sandpiper	-	M	Summer migrant to Australia. Widespread but scattered in NSW. East of the Great Divide, recorded from Casino and Ballina, south to Ulladulla. West of the Great Divide, widespread in the	Shallow fresh to saline wetlands, including coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands.	-	Unlikely – habitat marginal (lake), but no records of	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
				Riverina and Lower Western regions.			species within 5 km	
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	In NSW, distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. Isolated records known from as far north as Coffs Harbour and as far west as Mudgee.	Tall mountain forests and woodlands in summer; in winter, may occur at lower altitudes in open eucalypt forests and woodlands, and urban areas.	1	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Calyptorhynchus lathami	**Glossy Black-Cockatoo**	**V**	**-**	**In NSW, widespread along coast and inland to the southern tablelands and central western plains, with a small population in the Riverina.**	**Open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur.**	**17**	**Potential – habitat is marginal (some Allocasuarina littoralis and Casuarina glauca present and large hollows) and species known to occur within 5 km**	**Yes**
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Recorded from Rockhampton in Qld south to Ulladulla in NSW. Largest concentrations of populations occur in the sandstone escarpments of the Sydney basin and the NSW north-west slopes.	Wet and dry sclerophyll forests, Cyprus Pine dominated forest, woodland, sub-alpine woodland, edges of rainforests and sandstone outcrop country.	2	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
Charadrius leschenaultii	Greater Sand-plover	V	V, M	In NSW, recorded between the northern rivers and the Illawarra, with most records coming from the Clarence and Richmond estuaries.	Almost entirely restricted to coastal areas in NSW, mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks.	-	No – no records of species within 5 km and unsuitable habitat (no ebach or intertidal mudflats)	No
Chthonicola sagittata	Speckled Warbler	V	-	From south-eastern Qld, the eastern half of NSW and into Victoria, as far west as the Grampians, mostly on hills and tablelands of the Great Dividing Range and rarely on coast.	Eucalyptus-dominated communities with a grassy understorey and sparse shrub layer, often on rocky ridges or in gullies.	3	Unlikely – habitat marginal (eucalyptus-dominated canopy and rocky), but minimal records of species within 5 km	No
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	From eastern through central NSW, west to Corowa, Wagga Wagga, Temora, Forbes, Dubbo and Inverell.	Eucalypt woodlands and dry open forest.	2	Unlikely – habitat marginal (PCT 3592), but minimal records of species within 5 km	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
Daphoenositta chrysoptera	**Varied Sittella**	**V**	**-**	**Distribution in NSW is nearly continuous from the coast to the far west.**	**Inhabits eucalypt forests and woodlands, mallee and Acacia woodland.**	**15**	**Potential – habitat is marginal (PCT 3592) and species known to occur within 5 km**	**Yes**
Dasyornis brachypterus	Eastern Bristlebird	E1	E	There are three main populations: Northern - southern Qld/northern NSW, Central - Barren Ground NR, Budderoo NR, Woronora Plateau, Jervis Bay NP, Booderee NP and Beecroft Peninsula and Southern - Nadgee NR and Croajingalong NP in the vicinity of the NSW/Victorian border.	Central and southern populations inhabit heath and open woodland with a heathy understorey. In northern NSW, habitat comprises open forest with dense tussocky grass understorey.	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Qld.	Rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline.	1	Unlikely – habitat marginal (PCT 3592), but minimal records of species within 5 km	No
Delma impar	Striped Legless Lizard	V	V	In NSW, occurs in the Southern Tablelands, the South West Slopes and possibly on the Riverina.	Natural Temperate Grassland, secondary and modified grassland, open Box-Gum Woodland.	-	No – no records of species within 5 km and unsuitable	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
							habitat (no grassland nor box-gum woodland)	
Epinephelus daemelii	Black Rockcod	- (V under FM Act)	V	Along the entire NSW coast including Lord Howe Island.	Caves, gutters and beneath bomboras on rocky reefs. Small juveniles are often found in coastal rock pools, and larger juveniles around rocky shores in estuaries.	-	No – no records of species within 5 km and unsuitable habitat (no estuary)	No
Erythrotriorchis radiatus	Red Goshawk	E4A	V	In NSW, extends to ~30°S. Recent records confined to the Northern Rivers region north of the Clarence River.	Open woodland and forest, often along or near watercourses or wetlands. In NSW, preferred habitats include mixed subtropical rainforest, Melaleuca swamp forest and coastal riparian Eucalyptus forest.	-	Unlikely – habitat marginal (PCT 3592 next to lake), but no records of species within 5 km	No
Falco hypoleucos	Grey Falcon	E1	-	Arid and semi-arid zones. In NSW, found chiefly throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range.	Shrubland, grassland and wooded watercourses, occasionally in open woodlands near the coast, and near wetlands.	-	Unlikely – habitat marginal (PCT 3592 next to lake), but no records of species within 5 km	No
Falsistrellus tasmaniensis	**Eastern False Pipistrelle**	**V**	**-**	**South-east coast and ranges of Australia, from southern Qld to Victoria and Tasmania. In NSW,**	**Tall (greater than 20m) moist habitats.**	**9**	**Potential – habitat is marginal**	**Yes**

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
				records extend to the western slopes of the Great Dividing Range.			**(PCT 3592) and species known to occur within 5 km**	
Gallinago hardwickii	Latham's Snipe	-	M	Migrant to east coast of Australia, extending inland west of the Great Dividing Range in NSW.	Freshwater, saline or brackish wetlands up to 2000 m above sea-level; usually freshwater swamps, flooded grasslands or heathlands.	-	Unlikely – habitat suitable (lake), but no records of species within 5 km	No
Glossopsitta pusilla	**Little Lorikeet**	**V**	**-**	**In NSW, found from the coast westward as far as Dubbo and Albury.**	**Dry, open eucalypt forests and woodlands, including remnant woodland patches and roadside vegetation.**	**43**	**Potential – habitat is marginal (PCT 3592) and species known to occur within 5 km**	**Yes**
Grantiella picta	Painted Honeyeater	V	V	Widely distributed in NSW, predominantly on the inland side of the Great Dividing Range but avoiding arid areas.	Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests.	-	No – no records of species within 5 km and unsuitable habitat (no Boree, Brigalow and Box-Gum Woodlands	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
							and Box-Ironbark Forests)	
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	Distributed along the coastline of mainland Australia and Tasmania, extending inland along some of the larger waterways, especially in eastern Australia.	Freshwater swamps, rivers, lakes, reservoirs, billabongs, saltmarsh and sewage ponds and coastal waters. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, forest and urban areas.	2	Unlikely – habitat marginal (PCT 3592 and lake), but no records of species within 5 km	No
Heleioporus australiacus	Giant Burrowing Frog	V	V	South eastern NSW and Victoria, in two distinct populations: a northern population in the sandstone geology of the Sydney Basin as far south as Ulladulla, and a southern population occurring from north of Narooma through to Walhalla, Victoria.	Heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based.	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Hieraaetus morphnoides	Little Eagle	V	-	Throughout the Australian mainland, with the exception of the most densely-forested parts of the Dividing Range escarpment.	Open eucalypt forest, woodland or open woodland, including sheoak or Acacia woodlands and riparian woodlands of interior NSW.	2	Unlikely – habitat marginal (PCT 3592), but minimal records of species within 5 km	No
Hirundapus caudacutus	**White-throated Needletail**	**-**	**M, V**	**All coastal regions of NSW, inland to the western slopes and inland plains of the Great Divide.**	**Occur most often over open forest and rainforest, as well as**	**171**	**Potential – habitat is marginal (PCT 3592)**	**Yes**

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
					heathland, and remnant vegetation in farmland.		**and species known to occur within 5 km**	
Hoplocephalus bungaroides	Broad-headed Snake	E1	V	Largely confined to Triassic and Permian sandstones within the coast and ranges in an area within approximately 250 km of Sydney.	Dry and wet sclerophyll forests, riverine forests, coastal heath swamps, rocky outcrops, heaths, grassy woodlands.	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	E1	E	Found in south-eastern NSW, east of the Great Dividing Range south from the Hawkesbury River.	Heath or open forest with a heathy understorey on sandy or friable soils.	-	No – no records of species within 5 km and unsuitable habitat (no heathy understorey)	No
Lathamus discolor	**Swift Parrot**	**E1**	**CE**	**Migrates from Tasmania to mainland in Autumn-Winter. In NSW, the species mostly occurs on the coast and south west slopes.**	**Box-ironbark forests and woodlands.**	**14**	**Potential – habitat is marginal (PCT 3592) and species known to occur within 5 km**	**Yes**
Limosa lapponica	Bar-tailed Godwit	-	M	Summer migrant to Australia. Widespread along the coast of NSW, including the offshore	Intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons, bays,	-	Unlikely – habitat marginal	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
				islands. Also numerous scattered inland records.	seagrass beds, saltmarsh, sewage farms and saltworks, saltlakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms, and coral reef-flats. Rarely inland wetlands, paddocks and airstrips.		(lake), but no records of species within 5 km	
Litoria aurea	Green and Golden Bell Frog	E1	V	Since 1990, recorded from ~50 scattered sites within its former range in NSW, from the north coast near Brunswick Heads, south along the coast to Victoria. Records exist west to Bathurst, Tumut and the ACT region.	Marshes, dams and stream-sides, particularly those containing Typha spp. (bullrushes) or Eleocharis spp. (spikerushes). Some populations occur in highly disturbed areas.	11	Unlikely – habitat is unsuitable (lake with no Typha) but species known to occur within 5 km	No
Macquaria australasica	Macquarie Perch	- (E under FM Act)	E	Murray-Darling Basin (particularly upstream reaches) of the Lachlan, Murrumbidgee and Murray rivers, and parts of south-eastern coastal NSW, including the Hawkesbury and Shoalhaven catchments.	River and lake habitats, especially the upper reaches of rivers and their tributaries.	-	Unlikely – habitat marginal (lake), but no records of species within 5 km	No
Meridolum corneovirens	Cumberland Plain Land Snail	E1		Areas of the Cumberland Plain west of Sydney, from Richmond and Windsor south to Picton and from Liverpool, west to the Hawkesbury and Nepean Rivers at the base of the Blue Mountains.	Primarily inhabits Cumberland Plain Woodland. Also known from Shale Gravel Transition Forests, Castlereagh Swamp Woodlands and the margins of River-flat Eucalypt Forest.	1	No – no records of species within 5 km and unsuitable habitat (PCT 3592)	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
Micronomus norfolkensis	**Eastern Coastal Free-tailed Bat**	**V**	**-**	**Found along the east coast from south Queensland to southern NSW.**	**Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures.**	**7**	**Potential – foraging habitat is marginal (PCT 3592) and species known to occur within 5 km**	**Yes**
Miniopterus australis	Little Bentwing-bat	V		East coast and ranges south to Wollongong in NSW.	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub.	1	Unlikely – habitat marginal (PCT 3592), but minimal records of species within 5 km	No
Miniopterus orianae oceanensis	**Large Bent-winged Bat**	**V**	**-**	**Occur along the east and north-west coasts of Australia.**	**Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.**	**335**	**Potential – foraging habitat is marginal (PCT 3592) and species known to occur within 5 km**	**Yes**
Mixophyes balbus	Stuttering Frog	E1	V	Along the east coast of Australia from southern Qld to north-eastern Victoria.	Rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range.	-	Unlikely – habitat marginal (PCT 3592), but no records of	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
							species within 5 km	
Monarcha melanopsis	Black-faced Monarch	-	M	In NSW, occurs around the eastern slopes and tablelands of the Great Divide, inland to Coutts Crossing, Armidale, Widden Valley, Wollemi National Park and Wombeyan Caves. It is rarely recorded farther inland.	Rainforest, open eucalypt forests, dry sclerophyll forests and woodlands, gullies in mountain areas or coastal foothills, Brigalow scrub, coastal scrub, mangroves, parks and gardens.	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Motacilla flava	Yellow Wagtail	-	M	Regular summer migrant to mostly coastal Australia. In NSW recorded Sydney to Newcastle, the Hawkesbury and inland in the Bogan LGA.	Swamp margins, sewage ponds, saltmarshes, playing fields, airfields, ploughed land, lawns.	-	Unlikely – habitat marginal (exotic grass lawn), but no records of species within 5 km	No
Myiagra cyanoleuca	Satin Flycatcher	-	M	In NSW, widespread on and east of the Great Divide and sparsely scattered on the western slopes, with very occasional records on the western plains.	Eucalypt-dominated forests, especially near wetlands, watercourses, and heavily-vegetated gullies.	-	Unlikely – habitat marginal (PCT 3592 next to lake), but no records of species within 5 km	No
Myotis macropus	**Southern Myotis**	**V**	**-**	**In NSW, found in the coastal band. It is rarely found more than 100 km inland, except along major rivers.**	**Foraging habitat is waterbodies (including streams, or lakes or reservoirs) and fringing areas of vegetation up to 20m.**	**14**	**Potential – foraging habitat is present (lake and PCT 3592) and**	**Yes**

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
							species known to occur within 5 km	
Ninox connivens	**Barking Owl**	**V**	**-**	**Wide but sparse distribution in NSW, avoiding the most central arid regions. Core populations exist on the western slopes and plains and in some northeast coastal and escarpment forests.**	**Woodland and open forest, including fragmented remnants and partly cleared farmland, wetland and riverine forest.**	**5**	**Potential – hunting habitat is marginal (PCT 3592) and species known to occur within 5 km**	**Yes**
Ninox strenua	**Powerful Owl**	**V**	**-**	**In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered records on the western slopes and plains.**	**Woodland, open sclerophyll forest, tall open wet forest and rainforest.**	**600**	**Potential – hunting habitat is present (PCT 3592) and species known to occur within 5 km**	**Yes**
Notamacropus parma	Parma Wallaby	-	V	Patchily distributed along the Great Dividing Range	Wet sclerophyll forest with a thick, shrubby understorey and nearby grassy patches. The species also occurs in dry sclerophyll forest with a dense understorey and occasionally in rainforest.	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
Numenius madagascariensis	Eastern Curlew	-	CE, M	Summer migrant to Australia. Primarily coastal distribution in NSW, with some scattered inland records.	Estuaries, bays, harbours, inlets and coastal lagoons, intertidal mudflats or sandflats, ocean beaches, coral reefs, rock platforms, saltmarsh, mangroves, freshwater/brackish lakes, saltworks and sewage farms.	-	Unlikely – habitat marginal (freshwater lake), but no records of species within 5 km	No
Petauroides volans	Southern Greater Glider	E2	V	Occurs throughout eastern NSW. In the Sydney Basin, it is known from many IBRA subregions including Cumberland.	Eucalypt forests and woodlands.	1	No – habitat marginal (PCT 3592), but few records (one) of species within 5 km.	No
Petaurus australis australis	Yellow-bellied Glider	V	V	Along the eastern coast, from the NSW-Qld border to the NSW-Vic border, and inland to the western slopes of the Great Dividing Range.	Occurs in eucalypt-dominated woodlands and forests, including both wet and dry sclerophyll forests	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Petroica boodang	Scarlet Robin	V	-	In NSW, it occurs from the coast to the inland slopes.	Dry eucalypt forests and woodlands, and occasionally in mallee, wet forest, wetlands and tea-tree swamps.	1	Unlikely – habitat marginal (PCT 3592), but minimal records of species within 5 km	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
Phascolarctos cinereus	Koala	E	E	In NSW it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range. There are sparse and possibly disjunct populations in the Bega District, and at several sites on the southern tablelands.	Eucalypt woodlands and forests.	2	Unlikely – habitat marginal (PCT 3592), but minimal records of species within 5 km	No
Pommerhelix duralensis	**Dural Land Snail**	**E**	**E**	**Local Government Areas of The Hills Shire, Hawkesbury Shire and Hornsby Shire. Records from the Blue Mountains City, Penrith City and Parramatta City may represent this species.**	**The species has a strong affinity for communities in the interface region between shale-derived and sandstone-derived soils, with forested habitats that have good native cover and woody debris.**	**95**	**Potential – habitat is marginal (PCT 3592) and species known to occur within 5 km**	**Yes**
Prototroctes maraena	Australian Grayling	- (E in FM Act)	V	Streams and rivers on the eastern and southern flanks of the Great Dividing Range; in NSW, it occurs south from the Shoalhaven River.	Coastal rivers and streams, fresh and brackish coastal lagoons.	-	Unlikely – habitat suitable (freshwater lake), but no records of species within 5 km	No
Pseudomys novaehollandiae	New Holland Mouse	-	V	Fragmented distribution across eastern NSW.	Open heathlands, woodlands and forests with a heathland understorey, vegetated sand dunes.	-	No – no records of species within 5 km and unsuitable	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
							habitat (no heathland)	
Pseudophryne australis	Red-crowned Toadlet	V	-	Confined to the Sydney Basin, from Pokolbin in the north, the Nowra area to the south, and west to Mt Victoria in the Blue Mountains.	Open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings.	5	Unlikely – habitat is unsuitable (no ephemeral creek and minimal leaf litter) and minimal records within 5 km	No
Pteropus poliocephalus	**Grey-headed Flying-fox**	**V**	**V**	**Along the eastern coast of Australia, from Bundaberg in Qld to Melbourne in Victoria.**	**Subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops.**	**197,641**	**Likely – habitat suitable (foraging, no camps) and species known to occur within 5 km**	**Yes**
Pycnoptilus floccosus	Pilotbird	-	V	Upland Pilotbirds occur above 600 m in the Brindabella Ranges in the ACT, and in the Snowy Mountains in NSW and north-east Victoria. Lowland Pilotbirds occur in forests from the Blue Mountains west of Newcastle, around the wetter forestsof eastern Australia, to Dandenong near Melbourne.	Live on the ground in dense forests with heavy undergrowth	-	No – no records of species within 5 km and unsuitable habitat (no heavy undergrowth)	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
Rhipidura rufifrons	Rufous Fantail	-	M	Coastal and near coastal districts of northern and eastern Australia, including on and east of the Great Divide in NSW.	Wet sclerophyll forests, subtropical and temperate rainforests. Sometimes drier sclerophyll forests and woodlands.	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Rostratula australis	Australian Painted Snipe	E1	E	In NSW most records are from the Murray-Darling Basin. Other recent records include wetlands on the Hawkesbury River and the Clarence and lower Hunter Valleys.	Swamps, dams and nearby marshy areas.	-	No – no records of species within 5 km and unsuitable habitat (no swamps)	No
Saccolaimus flaviventris	**Yellow-bellied Sheathtail-bat**	**V**	**-**	**There are scattered records of this species across the New England Tablelands and North West Slopes. Rare visitor in late summer and autumn to south-western NSW.**	**Almost all habitats, including wet and dry sclerophyll forest, open woodland, open country, mallee, rainforests, heathland and waterbodies.**	**8**	**Potential – habitat is marginal (PCT 3592 and lake) and species known to occur within 5 km**	**Yes**
Scoteanax rueppellii	**Greater Broad-nosed Bat**	**V**	**-**	**Both sides of the great divide, from the Atherton Tableland in Qld to north-eastern Victoria, mainly along river systems and gullies. In NSW it is widespread on the New England Tablelands.**	**Woodland, moist and dry eucalypt forest and rainforest.**	**8**	**Potential – habitat is marginal (PCT 3592) and species known to**	**Yes**

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
							occur within 5 km	
Symposiachrus trivirgatus	Spectacled Monarch	-	M	Coastal eastern Australia south to Port Stephens in NSW.	Mountain/lowland rainforest, wooded gullies, riparian vegetation including mangroves.	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Thunnus maccoyii	Southern Bluefin Tuna	- (E in FM Act)	CD	Generally between the latitudes of 20°S and 45°S. The species migrates along the southeast Australian coastline. Considered to be historically rare in NSW waters.	Pelagic, generally occurring in cool temperate oceanic waters on the seaward side of the continental shelf.	-	No – no records of species within 5 km and unsuitable habitat (no oceanic waters)	No
Tringa nebularia	Common Greenshank	-	M	Summer migrant to Australia. Recorded in most coastal regions of NSW; also widespread west of the Great Dividing Range, especially between the Lachlan and Murray Rivers and the Darling River drainage basin, including the Macquarie Marshes, and north-west regions.	Terrestrial wetlands (swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans, saltflats, sewage farms and saltworks dams, inundated rice crops and bores) and sheltered coastal habitats (mudflats, saltmarsh, mangroves, embayments, harbours, river estuaries, deltas, lagoons, tidal pools, rock-flats and rock platforms).	-	Unlikely – habitat marginal (lake), but no records of species within 5 km	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of records within 5 km	Likelihood of Occurrence	Impact Assessment Required
Tyto novaehollandiae	Masked Owl	V	-	Recorded over approximately 90% of NSW, excluding the most arid north-western corner. Most abundant on the coast but extends to the western plains.	Dry eucalypt forests and woodlands from sea level to 1100 m.	2	Unlikely – habitat marginal (PCT 3592), but minimal records of species within 5 km	No
Tyto tenebricosa	Sooty Owl	V	-	Occupies the easternmost one-eighth of NSW, occurring on the coast, coastal escarpment and eastern tablelands.	Dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests.	1	Unlikely – habitat marginal (PCT 3592), but minimal records of species within 5 km	No

KEY
BC ACT: V = VULNERABLE, E1 = ENDANGERED, E2 = ENDANGERED POPULATION, E4A = CRITICALLY ENDANGERED, P = PROTECTED
EPBC ACT: V = VULNERABLE, E = ENDANGERED, CE = CRITICALLY ENDANGERED, M = MIGRATORY, CP = CONSERVATION DEPENDENT
FM ACT: V = VULNERABLE, E = ENDANGERED, CE = CRITICALLY ENDANGERED, EP = ENDANGERED POPULATION

Table 7-3: Likelihood of occurrence of threatened flora species within the study area

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of Records within 5 km	Likelihood of Occurrence	Impact Assessment Required
Acacia bynoeana	Bynoe's Wattle	E1	V	Found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains.	Heath or dry sclerophyll forest on sandy soils.	-	No – habitat unsuitable and no records of species within 5 km	No
Acacia pubescens	Downy Wattle	V	V	Restricted to the Sydney region around the Bankstown-Fairfield-Rookwood and Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon.	Open woodland and forest, including Cooks River/Castlereagh Ironbark Forest, Shale/Gravel Transition Forest and Cumberland Plain Woodland. Occurs on alluviums, shales and at the intergrade between shales and sandstones.	6	No – minimal records of species within 5 km	No
Allocasuarina glareicola	-	E1	E	Primarily restricted to the Richmond (NW Cumberland Plain) district, but with an outlier population found at Voyager Point, Liverpool.	Castlereagh woodland on lateritic soil. Found in open woodland with Eucalyptus parramattensis, Eucalyptus fibrosa, Angophora bakeri, Eucalyptus sclerophylla and Melaleuca decora.	-	No – no records of species within 5 km, and outside of range	No
Asterolasia elegans	-	E1	E	Occurs north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby local government areas. Also likely to occur in the western part of Gosford local government area.	Hawkesbury sandstone. Found in sheltered forests on mid- to lower slopes and valleys.	-	No – records of species within 5 km, and outside of range	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of Records within 5 km	Likelihood of Occurrence	Impact Assessment Required
Caladenia tessellata	Thick Lip Spider Orchid	E1	V	Currently known from two disjunct areas; one population near Braidwood on the Southern Tablelands and three populations in the Wyong area on the Central Coast.	Grassy sclerophyll woodland on clay loam or sandy soils, or low woodland with stony soil.	-	No – no records of species within 5 km, and outside of range	No
Callistemon linearifolius	Netted Bottle Brush	V	-	Georges River to Hawkesbury River in the Sydney area (limited to the Hornsby Plateau area), and north to the Nelson Bay area of NSW. Also Coalcliff in the northern Illawarra.	Dry sclerophyll forest.	1	No – no records of species within 5 km, and outside of range	No
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	In NSW, recorded mainly on coastal and near coastal ranges north from Victoria to near Forster, with two isolated occurrences inland north-west of Grafton.	Coastal heathlands, margins of coastal swamps and sedgelands, coastal forest, dry woodland, and lowland forest.	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Darwinia biflora	-	V	V	Recorded in Ku-ring-gai, Hornsby, Baulkham Hills and Ryde local government areas, in an area bounded by Maroota, North Ryde, Cowan and Kellyville.	Woodland, open forest or scrub-heath on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone.	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Dillwynia tenuifolia		V	-	Mainly on the Cumberland Plain, but also Bulga Mountains at Yengo in the north, and Kurrajong Heights and Woodford in the Lower Blue Mountains.	Scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest, transitional areas where these communities adjoin	2	No – records of species within 5 km, but unsuitable habitat (no heathland)	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of Records within 5 km	Likelihood of Occurrence	Impact Assessment Required
					Castlereagh Scribbly Gum Woodland, and disturbed escarpment woodland on Narrabeen sandstone.			
Epacris purpurascens var. *purpurascens*	-	V	-	Recorded from Gosford in the north, to Narrabeen in the east, Silverdale in the west and Avon Dam vicinity in the South.	Sclerophyll forest, scrubs and swamps. Most habitats have a strong shale soil influence.	769	No – records of species within 5 km, but unsuitable habitat (sandstone)	No
Eucalyptus camfieldii	Camfield's Stringybark	V	V	Narrow band from the Raymond Terrace area south to Waterfall.	Coastal heath on shallow sandy soils overlying Hawkesbury sandstone, mostly on exposed sandy ridges.	-	No – no records of species within 5 km and unsuitable habitat (no heath)	No
Eucalyptus sp. *Cattai*	-	CE	CE	Only known from north-western Sydney between Castle Hill and Cattai.	Scrub, heath and low woodland, in sandstone-derived soils	-	No – habitat unsuitable (no scrub, heath or low woodland), no records of species within 5 km	No
Genoplesium baueri	Bauer's Midge Orchid	E1	E	Has been recorded from locations between Nowra and Pittwater and may occur as far north as Port Stephens.	Dry sclerophyll forest and moss gardens over sandstone.	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Hibbertia superans	-	E1	-	From Baulkham Hills to South Maroota in the northern	Open woodland and heathland, and appears to	82	No – habitat marginal (PCT	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of Records within 5 km	Likelihood of Occurrence	Impact Assessment Required
				outskirts of Sydney, and at one locality at Mount Boss, inland from Kempsey.	prefer open disturbed areas.		3592), but no records of species within 5 km and outside geographic range	
Isotoma fluviatilis subsp. *fluviatilis*		E1	X	Currently known from only one property at Erskine Park in the Penrith LGA. Previously sighted at Homebush and at Agnes Banks.	Damp places on the Cumberland Plain, including freshwater wetland, grassland/alluvial woodland, and alluvial woodland/shale plains woodland.	1	No – minimal records of species within 5 km and outside geographic range	No
Lasiopetalum joyceae	-	V	V	Restricted to the Hornsby Plateau south of the Hawkesbury River, between Berrilee and Duffys Forest.	Heath on lateritic to shaley ridgetops over sandstone.	-	No – minimal records of species within 5 km and outside geographic range	No
Macadamia integrifolia	Macadamia Nut	P	V	Not known to occur naturally in the wild in NSW; recorded from Camden Haven but it is not known if the tree was cultivated or growing naturally.	Drier subtropical rainforest.	2	Unlikely – habitat marginal (PCT 3592), but minimal records of species within 5 km	No
Melaleuca biconvexa	Biconvex Paperbark	V	V	Only found in NSW, populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north.	Damp places, often near streams or low-lying areas on alluvial soils.	-	No – habitat marginal (PCT 3592 next to lake), but no records of species within 5 km and	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of Records within 5 km	Likelihood of Occurrence	Impact Assessment Required
							outside geographic range	
Melaleuca deanei	Deane's Paperbark	V	V	Ku-ring-gai/Berowra area, Holsworthy/Wedderburn area, Springwood (in the Blue Mountains), Wollemi National Park, Yalwal (west of Nowra) and Central Coast (Hawkesbury River) areas.	Heath on sandstone.	-	No – no records of species within 5 km and study area is outside geographic range.	No
Persicaria elatior	Tall Knotweed	V	V	In south-eastern NSW recorded from Mt Dromedary, Moruya State Forest near Turlinjah, the Upper Avon River catchment north of Robertson, Bermagui, and Picton Lakes. In northern NSW known from Raymond Terrace (near Newcastle) and the Grafton area (Cherry Tree and Gibberagee State Forests).	Beside streams and lakes, swamp forest or disturbed areas.	-	No – habitat marginal (PCT 3592 next to lake), but no records of species within 5 km and outside geographic range	No
Persoonia hirsuta	Hairy Geebung	E1	E	Scattered distribution around Sydney, from Singleton in the north, along the east coast to Bargo in the south and the Blue Mountains to the west.	Sandy soils in dry sclerophyll open forest, woodland and heath on sandstone.	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Persoonia nutans	Nodding Geebung	E1	E	Restricted to the Cumberland Plain in western Sydney, between Richmond in the north and Macquarie Fields in the south.	Northern populations: sclerophyll forest and woodland (Agnes Banks Woodland, Castlereagh Scribbly Gum Woodland and Cooks River / Castlereagh Ironbark	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of Records within 5 km	Likelihood of Occurrence	Impact Assessment Required
					Forest) on aeolian and alluvial sediments. Southern populations: tertiary alluvium, shale sandstone transition communities and Cooks River / Castlereagh Ironbark Forest.			
Pimelea curviflora var. *curviflora*	-	V	V	Confined to the coastal area of the Sydney and Illawarra regions between northern Sydney and Maroota in the north-west and Croom Reserve near Albion Park in the south.	Woodland, mostly on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes.	116	Unlikely – habitat is marginal but degraded so likely to be trampled (PCT 3592, sandy-loam on sandstone) and species known to occur within 5 km	No
Pimelea spicata	Spiked Rice-flower	E1	E	Two disjunct areas; the Cumberland Plain (Marayong and Prospect Reservoir south to Narellan and Douglas Park) and the Illawarra (Landsdowne to Shellharbour to northern Kiama).	Well-structured clay soils. *Eucalyptus moluccana* (Grey Box) communities and in areas of ironbark on the Cumberland Plain. Coast Banksia open woodland or coastal grassland in the Illawarra.	1	No – habitat unsuitable (sandy-loam soil), minimal records of species within 5 km and outside geographic range	No
Pomaderris brunnea	Brown Pomaderris	E1	V	In NSW, found around the Colo, Nepean and Hawkesbury Rivers, including the Bargo area and near Camden. It also occurs near Walcha on the New England tablelands.	Moist woodland or forest on clay and alluvial soils of flood plains and creek lines.	-	No – habitat marginal (PCT 3592 next to Lake), but no records of species within 5 km and	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of Records within 5 km	Likelihood of Occurrence	Impact Assessment Required
							outside geographic range	
Pomaderris prunifolia	P. prunifolia in the Parramatta, Auburn, Strathfield and Bankstown Local Government Areas	E2	-	Population is known from only three sites: at Rydalmere, within Rookwood Cemetery and at The Crest of Bankstown.	At Rydalmere it occurs among grass species on sandstone near a creek. At Rookwood Cemetery it occurs in a small gully of degraded Cooks River / Castlereagh Ironbark Forest on shale soils.	10	No – records of species within 5 km, but study area not at within Rookwood Cemetery or The Crest of Bankstown.	No
Pterostylis gibbosa	Illawarra Greenhood	E1	E	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra).	Open forest or woodland, on flat or gently sloping land with poor drainage.	-	No – no records of species within 5 km and unsuitable habitat (land is sloped) and outside geographic range	No
Pterostylis saxicola	Sydney Plains Greenhood	E1	E	Restricted to western Sydney between Freemans Reach in the north and Picton in the south.	Small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines, adjacent to sclerophyll forest or woodland on shale/sandstone transition soils or shale soils.	2	Unlikely – habitat marginal (sandstone rocks), but minimal records of species within 5 km	No
Rhizanthella slateri	Rhizanthella slateri (Rupp) M.A. Clem. & Cribb in the	E2,V	E	The population occurs near Bulahdelah (within the Great Lakes LGA).	Sclerophyll forest in shallow to deep loams.	-	Unlikely – habitat marginal (PCT 3592), but no	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of Records within 5 km	Likelihood of Occurrence	Impact Assessment Required
	Great Lakes local government area						records of species within 5 km	
Rhizanthella slateri	Eastern Australian Underground Orchid	V	E	In NSW, currently known from fewer than 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra.	Sclerophyll forest in shallow to deep loams.	-	No – habitat marginal (PCT 3592), but no records of species within 5 km and outside geographic range	No
Rhodamnia rubescens	Scrub Turpentine	CE	CE	Occurs from Batemans Bay NSW to areas inland of Bundaberg in Queensland.	Found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils.	9	Unlikely – habitat is marginal (PCT 3592) and species known to occur within 5 km, but not identified during field survey	No
Rhodomyrtus psidioides	Native Guava	CE	CE	Occurs from Broken Bay NSW, to Maryborough in Queensland.	Pioneer species found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest often near creeks and drainage lines.	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No
Syzygium paniculatum	Magenta Lilly Pilly	E1	V	Only in NSW, in a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest.	Subtropical and littoral rainforest on gravels, sands, silts and clays.	6	Potential – habitat is marginal (PCT 3592) and species known to occur within 5 km but not identified	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of Records within 5 km	Likelihood of Occurrence	Impact Assessment Required
							during field survey	
Tetratheca glandulosa	-	V	-	Found from Sampons Pass (Yengo NP) in the north to West Pymble (Lane Cove NP) in the south. The eastern limit is at Ingleside (Pittwater LGA) and the western limit is at East Kurrajong (Wollemi NP).	Heath, scrub, woodlands and open forest on upper-slopes and mid-slope sandstone benches. Soils generally shallow, consisting of a yellow, clayey/sandy loam.	1	Unlikely – habitat marginal (PCT 3592), but minimal records of species within 5 km	No
Thesium australe	Austral Toadflax	V	V	In eastern NSW it is found in very small populations scattered along the coast, and from the Northern to Southern Tablelands.	Grassland on coastal headlands or grassland and grassy woodland away from the coast.	-	No – no records of species within 5 km and unsuitable habitat (no grasslands)	No
Triplarina imbricata	Creek Triplarina	E1	E	A few locations in the ranges south-west of Glenreagh and near Tabulam in north-east NSW.	Along watercourses in low open forest with *Tristaniopsis laurina* (Water Gum).	2	No – habitat marginal (lake), but minimal records of species within 5 km and outside geographic range	No
Wilsonia backhousei	Narrow-leafed Wilsonia	V	-	In NSW, found on the coast between Mimosa Rocks National Park and Wamberal north of Sydney (Nelson's Lake, Potato Point, Sussex Inlet, Wowly Gully, Parramatta River at Ermington, Clovelly, Voyager	Margins of salt marshes and lakes.	1	Unlikely – habitat marginal (lake), but minimal records of species within 5 km	No

Scientific Name	Common Name	BC Act Status	EPBC Act Status	Distribution	Habitat	Number of Records within 5 km	Likelihood of Occurrence	Impact Assessment Required
				Point, Wollongong and Royal National Park).				
Zieria involucrata		E1	V	North and west of Sydney; recent records come from 22 populations in the catchments of the Macdonald, Colo and Hawkesbury Rivers between Melon Creek and Mogo Creek in the north to Little Cattai Creek (Hillside) and Wheeny Creek (Colo) in the south and from a single population in the upper Blue Mountains north of Katoomba. Also historically recorded south of Springwood Valley Heights and north-west of Kurrajong in the eastern Blue Mountains.	Wet sclerophyll forest on mid- to lower slopes and valleys; some populations extend upslope into drier vegetation.	-	Unlikely – habitat marginal (PCT 3592), but no records of species within 5 km	No

KEY
BC ACT: V = VULNERABLE, E1 = ENDANGERED, E2 = ENDANGERED POPULATION, E4A = CRITICALLY ENDANGERED, P = PROTECTED
EPBC ACT: V = VULNERABLE, E = ENDANGERED, CE = CRITICALLY ENDANGERED, M = MIGRATORY

C2 Tests of Significance (BC Act)

The 'Test of significance' (5-part test) is applied to species, populations and ecological communities listed on Schedules 1 and 2 of the BC Act and Schedules 4, 4A and 5 of the FM Act. The assessment sets out 5 factors, which when considered, allow proponents to undertake a qualitative analysis of the likely impacts of an action and to determine whether a significant impact is likely. All factors must be considered, and an overall conclusion made based on all factors in combination.

The threatened species, populations, and ecological communities to be assessed under the BC Act, which have potential to occur within the study area or may be indirectly impacted are:

Fauna

- Birds
  - *Calyptorhynchus lathami* (Glossy Black-Cockatoo) – Vulnerable
  - *Daphoenositta chrysoptera* (Varied Sittella) – Vulnerable
  - *Glossopsitta pusilla* (Little Lorikeet) – Vulnerable
  - *Lathamus discolor* (Swift Parrot) – Endangered
  - *Ninox connivens* (Barking Owl) – Vulnerable
  - *Ninox strenua* (Powerful Owl) – Vulnerable
- Microbats
  - *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) – Vulnerable
  - *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat) – Vulnerable
  - *Miniopterus orianae oceanensis* (Large Bent-winged Bat) – Vulnerable
  - *Myotis Macropus* (Southern Myotis) – Vulnerable
  - *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat) – Vulnerable
  - *Scoteanax rueppellii* (Greater Broad-nosed Bat) – Vulnerable
- Megabats
  - *Pteropus poliocephalus* (Grey-headed Flying-fox) – Vulnerable
- Snails
  - *Pommerhelix duralensis* (Dural Land Snail) – Endangered

Birds

The following bird species (woodland birds and owls) require BC Act Tests of Significance:

- *Calyptorhynchus lathami* (Glossy Black-Cockatoo) – Vulnerable
- *Daphoenositta chrysoptera* (Varied Sittella) – Vulnerable
- *Glossopsitta pusilla* (Little Lorikeet) – Vulnerable
- *Lathamus discolor* (Swift Parrot) – Endangered
- *Ninox connivens* (Barking Owl) – Vulnerable
- *Ninox strenua* (Powerful Owl) – Vulnerable

The proposed works include the removal of approximately 0.03 ha of foraging/hunting habitat for assessed birds. The study area does not represent potential breeding habitat for the Swift Parrot, which only breeds in Tasmania.

Table 7-4: Test of Significance – Glossy Black-Cockatoo, Varied Sitella, Little Lorikeet, Swift Parrot, Barking Owl, Powerful Owl

BC Act	Question	Response
7.3.1 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	These bird species may use trees within the study area for foraging/hunting. Viable local populations of these species are likely to use resources from a much larger area than the study area due to their mobile nature and large home ranges. There are no tree hollows suitable for roosting/breeding with the study area. Varied Sittella may form nests within the study area. The Swift Parrot breeds in Tasmania, so no breeding habitat would be affected. The suitability of the habitat is considered marginal, given its degraded nature, small area of direct impact, mobility of these species and large patches of potential habitat that outside of the study area around Lake Parramatta and Hunts Creek. Therefore, the proposed works are unlikely to affect their life cycles to the extent that would place the local populations at risk of extinction.
7.3.1 b) i	In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: 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	N/A
7.3.1 b) ii	In the case of an endangered ecological community or critically endangered ecological community: Whether the proposed development or activity is likely to substantially and adversely modify the composition of the ecological	N/A

BC Act	Question	Response
	community such that its local occurrence is likely to be placed at risk of extinction.	
7.3.1 c) i	In relation to the habitat of a threatened species or ecological community: The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity	Impacts relate to potential foraging/hunting habitat for the above species, and in the case of and Varied Sitella, potential roosting/breeding habitat. The proposed works will remove approximately 0.03 ha of potential habitat. No breeding habitat for the Swift Parrot, Barking Owl or Powerful Owl would be affected.
7.3.1 c) ii	In relation to the habitat of a threatened species or ecological community: 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	The proposed works will not fragment or isolate areas of habitat for such mobile species given the small scale of the proposed works and similar vegetation surrounding the study area in in the vicinity. These species can utilise remaining vegetation surrounding the study area for this purpose.
7.3.1 c) iii	In relation to the habitat of a threatened species or ecological community: The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.	The habitat to be removed is not considered important to the long-term survival of these species given the degraded nature of the study area (providing marginal foraging and breeding habitat) and that there is similar vegetation in the broader locality. These species are highly mobile, which means they can access the habitat in surrounding vegetation and utilise a range of resources.
7.3.1 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 proposed works will not have an adverse effect on any declared area of outstanding biodiversity value.
7.3.1 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.	There is one key threatening process (KTP) relevant to the proposed works and these species: • -Clearing of native vegetation Although the proposed works will result in the clearing of native vegetation, the patches to be removed are small in extent, and there are larger patches of similar vegetation surrounding the study area.
Conclusion	Is there likely to be a significant impact?	No, a significant impact is not likely because: • The habitat for roosting/breeding is considered marginal, given its small size. • There are larger patches of potential foraging and breeding habitat that form continuous areas of habitat throughout the locality • These species are highly mobile, which means they can access the habitat in surrounding vegetation

Microbats

The following microbat species requires a BC Act Tests of Significance:

- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) – Vulnerable
- *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat) – Vulnerable
- *Miniopterus orianae oceanensis* (Large Bent-winged Bat) – Vulnerable
- *Myotis Macropus* (Southern Myotis) – Vulnerable
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat) – Vulnerable
- *Scoteanax rueppellii* (Greater Broad-nosed Bat) - Vulnerable

The proposed works include the removal of approximately 0.03 ha of foraging habitat.

The **Eastern False Pipistrelle** is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania. It generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. Hunts beetles, moths, weevils and other flying insects above or just below the tree canopy. The local population is considered any individuals within a 5 km radius of the study area.

The **Eastern Coastal Free-tailed Bat** is found along the east coast from south Queensland to southern NSW and occurs in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. The Eastern Freetail-bat roost mainly in tree hollows but will also roost under bark or in man-made structures. They are usually solitary but have also been recorded roosting communally and are probably insectivorous. The local population is considered any individuals within a 5 km radius of the study area.

Large Bent-winged Bat occurs on both sides of the Great Dividing Range, from the coast inland to Moree, Dubbo and Wagga Wagga. It is found in rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland. The Large Bent-winged Bat forages above and below the tree canopy on small insects. The bats congregate at the same maternity roosts each year to give birth and rear young. In the southern part of the species' range, this occurs during spring. Maternity roosts may be in caves, abandoned mines, concrete bunkers or lava tubes. Over-wintering roosts, used outside the breeding period, include cooler caves, old mines, and stormwater channels, under bridges and occasionally buildings. The local population is considered any individuals within a 5 km radius of the study area.

The **Southern Myotis** is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage, and forages over streams and pools catching insects and small fish by raking their feet across the water surface. The local population is considered any individuals within a 5 km radius of the study area.

Yellow-bellied Sheathtail-bat roosts, singly or in groups of up to six, in tree hollows and buildings. In treeless areas, they are known to utilise mammal burrows. They forage in most habitats throughout their very wide range, including areas with and without trees and appear to defend an aerial territory. The local population is considered any individuals within a 5 km radius of the study area.

Greater Broad-nosed Bat is a large bat that feeds on moths and other large insects along edges of forest, cleared paddocks and tree-lined water courses. This species uses mostly tree hollows for roosting, and they have been recorded in a variety of vegetation types from woodland to rainforest. The local population is considered any individuals within a 5 km radius of the study area.

Table 7-5: Test of Significance – Microbats

BC Act	Question	Response
7.3.1 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	The extent of the local population is assessed as those individuals which may reside within a 5 km radius of the study area. The proposed works will result in impacts to 0.03 ha of potential foraging habitat for these microbats. There was no roosting habitat identified for these microbats within the study area (no small hollows, buildings, or caves). These microbats are highly mobile and several species may only utilise habitat within the study area on an occasional basis for foraging and dispersal. Due to their mobility, foraging habitat is unlikely to become isolated / fragmented from breeding habitat. Considering the significant area of potential foraging habitat to be available in adjacent lands (determined through a desktop assessment), the proposed works are unlikely to have an adverse effect on the lifecycle of the above listed microbats such that a viable local population would be placed at risk of extinction.
7.3.1 b) i	In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: 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	Not applicable.
7.3.1 b) ii	In the case of an endangered ecological community or critically endangered ecological community: Whether the proposed development or activity 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.	Not applicable.
7.3.1 c) i	In relation to the habitat of a threatened species or ecological community: The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity	The proposed works will result in the removal of up to 0.03 ha of potential foraging habitat for the above listed microbats. No roosting/breeding habitat is to be removed.
7.3.1 c) ii	In relation to the habitat of a threatened species or ecological community: Whether an area of habitat is likely to become fragmented or isolated from other	The area of habitat to be removed is 0.03 ha of potential foraging habitat for these microbats. No breeding habitat (i.e. small hollows, caves, culverts and/or tunnels) for these species would be affected.

BC Act	Question	Response
	areas of habitat as a result of the proposed development or activity	The assessed microbat species are highly mobile, and utilise a range of foraging resources throughout their foraging range. For any species present within the locality, there is potential foraging habitat present in vegetation surrounding Lake Parramatta and Hunts Creek. Removal of the vegetation within the impact area would not fragment foraging resources in the locality due to the microbats' high mobility. There is no roosting habitat within the study area. Removal of this vegetation is not likely to fragment or isolate this species as there is likely to be similar foraging habitat in the locality.
7.3.1 c) iii	In relation to the habitat of a threatened species or ecological community: The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.	The habitat to be removed is likely to be used as an occasional for foraging resource across a larger foraging and home range. The assessed microbat species would utilise a range of foraging resources within the locality. Considering the small size of potential habitat (0.03 ha) to be impacted within the study area and the high mobility of the species, the habitat to be removed is not considered critical to the long-term survival of these species within the locality.
7.3.1 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 proposed works will not have an adverse effect on any declared area of outstanding biodiversity value.
7.3.1 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.	There is one key threatening process (KTP) relevant to the proposed works and these species: • Clearing of native vegetation Although the proposed works will result in the clearing of native vegetation, the patch to be removed is small in extent, and there are larger patches of similar habitat surrounding the study area.
Conclusion	Is there likely to be a significant impact?	No, a significant impact is not likely because: • These microbats are highly mobile and several species may only utilise habitat within the study area on an occasional basis for foraging and dispersal • There is no roosting/breeding habitat within the study area • There is a significant area of potential foraging habitat available in adjacent lands

Grey-Headed Flying-fox

Pteropus poliocephalus (Grey-headed Flying-fox) requires a BC Act Tests of Significance because the proposed works include the removal of 0.03 ha of marginal foraging habitat for this species. There are no known camps within or close to the study area.

The nearest permanent camps within 20 km radius are (DCCEEW, 2022c):

- 2.5 km south at Parramatta Park (nationally important), 2,500-9,999 individuals in 2022
- 5.5 km south at Clyde (not nationally important), 500-2,499 individuals in 2020
- 9.5 km south west at Wetherill Park (not nationally important), 1-499 individuals in 2020
- 10 km north east at Gordon (nationally important), 500-2,499 individuals in 2021
- 13 km south east at Gladesville (not nationally important), 2,500-9,999 individuals in 2022
- 14.5 km south west at Cabramatta (not nationally important), 2,500-9,999 individuals in 2020
- 19 km west at Ropes Creek (not nationally important), 2,500-9,999 individuals in 2022
- 19.5 km south east at Wolli Creek (nationally important), 2,500-9,999 individuals in 2022

Table 7-6: Test of Significance – Grey-headed Flying-fox

BC Act	Question	Response
7.3.1 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	The proposed works would remove 0.03 ha of vegetation that constitutes foraging habitat for the Grey-headed Flying-fox. It could be used as a 'stepping stone', but there is other vegetation surrounding the study area that could be utilised. No breeding habitat in the form of camps would be impacted as part of the proposed works. It is considered unlikely that the proposed works would place a viable population of the species at risk of extinction given that the area of potential habitat is isolated and small in extent and would only be used occasionally, as part of a mosaic of foraging resources.
7.3.1 b) i	In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: 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	Not applicable.
7.3.1 b) ii	In the case of an endangered ecological community or critically endangered ecological community: Whether the proposed development or activity 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.	Not applicable.
7.3.1 c) i	In relation to the habitat of a threatened species or ecological community:	The proposed works would remove 0.03 ha of potential foraging habitat. No breeding habitat (camps) would be impacted.

BC Act	Question	Response
	The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity	
7.3.1 c) ii	In relation to the habitat of a threatened species or ecological community: 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	The proposed works would remove 0.03 ha of marginal foraging habitat for this species. This would not increase fragmentation, as this is a highly mobile species that would still be able to access similar vegetation within the locality.
7.3.1 c) iii	In relation to the habitat of a threatened species or ecological community: The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.	The proposed works would remove 0.03 ha of foraging habitat for Grey-headed Flying-fox. This small area of habitat to be impacted is not considered vital to the long-term survival of this species within the locality because the species is highly mobile and would be able to continue foraging in better condition vegetation within the locality (as identified via desktop assessment) and within 20 km of the nearest camp.
7.3.1 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 proposed works will not have an adverse effect on any declared area of outstanding biodiversity value.
7.3.1 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.	There is one key threatening process (KTP) relevant to the proposed works and this species: • -Clearing of native vegetation Although the proposed works will result in the clearing of native vegetation, the patch to be removed is small in extent, and there are larger patches of similar habitat surrounding the study area and within 20 km of the nearest camp that can be utilised by this highly mobile species for foraging.
Conclusion	Is there likely to be a significant impact?	No, a significant impact is not likely because: • This species is highly mobile and may only utilise habitat within the study area on an occasional basis for foraging and dispersal • There are no camps within the study area • There is foraging habitat available in adjacent lands and within 20 km of the nearest camp

Snails

Pommerhelix duralensis (Dural Land Snail) is endangered under the BC Act and requires a BC Act Test of Significance. The proposed works include the removal of approximately 0.03 ha of habitat.

Table 7-7: Test of Significance – Dural Land Snail

BC Act	Question	Response
7.3.1 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	The extent of the local population is assessed as those individuals which may reside within a 5 km radius of the study area. The proposed works will result in impacts to 0.03 ha of potential foraging habitat for the Dural Land Snail. Due to the degraded nature of the vegetation within the study area, and similar vegetation surrounding the study area along Lake Parramatta and Hunts Creek (determined through a desktop assessment), the proposed works are unlikely to have an adverse effect on the lifecycle of the Dural Land Snail such that a viable local population would be placed at risk of extinction.
7.3.1 b) i	In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: 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	Not applicable.
7.3.1 b) ii	In the case of an endangered ecological community or critically endangered ecological community: Whether the proposed development or activity 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.	Not applicable.
7.3.1 c) i	In relation to the habitat of a threatened species or ecological community: The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity	The proposed works will result in the removal of up to 0.03 ha of potential habitat for the Dural Land Snail in degraded condition.
7.3.1 c) ii	In relation to the habitat of a threatened species or ecological community: 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	The area of habitat for the Dural Land Snail to be removed is 0.03 ha. Removal of this vegetation is not likely to fragment or isolate this species as it is a small amount of vegetation and there is similar habitat to be retained within the study area and surrounding Lake Parramatta and Hunts Creeks with good connectivity.

BC Act	Question	Response
7.3.1 c) iii	In relation to the habitat of a threatened species or ecological community: The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.	Considering the small size of potential habitat (0.03 ha) to be impacted within the study area and the amount of similar vegetation retained within the study area and surrounding Lake Parramatta and Hunts Creek, the habitat to be removed is not considered critical to the long-term survival of these species within the locality.
7.3.1 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 proposed works will not have an adverse effect on any declared area of outstanding biodiversity value.
7.3.1 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.	There is one key threatening process (KTP) relevant to the proposed works and these species: • Clearing of native vegetation Although the proposed works will result in the clearing of native vegetation, the patch to be removed is small in extent, and there are larger patches of similar habitat within the study surrounding the study area. Area and surrounding the study area around Lake Parramatta and Hunts Creek.
Conclusion	Is there likely to be a significant impact?	No, a significant impact is not likely because: • The vegetation to be removed is degraded with only a small amount of leaf litter • The vegetation to be removed is small (0.03 ha) and there is similar vegetation to be retained within the study area and surrounding Lake Parramatta and Hunts Creek with good connectivity.

C3 Application of Significant Impact Criteria

The EPBC Act establishes a process for assessing the environmental impact of activities and developments where Matters of National Environmental Significance (MNES) may be affected. Under the Act, any action which 'has, will have, or is likely to have a significant impact on a matter of MNES' is defined as a controlled action, and requires approval from the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW), which is responsible for administering the EPBC Act.

The process includes undertaking an Assessment of Significance (AoS) for listed threatened species and ecological communities that represent a matter of MNES that will be affected as a result of the proposed action. Significant impact guidelines that outline several criteria have been developed by the Commonwealth of Australia (2013), to provide assistance in conducting the AoS and help decide whether or not a referral to the Commonwealth is required.

The following MNES has been assessed as a part of this assessment. These are:

Fauna:

- Birds
  - *Hirundapus caudacutus* (White-throated Needletail) – Vulnerable/Migratory
  - *Lathamus discolor* (Swift Parrot) – Critically Endangered
- Snails
  - *Pommerhelix duralensis* (Dural Land Snail) – Endangered
- Megabats
  - *Pteropus poliocephalus* (Grey-headed Flying-fox) – Vulnerable

Hirundapus caudacutus (White-throated Needletail)

The White-throated Needletail is listed as vulnerable and migratory under the EPBC Act and has been previously recorded within a 5 km radius of the action area (DPE, 2022b). The proposed activity includes the removal of 0.03 ha of foraging and roosting habitat for this species. The White-throated Needletail does not breed in Australia.

Considering that White-throated Needletail has potential to forage above PCT 3592 and roost in the trees within the action area on an occasional basis, a significance assessment has been undertaken in accordance with Significant impact guidelines 1.1 under the EPBC Act (Table 7-11).

Table 7-8: EPBC Act Assessment for *Hirundapus caudacutus (White-throated Needletail)*

Criterion	Assessment
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Criterion a: lead to a long-term decrease in the size of an important population of a species	The *Matters of National Environmental Significance Impact Guidelines 1.1* (CoA, 2013) defines an important population as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • Key source populations either for breeding or dispersal • Populations that are necessary for maintaining genetic diversity, and/or • Populations that are near the limit of the species range The proposed action would remove 0.03 ha marginal foraging and roosting habitat for White-throated Needletail. The species is highly mobile and would be able to access similar foraging and roosting habitat adjacent to the action area. Breeding habitat would not be impacted as the White-throated Needletail is migratory and does not breed in Australia. Therefore, it is unlikely that the action would lead to a long-term decrease in the size of an important population.
Criterion b: reduce the area of occupancy of an important population	The proposed action would reduce the area of potential foraging and roosting habitat available for the White-throated Needletail within the action area by 0.03 ha. This would reduce the area of occupancy of the species. The White-throated Needletail will not use the action area for breeding, and therefore the proposed action will not reduce the area of breeding habitat available.
Criterion c: fragment an existing important population into two or more populations	The two subspecies of White-throated Needletails breed in separate populations in the Northern Hemisphere, but only one occurs in Australia with no smaller populations (DCCEEW, 2022b). There is potential that the White-throated Needletail population could occasionally forage or roost within the action area. There will be an impact (0.03 ha) to foraging and roosting habitat for this population. However, the proposed action is unlikely to fragment this population into two or more populations as the White-throated Needletail is a highly mobile species and would therefore have the ability to forage a roost within adjacent similar vegetated areas (not field validated). The removal of 0.03 ha of vegetation which comprises some foraging and roosting habitat is unlikely to significantly remove foraging habitat to the extent that it would impede foraging for this species and fragment this important population into two or more populations.
Criterion d: adversely affect habitat critical to the survival of a species	'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary: • for activities such as foraging, breeding, roosting, or dispersal

Criterion	Assessment
	• for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • to maintain genetic diversity and long-term evolutionary development, or • for the reintroduction of populations or recovery of the species or ecological community. The proposed action will remove 0.03 ha of vegetation suitable as foraging or roosting habitat for the White-throated Needletail. However, given that this species is highly mobile, and the abundant habitat resources within the locality it is considered unlikely that the development would adversely affect habitat critical to the survival of this species.
Criterion e: disrupt the breeding cycle of an important population	The proposed action would not remove breeding habitat for this species. Foraging and roosting behaviour may be impacted but only to a small extent which would not disrupt the breeding cycle of the species because the species is highly mobile and uses a range of resources throughout its foraging range. There is other potential foraging and roosting habitat available in the vicinity of the action area.
Criterion f: modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The proposed action would remove 0.03 ha of potential foraging and roosting habitat for the White-throated Needletail, which would be used on an occasional basis, and as part of a range of foraging and roosting resources throughout the species range. Habitat within and around the action area has been significantly modified over time, which means that the vegetation within the action area is not likely to be a primary foraging habitat. The proposed action would remove a small area of foraging and roosting habitat but is unlikely to cause this species to decline.
Criterion g: result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The proposed action is unlikely to result in the establishment of an invasive species that is harmful to the White-throated Needletail, due to the small scale of the proposed action (i.e. removal of 0.03 ha of vegetation).
Criterion h: introduce disease that may cause the species to decline	The proposed action is unlikely to introduce disease that may cause the White-throated Needletail to decline.
Criterion i: interfere substantially with the recovery of the species	The proposed action would remove marginal foraging and roosting habitat. However, similar habitat is available for the highly mobile species within the adjoining land. Due to the highly mobile nature of this species, the proposed action is unlikely to fragment the population. Therefore, the proposed action is unlikely to interfere with the recovery of the species.
Conclusion	No. The proposed action is unlikely to have a significant impact on the White-throated Needletail for the following reasons: • The proposed action would not remove breeding habitat for the species. • The potential foraging and roosting habitat to be removed is only 0.03 ha • The species is highly mobile and could continue to forage and roost within the action area and beyond.

Lathamus discolor (Swift Parrot)

Lathamus discolour (Swift Parrot) is listed as Critically Endangered under the EPBC Act. This species was not recorded during survey, however foraging habitat was identified within the action area. No breeding habitat would be affected, as this species does not breed in NSW. Considering that this species may intermittently forage within the development site, the significant impact criteria has been applied in accordance with Significant Impact Guidelines (Table 7-9).

Table 7-9: Application of Significant Impact Criteria to Swift Parrot

Criterion	Assessment
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:	
Criterion a: lead to a long-term decrease in the size of a population	A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. The proposed action would remove 0.03 ha marginal foraging habitat for Swift Parrot. The species is highly mobile and would be able to access similar foraging habitat adjacent to the action area. Breeding habitat would not be impacted. Therefore, it is unlikely that the action would lead to a long-term decrease in the size of an important population.
Criterion b: reduce the area of occupancy of the species	The proposed action would reduce the area of potential foraging habitat available for the Swift Parrot within the action area by 0.03 ha. This would reduce the area of occupancy of the species. The Swift Parrot will not use the action area for breeding, and therefore the proposed action will not reduce the area of breeding habitat available.
Criterion c: fragment an existing population into two or more populations	A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to: • a geographically distinct regional population, or collection of local populations, or • a population, or collection of local populations, that occurs within a particular bioregion The Swift Parrot occurs as a single, migratory population (Stojanovic et al. 2018). The most recent population estimate was done for the Bird Action Plan 2010, which suggested there were approximately 2,000 mature individuals in the wild (Garnett et al. 2011). Swift parrots spend the winter on mainland Australia and nest in Tasmania over summer. Key foraging species includes Yellow Gum (*Eucalyptus leucoxylon*); Red Ironbark (*E. tricarpa*); Mugga Ironbark (*E. sideroxylon*); Grey Box (E. macrocarpa); White Box (*E. albens*); Yellow Box (*E. melliodora*); Swamp Mahogany (*E. robusta*); Forest Red Gum (*E. tereticornis*); Blackbutt (*E. pilularis*); and Spotted Gum (*Corymbia maculata*). The study area contained one of the key foraging species; *Eucalyptus pilularis* (Blackbutt). Therefore, there is potential that the Swift Parrot population could occasionally forage within the study area. There will be an impact (0.03 ha) to foraging habitat for this population. However, the proposed action is unlikely to fragment this population into two or more populations as the Swift Parrot is a highly mobile species and would therefore have the ability to forage within adjacent vegetated areas which are likely to also contain *E. pilularis* (not field validated). The removal of 0.03 ha of vegetation which comprises some foraging habitat is unlikely to significantly remove foraging habitat to the extent that it would impede foraging

Criterion	Assessment
	for this species and fragment this important population into two or more populations.
Criterion d: adversely affect habitat critical to the survival of a species	'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary: • for activities such as foraging, breeding, roosting, or dispersal • for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • to maintain genetic diversity and long term evolutionary development, or • for the reintroduction of populations or recovery of the species or ecological community. The Swift Parrot forages on flowers and psyllid lerps in Eucalyptus species on mainland Australia, and breeds in Tasmania. They have a preference for woodlands containing, *Eucalyptus robusta* and *Corymbia maculata*, which were not found in the action area. They are less likely to utilise disturbed or fragmented vegetation due to competition (DCCEEW, 2022b). The vegetation in the action area is in a degraded condition with frequent recreational use. Therefore, it is considered that the proposed action will not adversely affect habitat critical to the survival of this species.
Criterion e: disrupt the breeding cycle of a population	The proposed action would not remove breeding habitat for this species. Foraging behaviour may be impacted but only to a small extent which would not disrupt the breeding cycle of the species because the species is highly mobile and uses a range of resources throughout its foraging range. There is other potential foraging habitat available in the vicinity of the action area.
Criterion f:modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The proposed action would remove 0.03 ha of potential foraging and roosting habitat for the Swift Parrot, which would be used on an occasional basis, and as part of a range of foraging and roosting resources throughout the species range. Habitat within and around the development site has been significantly modified over time and is already degraded, which means that the vegetation within the action area is not likely to be a primary foraging habitat. The proposed action would remove a small area of foraging habitat but is unlikely to cause this species to decline.
Criterion g: result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species habitat	Removal of vegetation within the study area may increase competition with aggressive honeyeaters or introduced birds due to disturbance of their habitat. However, the proposed action is unlikely to result in the establishment of an invasive species that is harmful to the Swift Parrot as the condition of this habitat is already degraded with high recreational use.
Criterion h: introduce disease that may cause the species to decline, or	Psittacine Beak and Feather Disease (PBFD) is a widespread, lethal parrot disease, which has been recorded in swift parrots. This disease can have a significant impact if their health is reduced from stress associated with competition for nesting and food resources. Due to the degraded condition of the habitat in the action area, it is unlikely that it is a primary food source, so its removal would not significantly increase competition. Therefore, the proposed action is unlikely to introduce disease that may cause the Swift Parrot to decline.
Criterion i: interfere with the recovery of the species	The proposed action would remove marginal foraging and roosting habitat. However, similar habitat is available for the highly mobile species within the

Criterion	Assessment
	adjoining land. Due to the highly mobile nature of this species, the proposed action is unlikely to fragment the population. Therefore, the proposed action is unlikely to interfere with the recovery of the species.
Conclusion	No. The proposed action is unlikely to have a significant impact on the Swift Parrot for the following reasons: • The proposed action would not remove breeding habitat for the species. • The potential foraging habitat is small (0.03 ha) and is in degraded condition • The species is highly mobile and could continue to forage within the action area and beyond.

Pommerhelix duralensis (Dural Land Snail)

The Dural Land Snail is listed as endangered under the EPBC Act. The proposed action will impact 0.03 ha of habitat suitable for this species (PCT 3592).

Table 7-10: EPBC Act Assessment for *Pommerhelix duralensis* (Dural Land Snail)

Criterion	Assessment
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility of the following:	
Criterion a: will the action lead to a long-term decrease in the size of a population	The Conservation Advice for this species states that "given the species occurs in a limited location and has a fragmented distribution the Committee considers all populations to be important." The Conservation Advice also identifies that the Dural Land Snail "occurs in low abundance" with a maximum recorded density of three live snails per hectare. Given that the proposed action will affect 0.03 ha of degraded habitat with similar vegetation to be retained within the action area and around Lake Parramatta and Hunts Creek, this action is unlikely to lead to a long-term decrease in the size of the population.
Criterion b: will the action reduce the area of occupancy of the species	The proposed action will the reduce the potential habitat of this species by 0.03 ha.
Criterion c: will the action fragment an existing population into two or more populations	The proposed action will affect a small area of potential habitat (0.03 ha) for this species. This is not likely to fragment an existing population into two or more populations due to the small and degraded nature of the vegetation to be removed, and similar vegetation to be retained within the action area and in vegetation nearby surrounding Lake Parramatta and Hunts Creek.
Criterion d: will the action adversely affect habitat critical to the survival of a species	Habitat important to the survival of the species, as listed in the Conservation Advice for the Dural Land Snail, includes "shale-influenced vegetation types". The proposed action is on Gymea soil landscape on Hawkesbury Sandstone and minor shale and laminate lenses (DPE, 2022e). The proposed action will adversely affect 0.03 ha of habitat critical to the survival of the species (PCT 3592).
Criterion e: will the action disrupt the breeding cycle of a population	According to the Conservation Advice for the species, "the genetic viability of Dural Land Snail populations is of concern." The proposed action will affect 0.03 ha of habitat, which is not likely to contribute to genetic isolation and inbreeding depression due to the small scale and large tracts of similar vegetation to be retained within the action area and surrounding areas of vegetation along Lake Parramatta and Hunts Creek.
Criterion f: will the action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The proposed action will affect 0.03 ha of habitat available for the species within the action area. Dispersal of the Dural Land Snail is extremely slow (the Conservation Advice states the maximum nightly straight-line-dispersal recorded as 0.96 m in a survey conducted over 16 survey-animal-nights). However, due to the small area of vegetation to be removed (0.03 ha), the proposed action is unlikely destroy, isolate and decrease the availability or quality of habitat to the extent that the species is likely to decline.
Criterion g: will the action result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	The proposed action may result in the establishment of *Bradybaena similaris* (Asian Tramp Snail), and / or *Cornu aspersum* (Common Garden Snail) (imported via mining machinery or cars), invasive species that are harmful to the Dural Land Snail. The proposed action may also result in increased risk of predation by *Turdus merula* (Common Blackbird). However, it is highly likely that one or more of these invasive species is already present near to the action area.

Criterion	Assessment
Criterion h: will the action introduce disease that may cause the species to decline	The action is unlikely to introduce disease that would cause this species to decline.
Criterion i: will the action interfere with the recovery of the species	One of the primary conservation objectives listed in the Conservation Advice for the Dural Land Snail is "maintain and enhance the species' habitat and connectivity." The proposed action is not likely to substantially interfere with this objective as the habitat to be cleared is only 0.03 ha, and there are large tracts of similar vegetation to be retained within the action area and in surrounding vegetation along Lake Parramatta and Hunts Creek.
Conclusion	The proposed clearing of 0.03 ha of habitat will not have a significant impact on the Dural Land Snail for the following reasons: • The proposed action will remove a very small area of potential habitat with a low level of leaf litter • There are large tracts of similar vegetation to be retained within the action area and in surrounding vegetation along Lake Parramatta and Hunts Creek with good connectivity.

Pteropus poliocephalus (Grey-headed Flying-fox)

The Grey-headed Flying-fox is listed as vulnerable under the EPBC Act and has been previously recorded within a 5 km radius of the action area (DPE 2022b). The proposed works include the removal of 0.03 ha of foraging habitat for this species.

Grey-headed Flying-fox present in camps within a 20 km radius of the action area may use the foraging resources available within the action area. There are no known camps within the study area. The nearest permanent camps within 20 km radius are (DCCEEW, 2022c):

- 2.5 km south at Parramatta Park (nationally important), 2,500-9,999 individuals in 2022
- 5.5 km south at Clyde (not nationally important), 500-2,499 individuals in 2020
- 9.5 km south west at Wetherill Park (not nationally important), 1-499 individuals in 2020
- 10 km north east at Gordon (nationally important), 500-2,499 individuals in 2021
- 13 km south east at Gladesville (not nationally important), 2,500-9,999 individuals in 2022
- 14.5 km south west at Cabramatta (not nationally important), 2,500-9,999 individuals in 2020
- 19 km west at Ropes Creek (not nationally important), 2,500-9,999 individuals in 2022
- 19.5 km south east at Wolli Creek (nationally important), 2,500-9,999 individuals in 2022

Considering that Grey-headed Flying-fox is likely to forage on the eucalypt species within the action area on an occasional basis, a significance assessment has been undertaken in accordance with Significant impact guidelines 1.1 under the EPBC Act (Table 7-11).

Table 7-11: EPBC Act Assessment for *Pteropus poliocephalus* (Grey-headed Flying-fox)

Criterion	Assessment
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Criterion a: lead to a long-term decrease in the size of an important population of a species	The Matters of National Environmental Significance Impact Guidelines 1.1 (CoA, 2013) defines an important population as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • Key source populations either for breeding or dispersal • Populations that are necessary for maintaining genetic diversity, and/or • Populations that are near the limit of the species range The Grey-headed Flying-fox is considered one population due to the constant exchange of genetic material between individuals and its movement between camps throughout its entire geographic range (DCCEEW, 2021). Maternity or other roosting habitat is considered important habitat for this species. According to the National Flying-fox Monitoring Program, no Grey-headed Flying-fox camps currently occur or have historically been recorded within the action area (DCCEEW, 2021). The nearest active Grey-headed Flying-fox camp occurs at Parramatta Park approximately 2.5 km south of the action area. The proposed action will directly remove 0.03 ha of vegetation suitable as foraging habitat for the Grey-headed Flying-fox. The Grey-headed Flying-fox is recorded as travelling long distances (up to 20 km) on feeding forays. The individuals at the nearest camps have access to suitable foraging habitat within 20 km that is outside of the action area, so removal of vegetation within the action area would not remove a 'stepping-stone' or cause fragmentation for this species. Given the proximity of abundant habitat outside the action area, the removal of this potential foraging habitat would not lead to the long-term decrease in the size of an important population of Grey-headed Flying-fox.

Criterion	Assessment
Criterion b: reduce the area of occupancy of an important population	The proposed action will reduce the extent of available foraging habitat for the Grey-headed Flying-fox. About 0.03 ha of potential foraging habitat will be removed from the action area. The action area does not contain breeding or sheltering habitat (camps). The Grey-headed Flying-fox is known to fly long distances (up to 20 km per night) and move between bat camps. As such this species is likely to utilise a large extent of habitat around the Ropes Creek camp which may include some habitat within the action area and a large amount of habitat in adjacent lands. Due to the extent of habitat within a 20 km radius of the nearest known bat camp at Parramatta Park, the removal of a small amount of foraging habitat is unlikely to significantly reduce the extent of occupancy for this species.
Criterion c: fragment an existing important population into two or more populations	The proposed action will remove 0.03 ha of vegetation suitable as foraging habitat for the Grey-headed Flying-fox. No camps will be affected, and other areas of foraging habitat are present in the locality. Whilst the potential foraging habitat may contribute as a 'stepping-stone' for this highly mobile species to other more substantial foraging habitat sites, this function is unlikely to be significantly inhibited by the proposed action. Furthermore, this species has been recorded in urban environments and is likely to continue to forage adjacent to the action area and across the broader locality. Therefore, the proposed action is unlikely to fragment an existing important population into two or more populations.
Criterion d: adversely affect habitat critical to the survival of a species	The National Recovery Plan for the Grey-headed Flying-fox (DCCEEW, 2021) identifies a number of myrtaceous plants, including important winter and spring vegetation communities that contain *Eucalyptus tereticornis*, *E. albens, E. crebra, E. fibrosa, E. melliodora, E. paniculata, E. pilularis, E. robusta, E. seeana, E. sideroxylon, E. siderophloia, Banksia integrifolia, Castanospermum australe, Corymbia citriodora C. eximia, C. maculata, Grevillea robusta, Melaleuca quinquenervia* or *Syncarpia glomulifera* as important foraging resources for the Grey-headed Flying Fox. The plan also identifies habitat which contain native species used for foraging and occur within 20 km of a nationally important camp and native or exotic species used for roosting at the site of a nationally important Grey-Headed Flying-Fox camp as critical habitat important to the survival of the species. The action area contains native species used for foraging and is within 20 km of a nationally important camp, so is considered critical habitat. No nationally important camps will be directly affected by the proposed action. The proposed action will remove 0.03 ha of vegetation suitable as foraging habitat for the Grey-headed Flying-fox. However, given that this species is highly mobile (traveling up to 20 km to forage), and the abundant habitat resources within the locality it is considered unlikely that the development would adversely affect habitat critical to the survival of this species.
Criterion e: disrupt the breeding cycle of an important population	The proposed action will remove 0.03 ha of potential foraging habitat for the Grey-headed Flying-fox. The proposed action will not disrupt the breeding cycle of the Grey-headed Flying-fox given that no camps will be impacted by the proposed action and suitable foraging habitat is likely to be available outside of the action area.
Criterion f: modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The proposed action will remove 0.03 ha of potential foraging habitat for the Grey-headed Flying-fox. Given the small amount of foraging habitat to be removed, that habitat is likely to be available outside of the action area and that this species is highly mobile, it is unlikely that the habitat to be removed would cause the species to decline. Further, according to the National Flying-fox Monitoring Program, no Grey-headed Flying-fox camps currently occur or have ever been recorded within the action area (DCCEEW 2022c). The nearest active Grey-headed Flying-fox camp occurs approximately

Criterion	Assessment
	2.5 km to the south at Parramatta Park. Therefore, no known Grey-headed Flying-fox roosting camps for this species will be impacted by the proposed action.
Criterion g: result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The proposed action is unlikely to result in the establishment of an invasive species that is harmful to the Grey-headed Flying-fox.
Criterion h: introduce disease that may cause the species to decline	Grey-headed Flying-fox are reservoirs for the Australian bat lyssavirus which can cause clinical disease and mortality in Grey-headed Flying-fox. The species also carries and Hendra virus, although it does not cause evident clinical disease in flying-foxes. Lyssavirus infection is higher when individuals are under stress. The proposed action would not increase the incidence of Lyssavirus, as no camps would be directly impacted, and there is other foraging habitat surrounding each nearby camp.
Criterion i: interfere substantially with the recovery of the species	Considering the above factors, the proposed action will not interfere substantially with the recovery of the species.
Conclusion	In consideration of the above, the proposed action is considered unlikely to have a significant impact on the Grey-headed Flying-fox because: • individuals at the nearest camps have access to suitable foraging habitat within 20 km that is outside of the action area, so removal of vegetation within the action area would not remove a 'stepping-stone' or cause fragmentation for this species • there are no camps within the action area.

APPENDIX D

Preliminary Tree Assessment

Eco Logical Australia 2023

Lake Parramatta Swimming Area – Preliminary Tree Assessment

City of Parramatta

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Project Number	22SYD3841
Project Manager	Courtney Blick
Prepared by	Erin Hodgkin and Daniel McDonald
Reviewed by	Deanne Hickey, David Bidwell, Daniel McDonald and Rebecca Ben-Haim
Approved by	Rebecca Ben-Haim
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Template 2.8.1

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Abbreviations

Abbreviation	Description
AQF	Australian Qualifications Framework
AS	Australian Standards
DAB	Diameter at Base
DBH	Diameter at Breast Height
ELA	Eco Logical Australia
GIS	Geographic Information Systems
m	Metre
mm	Millimetre
NDE	Non-Destructive Excavation
NO	Number
NSW	New South Wales
SP	Species
SRZ	Structural Root Zone
TPZ	Tree Protection Zone
VTA	Visual Tree Assessment

1. Background

This Preliminary Tree Assessment (PTA) including guidance for the protection of trees was prepared for City of Parramatta Council (herein referred to as Council) to accompany a Review of Environmental Factors (REF) for the proposed upgrade of the Lake Parramatta swimming area in North Parramatta. The address of the subject land, along with additional information is presented in Table 1. The location of the Subject Land is shown in Figure 3.

Consultation undertaken with the community identified a key concern, being the retention of trees in proximity to the proposed swimming area. Given Council are still finalising the proposed construction method and detailed design for the project, the purpose of this report is to:

- undertake a visual tree assessment of the subject trees
- assess the current overall health and condition of the subject trees
- evaluate the retention value of the subject trees
- recommend tree protection measures to minimise adverse impacts to be incorporated into the construction method and detailed design, where feasible

This information will be used to maximise the retention of trees while achieving the proposed upgrade to the swimming area within Lake Parramatta.

Features of the subject land are presented in Table 1 below.

Table 1: Subject Land

Criteria	Description
Street address	Illawong Drive, North Parramatta
Lot and DP's intersecting with subject land	Lot 7023 DP 1124101 & Lot 7304 DP 1148769
Local Government Area	City of Parramatta Council
General land use	RE1 Public Recreation & W1 Natural Waterways

1.1 Proposed works

The proposed works layout (Figure 2) refers to the concept layout provided by Council for the proposed works. It describes the different elements associated with the proposed project, as well as works identified as potentially impacting trees. Existing features and aspects of the proposal include:

- Sandstone rock outcrops/boulders
- Sandstone block seating/retaining wall
- Coarse river sand 'beach'
- Concrete water access steps
- Underwater retaining wall
- Raised lifeguard platform

The proposed construction access track and construction compound are excluded as an impact, due to the existing use, hardstand, and open lawn in these areas.

Council have stated that an unformed existing dirt and granite track will provide access for equipment and materials. This track has been used intermittently for many years. It is assumed that any soil compaction or other impacts arising from vehicle use have already occurred. No significant increase in soil compaction from use of the track is expected. This assumption is only valid if the type of vehicle and weight of vehicle used for the proposal works is similar to vehicles that have been used previously. ELA have been advised by Council that the track has been previously used by a lightly loaded utility vehicle or dump truck (3T to 4.5 T).

2. Method

2.1 Definition of a tree

A tree is defined under the Australian Standard*, AS 4970-2009, Protection of Trees on Development Sites* as a long lived woody perennial plant greater than (or usually greater than) 3 m in height with one or relatively few main stems or trunks.

For the purpose of this report, trees have been assessed consistent with the local Councils definition of a tree. Parramatta Development Control Plan 2011 (Parramatta DCP) defines a tree as:

1. Any tree or palm – whether indigenous, endemic, exotic, or introduced species with a height equal to or exceeding 5 metres
2. Any tree or mangrove vegetation located on public lang, irrespective of size
3. Any tree or plant, irrespective of size:
    a. that is listed in a Register of Significant Trees; or
    b. that is or forms part of a heritage item, or that is within a heritage conservation area; or
    c. that is or forms part of an Aboriginal object, or that is within an Aboriginal place of heritage significance.

2.2 Visual tree assessment

The health and condition of the subject trees were assessed in accordance with a stage one visual tree assessment (VTA) as formulated by Mattheck and Breloer (1994) and practices consistent with modern arboriculture.

A total of **35 trees** (including trees assessed in groups) were inspected on Wednesday 10 November 2022 by AQF Level 5 Consulting Arborist David Bidwell. Some trees are assessed in groups (two groups of 3 trees), meaning that 31 trees or tree groups are presented in Figure 3 and Appendix D.

The following limitations apply to this methodology:

- Tree height was measured using a laser clinometer.
- Diameter at breast height (DBH) and diameter at base (DAB) was measured using DBH tape.
- Trees were inspected from ground level, without the use of any invasive or diagnostic tools and testing.
- Trees were inspected within limits of site access.
- The locations of the subject trees were recorded by ELA in the field using hand-held GPS units which have errors in accuracy of approximately 5-20 m pending satellite availability on the day. Tree locations were subsequently matched to NearMap imagery (2023) or aligned using field photos where possible using geographic information systems (GIS) techniques.
    - *Note: Tree location was also corrected by use of the site survey.*
- Tree canopy was measured by stepping out the distance within the dripline
- No aerial inspections or root mapping was undertaken.
- Tree identification was based on broad taxonomical features present and visible from ground level at the time of inspection.

Tree species, characteristics and other data collected for the purposes of this PTA is presented in Appendix D.

2.3 Retention value & landscape significance

The retention value or importance of a tree or group of trees is determined in accordance with the Institute of Australian Consulting Arborists (IACA) Significance of a Tree Assessment Rating System (STARS©), which is summarised in Appendix A. The method considers the Safe Useful Life Expectancy (SULE) and landscape significance of a tree. Trees are provided one of the following ratings:

- **High – priority for retention:** These trees are considered important and should be retained and protected. Design modification or re-location of building/s should be considered to accommodate the setbacks as prescribed by Australian Standard *AS 4970–2009 Protection of trees on development sites.*
- **Medium – consider for retention:** These trees are moderately important for retention. Their removal should only be considered if adversely affected by the proposed works and all other alternatives have been considered and exhausted.
- **Low – consider for removal:** These trees are not considered important for retention, nor require special works or design modification to be implemented for their retention.
- **Priority for removal:** These trees are considered hazardous, or in irreversible decline, or weeds and should be removed irrespective of development.

As summarised in Table 2, 13 high retention value trees, 20 are medium retention value trees and 2 low retention value trees were identified in the subject land. No trees were identified as a priority for removal.

Table 2: Tree retention values

Tree Retention Values	Total trees assessed
Priority for retention (high)	13
Consider for retention (medium)	20
Consider for removal (low)	2
Total	**35**

2.4 Protection zones

Protection zones determined in the PTA are presented in Figure 6, tabulated in Appendix D and defined below.

2.4.1 Tree protection zone (TPZ)

The TPZ is a specific radius area above and below ground and at a distance from the trunk set aside for the protection of a tree's roots and crown to provide for the viability and stability of a tree to be retained where it is potentially subject to damage by the development. The TPZ (as defined by AS 4970-2009) requires restriction of access during the development process. Groups of trees with overlapping TPZs may be included within a single protection area. Tree sensitive measures must be implemented if works are to proceed within the TPZ. The TPZ radius is determined by multiplying its DBH by 12 however, the TPZ of palms and monocots should not be less than 1 m outside the crown projection.

2.4.2 Structural root zone (SRZ)

The SRZ is the area of the root system (as defined by AS 4970-2009) used for stability, mechanical support, and anchorage of the tree. It is critical for the support and stability of trees. Severance of roots within the SRZ is not recommended as it may lead to the destabilisation and/or decline of the tree. The SRZ does not apply for palms and monocots (as outlined in AS 4970-2009).

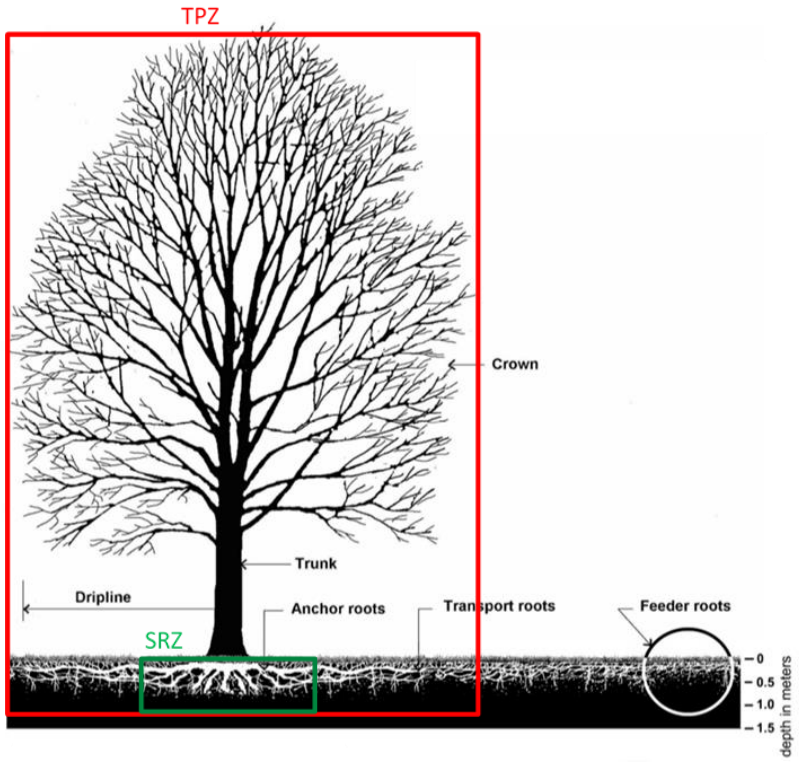

Figure 1: Representative tree structure and indicative TPZ and SRZ

2.5 Potential impacts

Trees may be impacted by physical or chemical damage to roots or above tree parts. Examples include impacts associated with site grading, soil compaction, excavation, stock piling within TPZ as well as changes in site hydrology, changes in soil level and site contamination. The extent of encroachment to the TPZ and SRZ determines the level of potential impact.

AS 4970-2009 defines types of encroachment as follows and as illustrated in Appendix B:

- **Major encroachment** – If the proposed encroachment is greater than 10% of the TPZ or inside the SRZ, the Project Arborist must demonstrate that the tree(s) would remain viable (Section 3.3.3 AS4970). The location and distribution of roots may be determined through non-destructive excavation (NDE) methods such as hydro-vacuum excavation (sucker truck), Air Spade or manual extraction. The area lost to this encroachment should be compensated for elsewhere and contiguous with the TPZ.
- **Minor encroachment** – If the proposed encroachment is less than 10% of the TPZ, and outside of the SRZ, detailed root investigations should not be required. The area lost to this encroachment should be compensated for elsewhere and contiguous with the TPZ.

Impacts to trees have not been assessed as part of this PTA. For the purposes of any future Arboricultural Impact Assessment (AIA), impacts to trees are to be calculated using GIS techniques and defined as follows:

Major Encroachment

- **High impact:** The SRZ is directly affected, or the proposed encroachment of the TPZ is greater than 20%. Trees may not remain viable if they are subject to high impact. These trees cannot be retained unless the proposal is changed and therefore are recommended for removal based on the current design.
- **Medium impact:** If the proposed encroachment is greater than 10% of the TPZ (but less than 20% of the TPZ) and outside of the SRZ, the Project Arborist may require additional information (e.g., root investigation and further detail of construction methods etc.) along with consideration of tree age, health and structure, these trees may be recommended for retention subject to specific protection measures; or they may be recommended for removal based on the current design.
- A major encroachment does necessarily mean that a tree will not remain viable. However, a tree that has received a major encroachment is significantly more likely to decline and potentially die. This is further discussed in Section 3.
- Trees are unlikely to become hazardous in the short term unless they have received an impact to their SRZ.

Minor Encroachment

- **Low impact:** If the proposed encroachment is less than 10% (total area) of the TPZ, and outside of the SRZ, these trees can be retained without further investigation and are recommended for retention.
- **No impact:** No likely or foreseeable encroachment within the TPZ and are recommended for retention.

3. Potential construction-related impacts

3.1 Background

The Australian Standard (AS4970-2007) provides additional information relevant to the proposed works in *Appendix B Potential Damage to Trees on Development Sites.* Information relevant to the proposed works has been reproduced below.

An impact assessment has not been undertaken for the proposed works in relation to trees due to limited available knowledge around construction methods, due to site constraints. This section explains relevant potential impacts for consideration in preparing a construction methodology. A supervising arborist must be present on site before and during construction to provide guidance and ensure the best possible chance of tree retention. It is assumed that some flexibility in construction methods will be allowed for onsite to avoid severing tree roots, compaction and other impacts described below.

3.1.1 Physiological balance of above ground parts

Physiological above ground parts are namely leaves, branches and trunk; and below ground parts, namely roots. The Standard states:

> *A tree is in a state of physiological equilibrium between the above ground and below round sections, so that if one of these sections is damaged, the entire tree will suffer and symptoms may appear in any part of the tree.*
>
> *Thus any demolition and construction operations that occur around trees must be carried out in such a way as to minimise the impact on the health of the tree.*

3.1.2 Background Biology – Roots

The Standard states:

> *The importance of roots is easily overlooked because they are not visible, that is 'out of sight, out of mind'. Damage to the root system is a common cause of tree decline and death and is the most common form of damage associated with development sites.*

3.1.3 Section B3 Effects of Development on Trees – B3.3 Root damage

The Standard states:

> *Root damage is the most common cause of damage to trees on development sites. Roots are far more extensive and closer to the surface than commonly thought. Roots can be damaged in the following ways:*
>
> *a. Removed during grading, excavation and trenching for foundations services, etc.*
> *b. Mechanically wounded, crushed or torn.*
> *c. Compaction by machinery, storage of materials, and installation of work sheds.*
> *d. Soil buildup.*
> *e. Laying of pavements.*
> *f. Chemical contamination of the soil by solvents, fuel, oil, diesel, herbicides, cement waste, etc.*
> *g. Changes in air levels through changes in drainage patterns.*

h. Changes in available water.

Apart from the actual removal of roots during excavation or trenching, soil compaction is one of the major causes of root damage on development sites. Compaction is defined as the loss of large pore space (macropores) within the soil with a net loss of total pore space. Macropores are essential for the exchange of gasses between the soil air and the atmosphere (aeration) and the removal of excess water from the soil (drainage).

3.2 Potential impacts

3.3 Root severance through excavation

As stated above, the TPZ as defined by the Australian Standard is: '*A specified area above and below ground and at a given distance from the trunk set aside for the protection of a tree's roots and crown to provide for the viability and stability of a tree to be retained where it is potentially subject to damage by development.'*

There have been a limited number of studies on the impact of trenching on trees. Research on the impact of trenching is relevant because it provides guidance on the impacts of root severance. Given that roots can occur closer to the surface than commonly thought, and that even minor excavations may have the potential to sever tree roots rather than what is typically thought of as 'trenching'. Some of the studies are briefly discussed below.

Benson *et al.* (2019) states that TPZs that are equal to 12 x the trunk diameter are common. The study examined the impact of trenching on 18 *Quercus virginiana* trees (average DBH 28.25 cm) with an impact varying from 3 x to 15 x the distance from the trunk. They state: '*The results reveal that a TPZ defined by 12 times the trunk diameter was insufficient to adequately avoid short-term physiological perturbations in Quercus virginiana.*

Watson (1998) studied the impact of trenching on 1, 2 or 3 sides of the pin oak *Quercus palustris* trees. The trees had an average DBH of 29 cm. *The distance of between the trench and the base of the trunk was approximately equal to the trunk circumference with slight variation of the caused by machine access and tree spacing.* Stated another way, the trench was dug at a distance of 3.17 times the DBH away from the trunk. The impact of the trenching on the trees was recorded for five years. Watson (1998) recorded the following result: '*Generally, the more severe the trenching treatment, the greater the growth reduction and the longer the reduction persisted. The most severe treatment resulted in significant reductions in total dbh and twig growth compared to the controls. All trees survived.*

In contrast, Morell (1984) recorded the impacts of trenching on roadside trees. The original trenching was completed in 1971 and 1972. The trees were revisited in 1983 to examine their health and survival. In 1971, trenching was undertaken next to 135 trees. In the following year trenching was undertaken next to 127 trees.

Morell noted that by 1983, 60 trees out of the original 135 trees (1971 population) had been removed, a 44% loss and 13 trees had significant dieback in their crowns. Thirty-two (32) trees out of the original 129 trees had been removed from the 1972 population, a 25% loss and 14 trees had crown dieback.

Rogers (2014) provides an Australian perspective and stated that: '*I have found trees to be significantly more resilient than we give them credit. They appear to be able to initiate feeder roots quickly in response to root severance as long as adequate quantities of water are available.'*

Roberts *et al.* (2006) state the following: '*…it is commonly observed that resilience to root severance declines as trees become more mature. Young, vigorously growing trees are more able to withstand damage to their roots than older trees, because growth slows as trees age'.* This statement provides a guide to understanding the impacts of root damage on trees. Older trees are less likely to withstand the impacts of severed roots resulting from excavations and should therefore be treated with caution in order to ensure their viability or survival.

Methods to reduce impacts to trees by root severance are provided in 3.6.1, 3.6.2 and 4.2 below.

3.4 Soil compaction and tree death

Franklin *et al.* (1987) state that: '*Although tree death is sometimes abrupt, it is more frequently a complex and gradual process with multiple contributors.'* They describe tree death as a *'mortality spiral'*, a heathy tree is a tree that has high levels of vitality and little or no stress. As a tree experiences various stresses, it descends the spiral towards death. Initially if the tree only experiences limited amounts of stress it can recover and regain good health.

On the other hand, they state: '*As the tree progresses along this spiral, its opportunities to escape death become more limited.'*

Hirons and Thomas (2018) expand on this discussion and state that there are two principal mechanisms for tree mortality – carbon starvation (lack of food generated by photosynthesis) and hydraulic failure (lack of water). Short term deficits of either food or water, if they are recovered, are unlikely to lead to tree death. However, if either carbon starvation and/or water deficit is prolonged then eventually the tree will die. These impacts can occur via soil compaction, which occurs on construction sites through movement of vehicles, stockpiling and placement of materials. Specifically, in the proposed works, soil compaction has the potential to occur as a result of heavy vehicle movements and permanent placement of heavy sandstone elements within a TPZ or SRZ. Methods to avoid this during construction are provided in Section 3.6.3 and 4.3 below.

3.5 Potential for long-term increase in wind-throw

Moore (2014) suggested that the history of management practices including root disturbance and compaction appeared to be correlated with wind throw in urban trees.

Human mortality and injury caused by wind throw including both loss of branches and trunk failure is very low at approximately one injury or death per year per 2 to 10 million (Ball and Watt 2013; Dunster 2014; Hartley and Chalk 2019). Nevertheless, the risk of death or injury due to human induced impacts on trees is probably slightly increased.

Regular (annual) monitoring of the health, vitality and structure of the trees in areas of relatively high human activity is recommended. Use of a recognised tree hazard assessment method is likely to assist in reducing the risks associated with trees.

3.6 Reducing the impacts of construction damage

3.6.1 Root mapping

The Australian Standard notes that the location of tree roots can be determined prior to construction works. Root mapping can be undertaken during excavation works under supervision by a Project Arborist. Alternatively, a root mapping report can be prepared to guide design works.

The results of root mapping can be used to locate roots critical to tree stability. Works such as installation of footings, installation of masonry structures, regrading, installation of piers or landscaping may require modification to minimise the impact of the works on trees.

3.6.2 Unavoidable root severence

Roberts *et al.* (2006) state that:

> '*If trenching is unavoidable and roots must be cut, the risk of damage to the tree can be minimised by (i) ensuring the minimum necessary proportion of the root system is removed and (ii) not allowing root cutting at times of the year when reserves of energy in the tree are low.'* In the Australian context root severance impacts can be minimised by avoiding tree impacts during dry summers or when trees are already stressed.

3.6.3 Soil compaction

As stated above the Australian Standard includes the following text:

> '*Apart from the actual removal of roots during excavation or trenching, soil compaction is one of the major causes of root damage on development sites.*'

Soil compaction is well understood to impact on plant growth. Modelling soil compaction is difficult (O'Sullivan and Simota 1995, Nawaz et al. 2013). O'Sullivan and Simota (1995) state: 'Soil compactibility depends strongly on soil water content'.

Consequently, minimising soil compaction requires, where possible, avoiding works when the soils are moist. It is acknowledged this is in some ways opposite to the advice that trees are likely to have their greatest vigour and are most resilient after periods of satisfactory soil moisture and tree growth.

3.6.4 Management of potentially impacted trees

Tree management including the tree protection plan for those trees to be retained, along with hold points, inspection schedules and arborist certification are outlined in Section 5.

4. Recommendations

Site-specific recommendations have been provided below to maximise the opportunities for tree retention before, during and after the proposed works. All works will require a supervising project arborist to be present on site.

General and standard measures for tree protection should also be referenced (Section 5 below).

4.1 Design considerations

Given the construction methodology and detailed design for the project are not yet finalised, the provided recommendations are general in nature and are provided to assist in decision making.

It is recommended to either undertake root mapping prior to final design works or alternatively use root mapping to guide installation works for the retaining wall and other project elements within a TPZ.

4.2 Minimise impacts from root severance

- Avoid pruning roots that are larger than 5 cm in diameter.
- Where there is a choice between an impact on an older tree (DBH > 50 cm) and a younger tree (DBH < 50 cm) within in a TPZ. A younger tree is more likely to be resilient to impacts.
- Whenever possible avoid excavation works. If materials can be supported on top of existing soil grade within TPZs, impacts on tree roots will be reduced.
- Impacts to trees within their TPZ but outside their SRZ may have a negative impact on their vitality, but those impacts are unlikely to increase risk in the short term.

4.3 Minimising soil compaction

- Avoid traversing the site with vehicles when soils are moist (during and after rainfall).
- Use of relatively light weight excavators, namely skid shift excavators no greater than five (5) tonnes that use rubber tracks will minimise soil compaction. These types of excavators are used in forestry work. Ensure that use of the skid shift excavator is supervised by an arborist (AQF Level 5) and ensure the twisting and sliding is minimised. Turning is to be undertaken using large turning circles where possible to minimise soil disturbance.
- Use of the existing access track with a lightweight vehicle will reduce impacts extending beyond areas that have previously experienced soil compaction.
- Use of rumble boards and similar materials as described in the Australian Standard 4970 will assist in mitigating the impacts from soil compaction.
- Use cranes to transfer materials down to the swimming area wherever feasible.

4.4 Assist trees in recovering once works are complete

- Addition of mulch significantly improves soil moisture retention and consequently assists in tree recovery.
- Maintaining good health potentially though additional watering or irrigation during warmer months when required will assist in tree recovery.

5. Tree Management Plan

5.1 General Tree Protection Plan

Before any tree works commence, the following must be in place:

- All tree work must be in accordance with Australian Standard *AS 4373-2007, Pruning of Amenity Trees* and the NSW WorkCover Code of Practice for the Amenity Tree Industry (1998).
- Any additional construction activities within the TPZ of the subject trees must be assessed and approved by the project arborist and must comply with *AS 4970-2009 - Protection of trees on development sites.*

An AQF Level 5 Consulting Arborist must be engaged to supervise tree work within the TPZ of trees to be retained, provide advice regarding tree protection, and monitor compliance. The Project Arborist is required to ensure all tree protection measures are implemented, as outlined in this plan, along with any other measures conditioned by the consenting authority or deemed necessary during works.

General tree protection measures applicable are summarised in Table 3 and further information is provided in Appendix E.

Tree protection measures for three trees (Tree 4, 6 and 7) that are subject to potentially high impacts are to follow this guidance and consultation with a project arborist when the construction methodology has been determined is recommended. Conditions on-site are not yet known, including the precise location of tree roots in relation to the proposed works. As such, tailoring of construction methods in accordance with these measures and Project Arborist advice on site is required. Supervision by a Project Arborist at all stages of construction (including site set-up) is required in order to achieve the best possible outcomes for tailoring construction methods and minimising impacts. Please read the general measures below with reference to the site-specific recommendations in Section 4.

Table 3: Summary of tree protection measures

Type	More details	Comment
Signage	Appendix E1	Prominently sign posted with 300 mm x 450 mm boards stating, “NO ACCESS - TREE PROTECTION ZONE”.
Tree protection fencing	Appendix E1	Protective cyclone chain wire link fence to be erected around the TPZ to protect and isolate retained trees from the construction works. Existing boundary fencing may be used.
Crown protection	Appendix E2	Where required, crown protection may include the installation of a physical barrier, pruning selected branches to establish clearance, or the tying/bracing of branches.
Trunk and branch protection	Appendix E3	When fencing is not practical or prior to any activities within the TPZ, trunk protection is required and consist of a layer geotextile fabric or similar followed by 1.8 m lengths of softwood timbers spaced evenly around the trunk and secured with a galvanised hoop strap.
Ground protection	Appendix E4	Install and maintain 100mm thick layer of mulch around tree in TPZ. For machine or vehicle access within TPZ geotextile fabric beneath crushed rock or rumble boards may be required.

Type	More details	Comment
Soil moisture		Soil moisture levels should be regularly monitored by the Project Arborist. Temporary irrigation or watering may be required within TPZ.
Root protection and investigation	Appendix E5	If incursions/excavation within the TPZ are unavoidable, root investigation may be needed to determine the extent and location of roots within the area of construction activity using non-destructive excavation (NDE) methods.
Underground services	Appendix E6	All underground services should be routed outside of the TPZ. If underground services need to be installed within the TPZ, they should be installed using horizontal directional drilling (HDD), non-destructive excavation (NDE) methods such as hydro-vacuum, Air Spade or manually excavated trenches.

5.2 Hold points, inspection and certification

A Project Arborist (AQF Level 5 Consulting Arborist) needs to be engaged to supervise work within the TPZ of trees proposed for retention. A Project Arborist should be engaged to provide advice regarding tree protection and to monitor compliance. Once each stage is reached, the work will be inspected and certified by the Project Arborist and the next stage may commence. Alterations to this schedule may be required due to necessity, however, this shall be through consultation with the Project Arborist only.

A copy of this report must be available on-site prior to the commencement of works, and throughout the entirety of the project. Hold points have been specified in the schedule of works below to ensure trees are adequately protected during construction. It is the responsibility of the principal contractor to complete each of the tasks.

Additionally, it is assumed that potential impacts are considered during design works and during active construction works. As the proposal has not been finalised, assessments of potential impacts may required calculation during the construction process. Any works that are likely to impact on any tree protection zones will require further assessment.

Project design

Section 2.3.4 of the Australian Standard *Development design and review* states:

> *The preliminary arboricultural report should guide the development layout. During design and documentation stages, the project arborist should be involved in ongoing review of architectural, engineering (eg: bulk earth works and construction drawings), services and landscape drawings. The purpose of this is to determine the potential impact on trees proposed to be retained.*

Pre-construction

Prior to any construction, an onsite meeting should be conducted with attendee's subject but not limited to the Project Arborist (AQF Level 5 Consulting Arborist), site manager and construction personnel team to walkthrough the tree protection measures requirements. All trees approved for removal are to be indicated clearly with spray paint on trunks.

During construction

Prior to any earthworks, and/or construction works the project arborist is to consider potential impacts on trees and where possible provide recommendations that minimise tree impacts.

Regular inspection of trees by the Project Arborist (or other timing as agreed with the Project Arborist) is recommended to be completed on trees to be retained. The Project Arborist is to supervise all works to be completed within the TPZ of trees to be retained and provide advice regarding tree protection and monitor compliance.

Post-construction

A final inspection of trees to be retained should be undertaken by Project Arborist after all major construction has ceased and following the removal of tree protection measures.

If any trees are retained that experience impacts that are greater than 10% of the tree protection zone, their health must be monitored annually. It is the understanding that Parramatta Council undertakes annual tree hazard assessments on trees near the swimming area. Past tree hazard assessments have not been provided to ELA for verification.

Additional measures such as weed removal and mulching where appropriate is likely to improve the long-term health of the trees. Maintaining tree health (vitality) will increase the likelihood of survival of any tree that has been impacted. It will also lessen the likelihood of failure of the whole tree or a tree part (e.g., branch).

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6.2 Project specific references

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Appendix A Tree retention assessment method

A1 Tree Significance Assessment Criteria - STARS©

The tree is to have a minimum of three criteria in a category to be classified in that group.

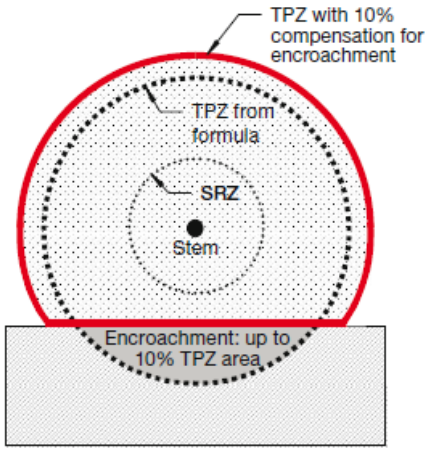
Low	Medium	High
The tree is in fair-poor condition and good or low vigour.	The tree is in fair to good condition and good or low vigour	The tree is in good condition and good vigour
The tree has form atypical of the species	The tree has form typical or atypical of the species	The tree has a form typical for the species
The tree is not visible or is partly visible from the surrounding properties or obstructed by other vegetation or buildings	The tree is a planted locally indigenous or a common species with its taxa commonly planted in the local area	The tree is a remnant or is a planted locally indigenous specimen and/or is rare or uncommon in the local area or of botanical interest or of substantial age.
The tree provides a minor contribution or has a negative impact on the visual character and amenity of the local area	The tree is visible from surrounding properties, although not visually prominent as partially obstructed by other vegetation or buildings when viewed from the street	The tree is listed as a heritage item, threatened species or part of an endangered ecological community or listed on Council's significant tree register
The tree is a young specimen which may or may not have reached dimensions to be protected by local Tree Preservation Orders or similar protection mechanisms and can easily be replaced with a suitable specimen	The tree provides a fair contribution to the visual character and amenity of the local area	The tree is visually prominent and visible from a considerable distance when viewed from most directions within the landscape due to its size and scale and makes a positive contribution to the local amenity.
The tree's growth is severely restricted by above or below ground influences, unlikely to reach dimensions typical for the taxa in situ – tree is inappropriate to the site conditions	The tree's growth is moderately restricted by above or below ground influences, reducing its ability to reach dimensions typical for the taxa in situ	The tree supports social and cultural sentiments or spiritual associations, reflected by the broader population or community group or has commemorative values.
The tree is listed as exempt under the provisions of the local Council Tree Preservation Order or similar protection mechanisms		The tree's growth is unrestricted by above and below ground influences, supporting its ability to reach dimensions typical for the taxa in situ – tree is appropriate to the site conditions.
The tree has a wound or defect that has the potential to become structurally unsound.		
Environmental Pest / Noxious Weed The tree is an environmental pest species due to its invasiveness or poisonous/allergenic properties. The tree is a declared noxious weed by legislation.		
Hazardous /Irreversible Decline The tree is structurally unsound and / or unstable and is considered potentially dangerous. The tree is dead, or is in irreversible decline, or has the potential to fail or collapse in full or part in the immediate to short term.		

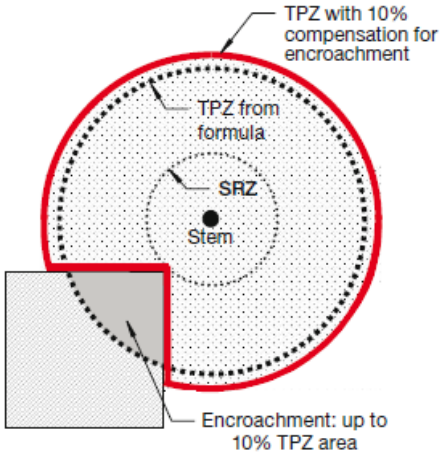
A2 Matrix assessment - STARS©

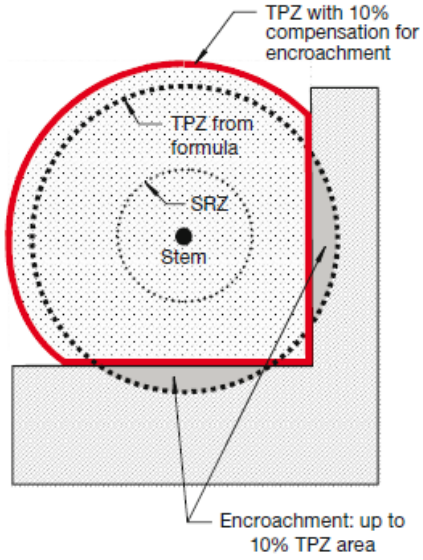
		Tree significance				
		High	Medium	Low		
		Significance in Landscape	Significance in Landscape	Significance in Landscape	Environmental Pest/Noxious Weed Species	Hazardous/ Irreversible Decline
Useful Life Expectancy	Long >40 years					
	Medium 15-40 years					
	Short <1-15 years					
	Dead					

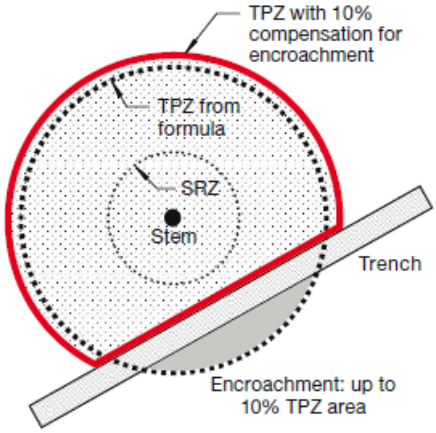
	Priority for retention (High): Tree considered important so should be retained and protected. Design modification or re-location of structure should be considered to accommodate the setbacks as prescribed by the *Australian Standard AS4970 Protection of trees on development sites*. Tree sensitive construction measures must be implemented if works are to proceed within the Tree Protection Zone.
	Consider for retention (Medium): Tree considered less important; however, retention should remain priority. Removal considered only if adversely affecting the proposed building/works and all other alternatives have been considered and exhausted.
	Consider for removal (Low): Tree not considered important for retention, nor requiring special works or design modification to be implemented for their retention.
	Priority for removal: These trees are considered hazardous, or in irreversible decline, or weeds and should be removed irrespective of development.

Appendix B Encroachment into tree protection zones - AS 4970-2009









Appendix C Maps

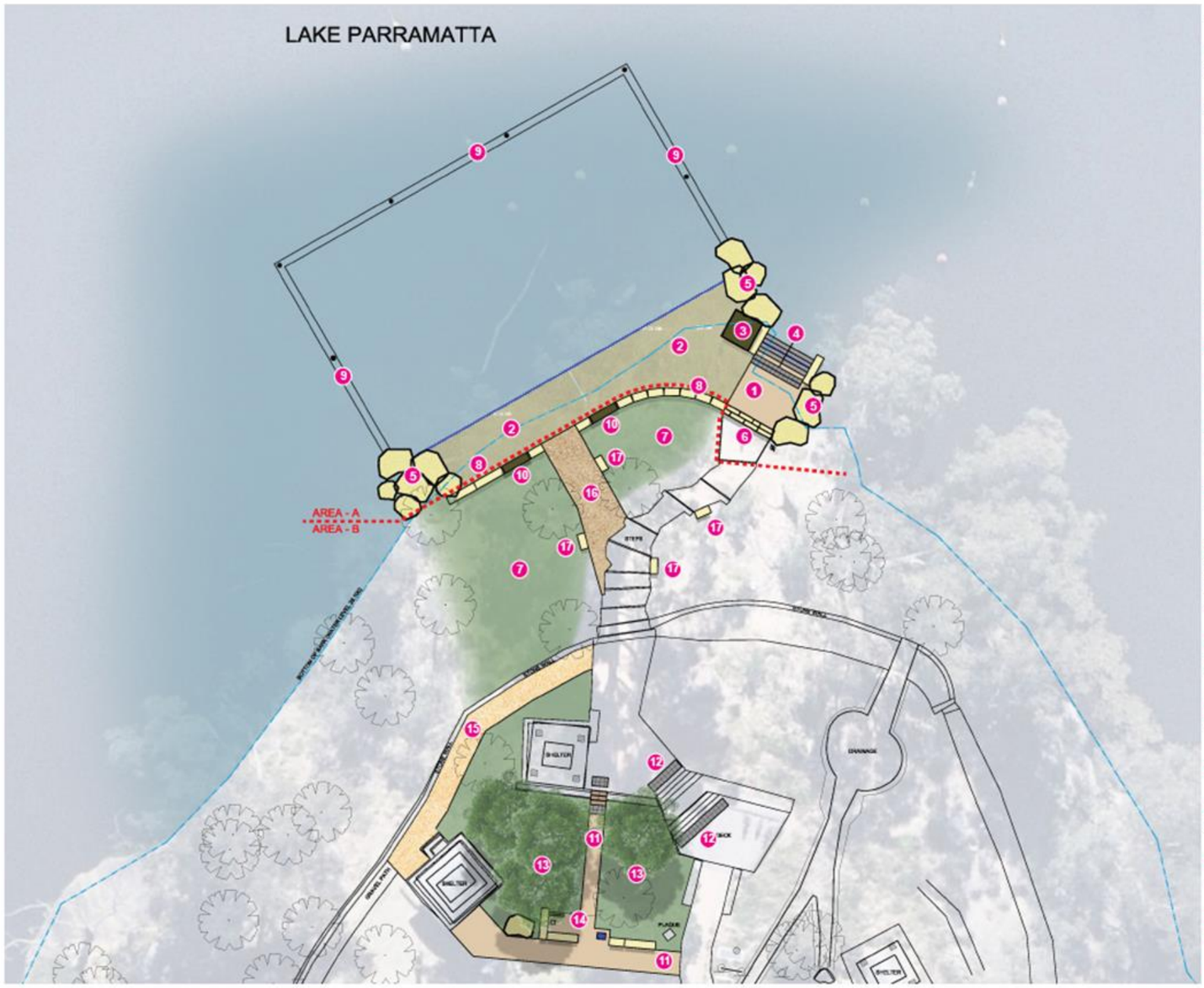


Figure 2: Landscape Concept Plan (City of Parramatta 2023)

Figure 3: Location of the proposed works

Figure 4: Tree locations

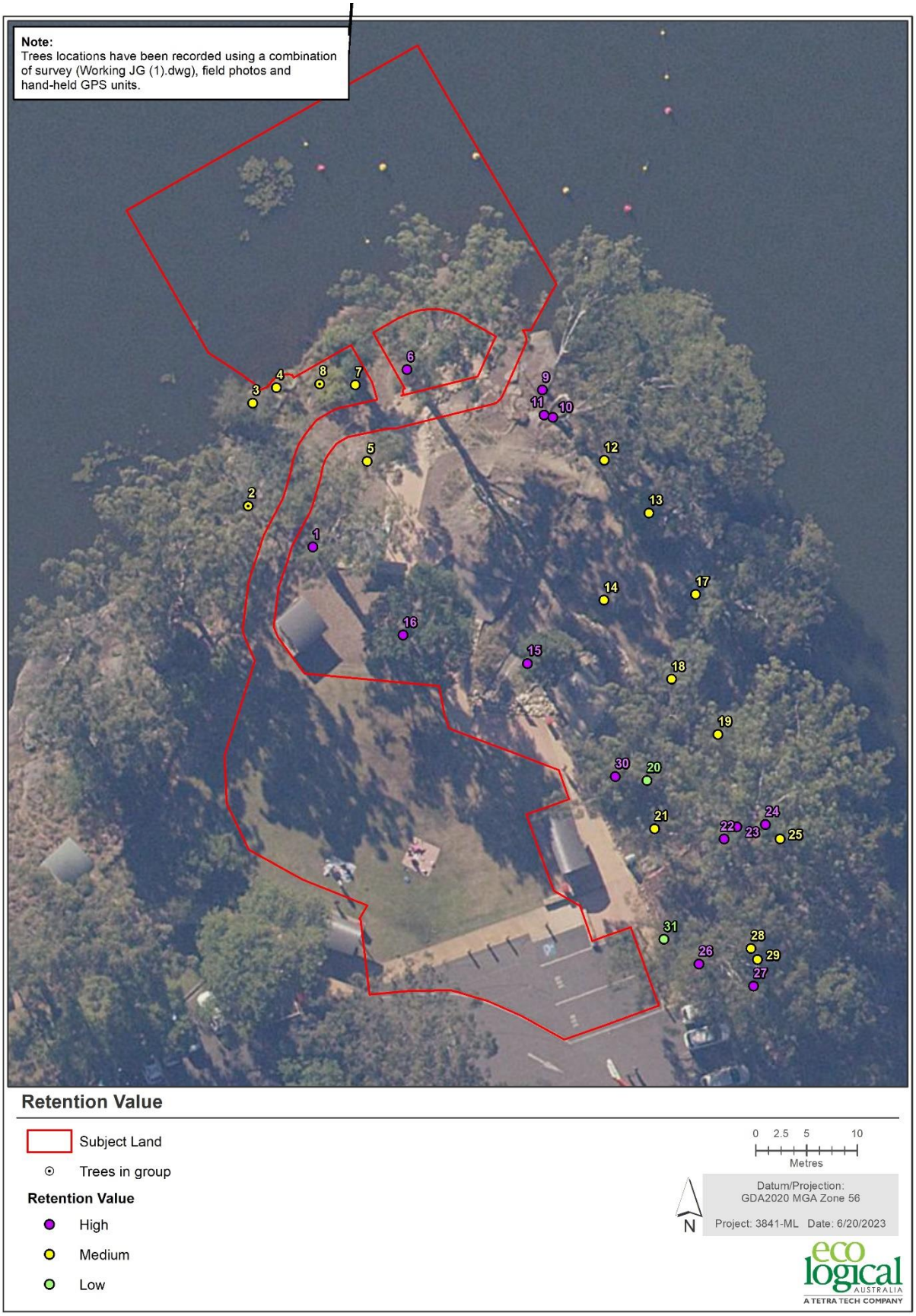


Figure 5: Retention values

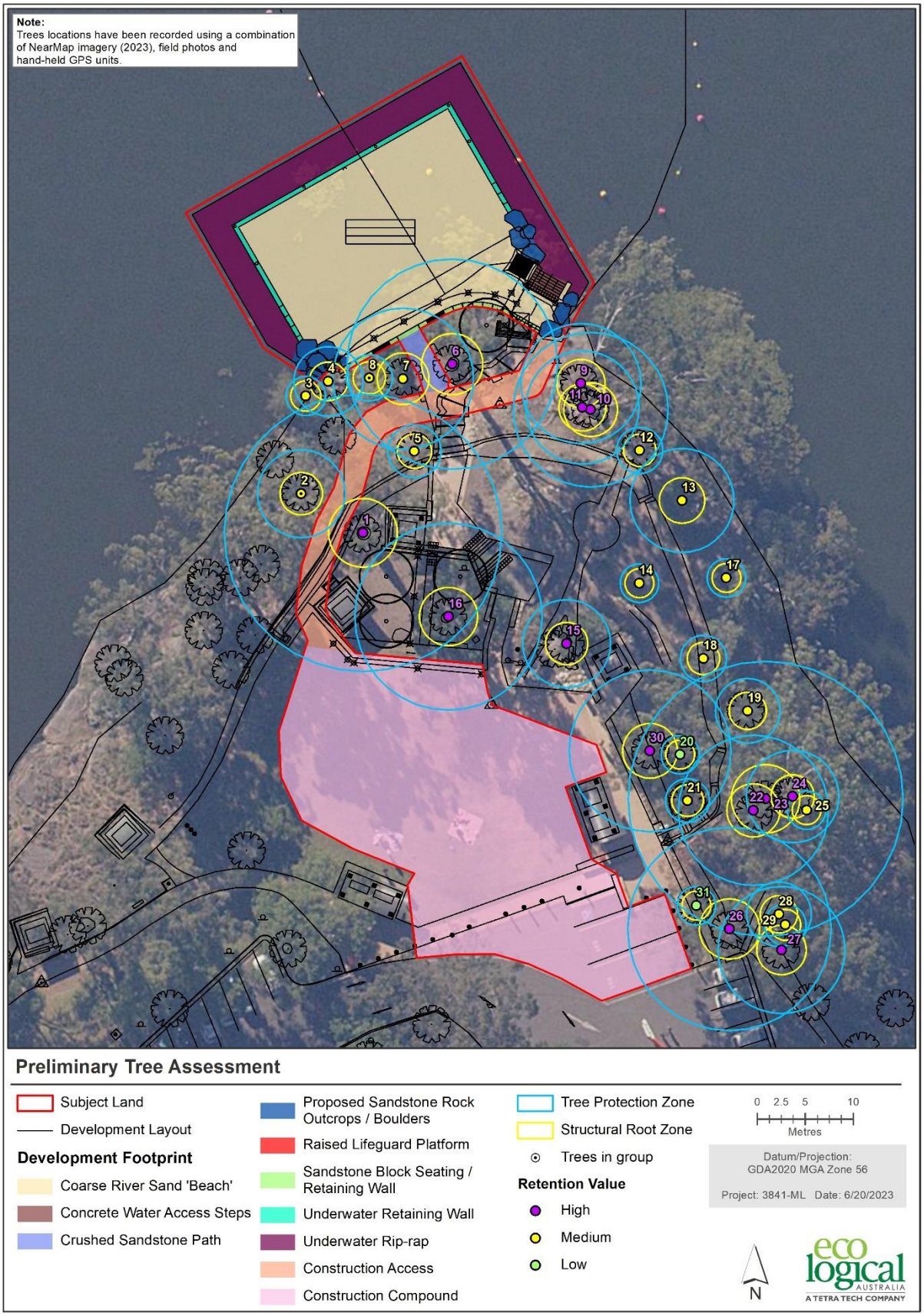


Figure 6: Preliminary tree assessment

Appendix D Tabulated results of Preliminary Tree Assessment

Tree Number	Botanical name	Trees in Group	Location determined by	Height (m)	Spread (m)	DBH (mm)	DAB (mm)	Health	Structure	ULE	Landscape significance	Retention value	TPZ (m)	SRZ (m)	Notes
1	*Eucalyptus* sp.	1	NearMap Imagery (2023) & field photos & survey.	15	11	1200	1330	Fair	Poor	Medium (15-40 years)	Medium	High	14.4	3.57	Termites in trunk, Cavities, hollows, and previous pruning
2	*Angophora bakeri*	3	NearMap Imagery (2023) & field photos & survey.	5	7	380	550	Fair	Fair	Medium (15-40 years)	Medium	Medium	4.56	2.20	Small tree, minor decay in base
3	*Angophora bakeri*	1	NearMap Imagery (2023) & field photos & survey.	6	3	170	220	Fair	Fair	Medium (15-40 years)	Low	Medium	2.04	1.57	termite activity, lost top
4	*Allocasuarina/ Casuarina* sp.	1	NearMap Imagery (2023) & field photos & survey.	9	6	300	400	Good	Good	Long (>40 years)	Low	Medium	3.6	2.00	Clump of small to medium trees, six stems
5	*Eucalyptus pilularis*	1	NearMap Imagery (2023) & field photos & survey.	9	4	230	300	Good	Good	Long (>40 years)	Low	Medium	2.76	1.79	
6	*Eucalyptus pilularis*	1	NearMap Imagery (2023) & field photos & survey.	25	22	910	1050	Good	Good	Long (>40 years)	High	High	10.92	3.18	
7	*Eucalyptus pilularis*	1	NearMap Imagery (2023) & field photos & survey.	12	6	610	660	Good	Poor	Medium (15-40 years)	Medium	Medium	7.32	2.69	Termite activity, decay
8	*Glochidion ferdinandi*	3	NearMap Imagery (2023) & field photos & survey.	5	6	200	220	Good	Good	Long (>40 years)	Low	Medium	2.4	1.68	Clump of three small/medium trees

Tree Number	Botanical name	Trees in Group	Location determined by	Height (m)	Spread (m)	DBH (mm)	DAB (mm)	Health	Structure	ULE	Landscape significance	Retention value	TPZ (m)	SRZ (m)	Notes
9	*Eucalyptus pilularis*	1	NearMap Imagery (2023) & field photos & survey.	15	12	520	600	Good	Good	Long (>40 years)	High	High	6.24	2.51	Distinct lean, appears stable
10	*Eucalyptus pilularis*	1	NearMap Imagery (2023) & field photos & survey.	22	15	670	820	Good	Good	Long (>40 years)	High	High	8.04	2.80	Leaning, Very close to Tree 11
11	*Eucalyptus pilularis*	1	NearMap Imagery (2023) & field photos & survey.	22	15	490	570	Good	Good	Long (>40 years)	High	High	5.88	2.45	Very close to Tree 10
12	*Angophora bakeri*	1	NearMap Imagery (2023) & field photos & survey.	6	5	200	250	Fair	Fair	Medium (15-40 years)	Low	Medium	2.4	1.68	Twin stemmed
13	*Angophora bakeri*	1	NearMap Imagery (2023) & field photos & survey.	7	7	450	540	Fair	Fair	Medium (15-40 years)	Medium	Medium	5.4	2.37	Dead top
14	*Angophora bakeri*	1	NearMap Imagery (2023) & field photos & survey.	5	2	100	130	Good	Good	Medium (15-40 years)	Low	Medium	2	1.50	
15	*Syncarpia glomulifera*	1	NearMap Imagery (2023) & field photos & survey.	12	8	380	470	Good	Good	Long (>40 years)	Medium	High	4.56	2.20	
16	*Syncarpia glomulifera*	1	NearMap Imagery (2023) & field photos & survey.	16	15	810	1030	Good	Good	Long (>40 years)	High	High	9.72	3.03	
17	*Angophora bakeri*	1	NearMap Imagery (2023) & field photos & survey.	5	4	100	140	Fair	Fair	Medium (15-40 years)	Low	Medium	2	1.50	Dead top

Tree Number	Botanical name	Trees in Group	Location determined by	Height (m)	Spread (m)	DBH (mm)	DAB (mm)	Health	Structure	ULE	Landscape significance	Retention value	TPZ (m)	SRZ (m)	Notes
18	*Angophora bakeri*	1	GPS hand-held unit & survey.	8	8	200	280	Fair	Fair	Medium (15-40 years)	Medium	Medium	2.4	1.68	Dead top
19	*Angophora bakeri*	1	GPS hand-held unit & survey.	8	5	280	320	Fair	Fair	Medium (15-40 years)	Medium	Medium	3.36	1.94	Triple stemmed
20	*Angophora bakeri*	1	GPS hand-held unit & survey.	5	5	150	180	Poor	Fair	Short (5-15 years)	Low	Low	2	1.50	Triple stemmed
21	*Angophora bakeri*	1	GPS hand-held unit & survey.	7	5	190	200	Fair	Fair	Medium (15-40 years)	Low	Medium	2.28	1.65	
22	*Eucalyptus pilularis*	1	GPS hand-held unit & survey.	16	15	650	720	Good	Good	Long (>40 years)	High	High	7.8	2.76	Leaning Very close to Tree 23
23	*Eucalyptus pilularis*	1	GPS hand-held unit & survey.	28	30	1190	1340	Good	Good	Long (>40 years)	High	High	14.28	3.56	Very close to Tree 22
24	*Syncarpia glomulifera*	1	GPS hand-held unit & survey.	12	10	400	450	Good	Good	Long (>40 years)	Medium	High	4.8	2.25	
25	*Angophora bakeri*	1	GPS hand-held unit & survey.	6	5	23	240	Fair	Fair	Medium (15-40 years)	Low	Medium	2	1.50	Very close to Tree 24
26	*Eucalyptus pilularis*	1	NearMap Imagery (2023) & field photos & survey.	20	25	880	1040	Good	Fair	Long (>40 years)	High	High	10.56	3.14	Large wound at base and lower trunk
27	*Eucalyptus pilularis*	1	GPS hand-held unit & survey.	16	14	550	650	Good	Good	Long (>40 years)	High	High	6.6	2.57	
28	*Eucalyptus pilularis*	1	GPS hand-held unit & survey.	14	8	280	320	Good	Good	Long (>40 years)	Medium	Medium	3.36	1.94	Leaning
29	*Angophora bakeri*	1	GPS hand-held unit & survey.	5	5	180	180	Fair	Fair	Medium (15-40 years)	Low	Medium	2.16	1.61	Very close to trees 28 and 29
30	*Eucalyptus pilularis*	1	NearMap Imagery (2023) & field photos & survey.	18	20	700	910	Good	Good	Long (>40 years)	High	High	8.4	2.85	Wound at base with possible decay

Tree Number	Botanical name	Trees in Group	Location determined by	Height (m)	Spread (m)	DBH (mm)	DAB (mm)	Health	Structure	ULE	Landscape significance	Retention value	TPZ (m)	SRZ (m)	Notes
31	*Angophora bakeri*	1	GPS hand-held unit & survey.	7	3	120	150	Poor	Fair	Short (5-15 years)	Low	Low	2	1.50	

Appendix E Tree protection guidelines

The following tree protection guidelines must be implemented during the construction period if no tree-specific recommendations are detailed.

E1 Tree protection fencing

The TPZ is a restricted area delineated by protective fencing or the use of an existing structure (such as a wall or fence).

Trees that are to be retained must have protective fencing erected around the TPZ (or as specified in the body of the report) to protect and isolate it from the construction works. Fencing must comply with the Australian Standard, AS 4687-2007, Temporary fencing and hoardings.

Tree protection fencing must be installed prior to site establishment and remain intact until completion of works. Once erected, protective fencing must not be removed or altered without the approval of the Project Arborist.

If the protective fencing requires temporary removal, trunk, branch and ground protection must be installed and must comply with *AS 4970-2009, Protection of Trees on Development Sites*.

Tree protection fencing shall be:

- Enclosed to the full extent of the TPZ (or as specified in the Recommendations and Tree Protection Plan).
- Cyclone chain wire link fence or similar, with lockable access gates.
- Certified and Inspected by the Project Arborist.
- Installed prior to any machinery or material are brought to site and before the commencement of works.
- Prominently sign posted with 300 mm x 450 mm boards stating, “NO ACCESS - TREE PROTECTION ZONE”.

E2 Crown protection

Tree crowns/canopy may be injured or damaged by machinery such as; excavators, drilling rigs, trucks, cranes, plant and vehicles. Where crown protection is required, it will usually be located at least one meter outside the perimeter of the crown.

Crown protection may include the installation of a physical barrier, pruning selected branches to establish clearance, or the tying/bracing of branches.

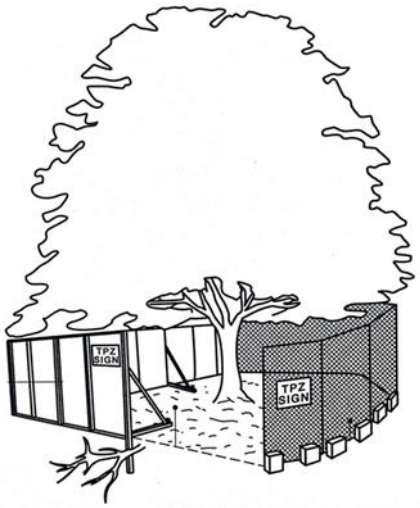
E3 Trunk protection

Where provision of tree protection fencing is impractical or must be temporarily removed, trunk protection shall be installed for the nominated trees to avoid accidental mechanical damage.

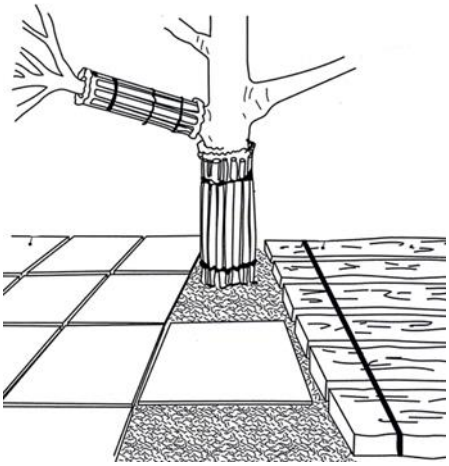
The removal of bark or branches allows the potential ingress of micro-organisms which may cause decay. Furthermore, the removal of bark restricts the trees' ability to distribute water, mineral ions (solutes), and glucose.

Trunk protection shall consist of a layer of either carpet underfelt, geotextile fabric or similar wrapped around the trunk, followed by 1.8 m lengths of softwood timbers aligned vertically and spaced evenly around the trunk (with an approx. 50 mm gap between the timbers).

The timbers must be secured using galvanised hoop strap (aluminium strapping). The timbers shall be wrapped around the trunk but not fixed to the tree, as this will cause injury/damage to the tree.



Tree protection fencing



Trunk protection fencing

E4 Ground protection

Tree roots are essential for the uptake/absorption of water, oxygen and mineral ions (solutes). It is essential to prevent the disturbance of the soil beneath the dripline and within the TPZ of trees that are to be retained. Soil compaction within the TPZ will adversely affect the ability of roots to function correctly.

If temporary access for machinery is required within the TPZ ground protection measures will be required. The purpose of ground protection is to prevent root damage and soil compaction within the TPZ. Maintain a thick layer of mulch around all retained trees to a depth of 100 mm using coarse pine bark or wood chip material that complies with AS 4454. Where the existing landscape within the TPZ is to remain unaltered (e.g. garden beds or turf) mulch may not be required.

For heavy vehicle access within TPZ, ground protection may include a permeable membrane such as geotextile fabric beneath a layer of crushed rock or rumble boards.

If the grade is to be raised within the TPZ, the material should be coarser or more porous than the underlying material.

E5 Root protection and investigation

If incursions/excavation within the TPZ are unavoidable, root investigation may be needed to determine the extent and location of roots within the area of construction activity. The location and distribution of roots are found through non-destructive excavation (NDE) methods such as hydro-vacuum excavation (sucker truck), air spade and manual excavation. Root investigation does not guarantee the retention of the tree.

If the Project Arborist identifies conflicting roots that requiring pruning, they must be pruned with a sharp implement such as; secateurs, pruners, handsaws or a chainsaw back to undamaged tissue. The final cut must be a clean cut.

E6 Underground services

All underground services should be routed outside of the TPZ. If underground services need to be installed within the TPZ, they should be installed using horizontal directional drilling (HDD), non-destructive excavation (NDE) methods such as hydro-vacuum, Air Spade or manually excavated trenches. The horizontal drilling/boring must be at minimum depth of 600 mm below grade. Trenching for services is to be regarded as “excavation”. The Project Arborist should assess the likely impacts of boring and bore pits on retained trees.

Appendix F Tree Photos

All photos provided in this Appendix were taken by Consulting Arborist, David Bidwell.

Figure 7: High retention value Tree 1

Figure 8: Medium retention value Tree 2

Figure 9: Medium retention value Tree 3

Figure 10: Medium retention value Tree 4

Figure 11: Medium retention value Tree 5

Figure 12: High retention value Tree 6 (base)

Figure 13: High retention value Tree 6

Figure 14: High retention value Tree 9

Figure 15: High retention value Tree 10

Figure 16: High retention value Tree 11

Figure 17: Medium retention value Tree 15

Figure 18: Medium retention value Tree 16

Figure 19: High retention value Tree 22

Figure 20: High retention value Tree 23

Figure 21: High retention value Tree 24

Figure 22: High retention value Tree 26

Figure 23: High retention value Tree 27

Figure 24: High retention value Tree 30

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APPENDIX E

AHIMS Search Results

AHIMS Web Services (AWS)
Search Result

Your Ref/PO Number : 3841
Client Service ID : 730720

Eco Logical Australia Pty Ltd - Sydney - Individual users

Date: 09 November 2022

PO Box 12 668 Old Princes Hwy
Sutherland New South Wales 1499

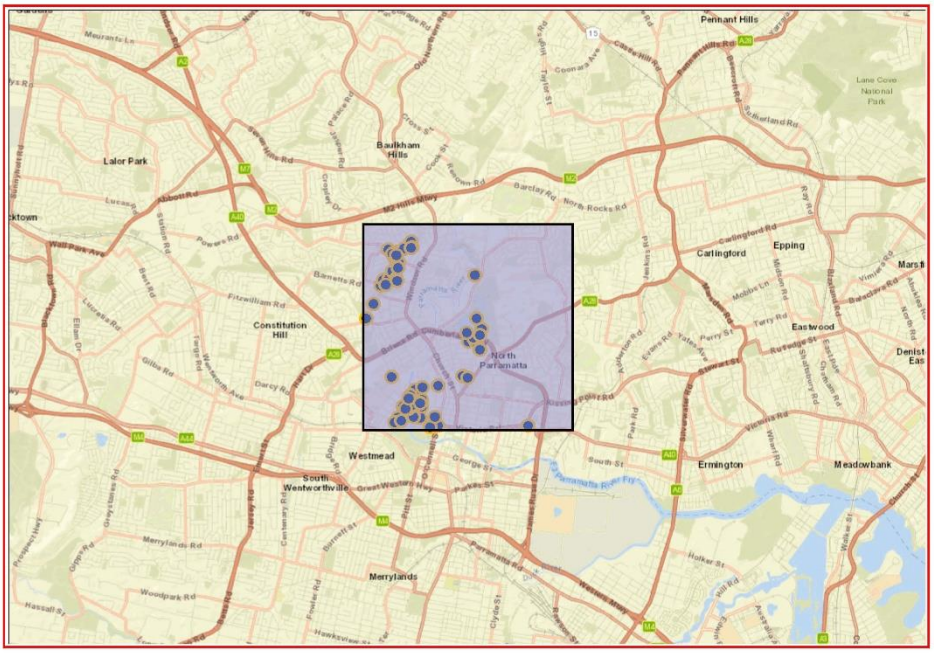
Attention: Charlotte Bradshaw

Email: charlotteb@ecoaus.com.au

Dear Sir or Madam:

AHIMS Web Service search for the following area at Datum :GDA, Zone : 56, Eastings : 313579.0 - 317579.0, Northings : 6257267.0 - 6261267.0 with a Buffer of 0 meters, conducted by Charlotte Bradshaw on 09 November 2022.

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



A search of Heritage NSW AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

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

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 22SYD3172
Client Service ID : 730722

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
45-5-2463	Parramatta Regional Park (IF1)	GDA	56	314462	6257627	Open site	Valid	Artefact : -	Isolated Find	102142,102196
	Contact	Recorders	J Steel					Permits	3994	
45-5-2464	Parramatta Regional Park (IF2)	GDA	56	314400	6257619	Open site	Valid	Artefact : -	Isolated Find	102196
	Contact	Recorders	J Steel					Permits		
45-5-1065	Parra Park 3;PP 3;	AGD	56	314620	6257620	Open site	Valid	Artefact : -	Open Camp Site	102142,102196
	Contact	Recorders	Michael Guider					Permits		
45-6-1886	William Place Shelters.;	AGD	56	315600	6260100	Closed site	Valid	Artefact : -	Shelter with Deposit	1566,102196
	Contact	Recorders	R Mackay					Permits		
45-6-2553	Lake Parra R1;LP R1;	AGD	56	315640	6258780	Open site	Valid	Artefact : -	Open Camp Site	102196
	Contact	Recorders	Michael Guider					Permits		
45-6-2560	Lake Parra R2;LP R2;	AGD	56	315500	6258780	Open site	Valid	Artefact : -	Open Camp Site	102196
	Contact	Recorders	Michael Guider					Permits	2928	
45-6-2578	Collett Park;	AGD	56	316680	6257140	Open site	Valid	Artefact : -	Open Camp Site	102196
	Contact	Recorders	Michael Guider					Permits		
45-5-1110	Redbank;Northmead;	AGD	56	314020	6258060	Open site	Valid	Grinding Groove : -	Axe Grinding Groove	102196
	Contact	Recorders	Michael Guider					Permits		
45-5-0842	Toongabbie Creek 3 Old Toongabbie	GDA	56	313602	6259394	Open site	Valid	Artefact : -	Open Camp Site	102742
	Contact	Recorders	Michael Guider,Kelleher Nightingale Consulting Pty Ltd,Miss.Kristen Taylor					Permits		
45-6-2036	Lake Parramatta 2	AGD	56	315710	6258920	Closed site	Valid	Art (Pigment or Engraved) : -	Shelter with Art	102196
	Contact	Recorders	Val Attenbrow					Permits		
45-5-0277	Cumberland Oval;Parramatta;	AGD	56	314588	6257260	Open site	Destroyed	Modified Tree (Carved or Scarred) : -	Scarred Tree	223,260,1018,102142,102196
	Contact	Recorders	Cook					Permits		
45-6-1781	Lake Parramatta Reserve Shelter.;	AGD	56	315650	6259250	Closed site	Valid	Art (Pigment or Engraved) : -	Shelter with Art	102196
	Contact	Recorders	Sherie-Lee Evans					Permits		
45-5-0824	Moxhams Road Cave;	AGD	56	313926	6260011	Closed site	Valid	Artefact : 8	Shelter with Deposit	102742
	Contact	Recorders	Michael Guider,Jo McDonald Cultural Heritage Management see GML					Permits		
45-5-0792	John Curtin Reserve, Northmead.;	AGD	56	314069	6260281	Closed site	Valid	Artefact : -	Shelter with Deposit	1809,2047
	Contact	Recorders	Val Attenbrow,Murray Williams,Jo McDonald Cultural Heritage Management see GI					Permits	207	
45-5-2970	Moxhams Road Bridge	AGD	56	313817	6259968	Closed site	Valid	Potential Archaeological Deposit (PAD) : 5		102742

Report generated by AHIMS Web Service on 09/11/2022 for Charlotte Bradshaw for the following area at Datum :GDA, Zone : 56, Eastings : 313579.0 - 317579.0, Northings : 6257267.0 - 6261267.0 with a Buffer of 0 meters.. Number of Aboriginal sites and Aboriginal objects found is 56

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 22SYD3172
Client Service ID : 730722

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists (MDCA),Jo McDonald Cultural Heritage Man					**Permits**		
45-5-2971	The Fernbanks	AGD	56	313771	6259863	Closed site	Valid	Potential Archaeological Deposit (PAD) : -		102742
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists (MDCA),Jo McDonald Cultural Heritage Man					**Permits**		
45-6-2805	Lake Parramatta Playground 1	GDA	56	315572	6259151	Open site	Valid	Artefact : -		102196,103774
	Contact Searle	**Recorders**	Jim Wheeler					**Permits**	2525	
45-5-3336	Quarry Branch 1	GDA	56	314464	6260821	Closed site	Valid	Potential Archaeological Deposit (PAD) : -		
	Contact Searle	**Recorders**	Jo McDonald Cultural Heritage Management see GML					**Permits**		
45-5-3337	Quarry Branch 2	GDA	56	314448	6260803	Open site	Valid	Potential Archaeological Deposit (PAD) : -		
	Contact Searle	**Recorders**	Jo McDonald Cultural Heritage Management see GML					**Permits**		
45-5-3338	Quarry Branch 3	AGD	56	314349	6260745	Open site	Valid	Potential Archaeological Deposit (PAD) : -		
	Contact Searle	**Recorders**	Jo McDonald Cultural Heritage Management see GML					**Permits**		
45-5-3339	Quarry Branch 4	GDA	56	314305	6260783	Open site	Valid	Potential Archaeological Deposit (PAD) : -		
	Contact Searle	**Recorders**	Jo McDonald Cultural Heritage Management see GML					**Permits**		
45-5-3340	Quarry Branch 5	GDA	56	314185	6260714	Open site	Valid	Potential Archaeological Deposit (PAD) : -		
	Contact Searle	**Recorders**	Jo McDonald Cultural Heritage Management see GML					**Permits**		
45-5-3341	Quarry Branch 6	GDA	56	314002	6260763	Closed site	Valid	Potential Archaeological Deposit (PAD) : -		102742
	Contact Searle	**Recorders**	Jo McDonald Cultural Heritage Management see GML					**Permits**		
45-5-3342	Quarry Branch	GDA	56	314082	6260683	Closed site	Valid	Potential Archaeological Deposit (PAD) : -		102742
	Contact Searle	**Recorders**	Jo McDonald Cultural Heritage Management see GML					**Permits**		
45-5-3343	Quarry Branch 8	GDA	56	314162	6260659	Closed site	Valid	Potential Archaeological Deposit (PAD) : -		
	Contact Searle	**Recorders**	Jo McDonald Cultural Heritage Management see GML					**Permits**		

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 22SYD3172
Client Service ID : 730722

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
45-5-3344	Quarry Branch 9	GDA	56	314181	6260406	Closed site	Valid	Potential Archaeological Deposit (PAD) : -		
	Contact Searle	**Recorders**	Jo McDonald Cultural Heritage Management see GML					**Permits**		
45-5-3345	Quarry Branch 10	GDA	56	314101	6260345	Closed site	Valid	Potential Archaeological Deposit (PAD) : -		102742
	Contact Searle	**Recorders**	J & M Cook Engineering Services					**Permits**		
45-5-3346	Quarry Branch 11	GDA	56	314173	6260191	Open site	Valid	Water Hole : 1		
	Contact Searle	**Recorders**	Jo McDonald Cultural Heritage Management see GML					**Permits**		
45-5-3347	Quarry Branch 12	GDA	56	314188	6260156	Closed site	Valid	Potential Archaeological Deposit (PAD) : -		
	Contact Searle	**Recorders**	Jo McDonald Cultural Heritage Management see GML					**Permits**		
45-5-3348	Quarry Branch 13	GDA	56	313978	6260064	Closed site	Valid	Potential Archaeological Deposit (PAD) : -		102742
	Contact Searle	**Recorders**	Jo McDonald Cultural Heritage Management see GML					**Permits**		
45-5-3349	Quarry Branch 14	GDA	56	313744	6259675	Open site	Valid	Artefact : 1, Potential Archaeological Deposit (PAD) : -		102742
	Contact Searle	**Recorders**	Jo McDonald Cultural Heritage Management see GML					**Permits**		
45-5-3350	Quarry Branch 15	GDA	56	314214	6260521	Closed site	Valid	Potential Archaeological Deposit (PAD) : -		
	Contact Searle	**Recorders**	Jo McDonald Cultural Heritage Management see GML					**Permits**		
45-5-3693	Model Farms Reserve	GDA	56	314200	6260400	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Michael Guider					**Permits**		
45-5-3694	Yarrabee Cave	GDA	56	314120	6260620	Closed site	Valid	Artefact : -		
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-2931	Lake Parra R3	GDA	56	315820	6258820	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Michael Guider					**Permits**		
45-5-3695	Lake Parra R4	GDA	56	315856	6259227	Open site	Valid	Artefact : -		102742
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-2932	Lake Parra R5	GDA	56	315700	6259050	Closed site	Valid	Artefact : -		
	Contact	**Recorders**	Michael Guider					**Permits**		
45-6-2933	Belmore Park	GDA	56	315500	6258293	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Michael Guider,Kelleher Nightingale Consulting Pty Ltd,Miss.Madeline Harding					**Permits**		

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 22SYD3172
Client Service ID : 730722

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
45-5-4630	Parramatta Leagues Club PAD	GDA	56	314974	6257483	Open site	Not a Site	Potential Archaeological Deposit (PAD) : -		103589
	Contact	**Recorders**	GML Heritage Pty Ltd - Surry Hills,Doctor.Tim Owen,Doctor.Tim Owen					**Permits**	3958	
45-5-4533	Paddocks Playground Parra Park	GDA	56	314323	6257378	Open site	Partially Destroyed	Artefact : -		
	Contact	**Recorders**	Ms.Tory Stening					**Permits**	3822	
45-5-4534	Parramatta Park - Location C	GDA	56	314568	6257473	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Annie Bickford					**Permits**		
45-5-4537	Parramatta Park - Location H	GDA	56	314199	6257357	Open site	Partially Destroyed	Artefact : -		
	Contact	**Recorders**	Val Attenbrow					**Permits**	3822	
45-5-4538	Parramatta Park - Location J	GDA	56	314351	6257676	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Val Attenbrow					**Permits**	3994	
45-5-4539	Parramatta Park - Location K	GDA	56	314460	6257823	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Val Attenbrow					**Permits**	3994	
45-5-4540	Parramatta Park - Location I	GDA	56	314260	6257448	Open site	Partially Destroyed	Artefact : -		
	Contact	**Recorders**	Val Attenbrow					**Permits**	3822	
45-5-4542	Parramatta Park - Location L	GDA	56	314542	6257709	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Val Attenbrow					**Permits**	3994	
45-5-4543	Parramatta Park - Location N	GDA	56	314693	6257737	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Val Attenbrow					**Permits**		
45-5-4544	Parramatta Park - Location O	GDA	56	314725	6257680	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Val Attenbrow					**Permits**		
45-5-4541	Parramatta Park - Location M	GDA	56	314608	6257586	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Val Attenbrow					**Permits**		
45-6-3195	Cumberland Hospital East	GDA	56	315022	6258090	Open site	Valid	Potential Archaeological Deposit (PAD) : -		103863
	Contact	**Recorders**	Ms.Jillian Comber					**Permits**	3932,4900	
45-6-3692	VOC IF1	GDA	56	315044	6257297	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Artefact - Cultural Heritage Management - Pyrmont,Ms.Jennifer Norfolk					**Permits**	4900	
45-5-5126	Cumberland West	GDA	56	314493	6257901	Open site	Valid	Potential Archaeological Deposit (PAD) : 1		
	Contact	**Recorders**	Comber Consultants Pty Limited,Ms.Jillian Comber					**Permits**	4363,4468	
45-5-5251	Western Sydney Stadium	GDA	56	314884	6257269	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Doctor.Jillian Comber,Comber Consultants Pty Limited					**Permits**		

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 22SYD3172
Client Service ID : 730722

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
45-6-3764	Belmore Park ISO 1	GDA	56	315593	6258267	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Artefact - Cultural Heritage Management - Pyrmont,Ms.Jennifer Norfolk					**Permits**		
45-5-5472	PLR CHE Area	GDA	56	314724	6258051	Open site	Valid	Artefact : -, Potential Archaeological Deposit (PAD) : -		
	Contact	**Recorders**	GML Heritage Pty Ltd - Surry Hills,Doctor.Tim Owen					**Permits**		
45-5-5473	PLR AT14	GDA	56	314592	6258005	Open site	Valid	Artefact : -, Hearth : -, Potential Archaeological Deposit (PAD) : -		
	Contact	**Recorders**	GML Heritage Pty Ltd - Surry Hills,Doctor.Tim Owen					**Permits**		

** **Site Status**
Valid - The site has been recorded and accepted onto the system as valid
Destroyed - The site has been completely impacted or harmed usually as consequence of permit activity but sometimes also after natural events. There is nothing left of the site on the ground but proponents should proceed with caution.
Partially Destroyed - The site has been only partially impacted or harmed usually as consequence of permit activity but sometimes also after natural events. There might be parts or sections of the original site still present on the ground
Not a site - The site has been originally entered and accepted onto AHIMS as a valid site but after further investigations it was decided it is NOT an aboriginal site. Impact of this type of site does not require permit but Heritage NSW should be notified

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APPENDIX F

Statement of Heritage Impact

Eco Logical Australia 2023

Lake Parramatta Swimming Area – Statement of Heritage Impact

City of Parramatta

ecological AUSTRALIA
A TETRA TECH COMPANY

1300 646 131
www.ecoaus.com.au

DOCUMENT TRACKING

Project Name	Lake Parramatta Swimming Area – Statement of Heritage Impact
Project Number	600-22SYD3841
Project Manager	Courtney Blick
Prepared by	Jessica Horton and Charlotte Bradshaw
Reviewed by	Karyn McLeod and Courtney Blick
Approved by	Rebecca Ben-Haim
Status	Final
Version Number	2
Last saved on	11 July 2023

This report should be cited as 'Eco Logical Australia 2023. *Lake Parramatta Swimming Area - Statement of Heritage Impact.* Prepared for City of Parramatta.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd.

Template 2.8.1

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Abbreviations

Abbreviation	Description
CBD	Central Business District
ELA	Eco Logical Australia Pty Ltd
DCP	Development Control Plan
LEP	Local Environmental Plan
LGA	Local Government Area
PoM	Plan of Management
REF	Review of Environmental Factors
SHI	State Heritage Inventory
SHR	State Heritage Register
SoHI	Statement of Heritage Impact

1. Introduction

1.1. Background

Eco logical Australia (ELA) has been commissioned by City of Parramatta Council to prepare a Statement of Heritage Impact (SoHI) to support a Review of Environmental Factors (REF) for the implementation of access works for the upgraded swimming location within Lake Parramatta.

The study area is located within the curtilage of one (1) local heritage item listed on Schedule 5 of the Parramatta Local Environmental Plan 2023 (Parramatta LEP), being Lake Parramatta Reserve (Item No. I305) and is within the vicinity (200 m) of one (1) State Heritage Register (SHR) item (Lake Parramatta Dam SHR listing No. 01879; Lake Parramatta Dam Parramatta LEP 2023 Item No. I304).

Under clause 5.10 of the Parramatta LEP 2023, submission of a SoHI is required for works to heritage listed items, items, in conservation areas and in the vicinity of heritage items.

This report will identify and assess any potential impacts to the heritage significance of the item as a result of the proposal. Where necessary mitigative measures and recommendations for the long-term conservation of heritage values will be provided.

1.2. Study area location

The study area is known as Lake Parramatta Swimming Area, located in North Parramatta within the City of Parramatta Local Government Area (LGA) (Figure 1). It is bounded by James Ruse Drive in the south and Lake Parramatta to the North, East, and West. The study area is located approximately 3 km north of the Parramatta CBD and 20 km north-west of the Sydney CBD. The proposed works are located within part of Lot 7304 DP 1148769 and part of Lot 7023 DP 1124101. The study area is located in the Parish of Field of Mars in the County of Cumberland.

1.3. Proposal

The proponent is proposing an upgrade to the existing Lake Parramatta swimming area, to be conducted in two stages – Stage 1 involves the construction of a new stepped lake entry area and new swimming area or 'beach' including underwater retaining structure for the retention of the new beach material and Stage 2 involves embellishment of the amenity of the immediate embankment area including shade structures, seating, and the installation of an overwater pontoon. The scope of works is discussed in further detail in Section3.3. Refer to Figure 18 for design plan.

1.4. Methodology

This Heritage Impact Statement has been prepared in accordance with the NSW *Heritage Manual Statements of Heritage Impact* (2002) and *Assessing Heritage Significance* (2001) guidelines. The philosophy and process adopted is that guided by the *Australia ICOMOS Burra Charter* 1999.

The subject proposal has been assessed in relation to the Parramatta LEP 2023 and the Parramatta Development Control Plan (DCP) 2011.

1.5. Author identification

This report has been prepared by ELA Senior Heritage Consultant Jessica Horton (BA Archaeology & History, MA Heritage Conservation) and ELA Heritage Consultant Charlotte Bradshaw (BA Archaeology) with input and review by ELA Principal Heritage Consultant, Karyn McLeod (BA [Hons] Archaeology, MA Cultural Heritage). All photographs by Jessica Horton unless noted otherwise.

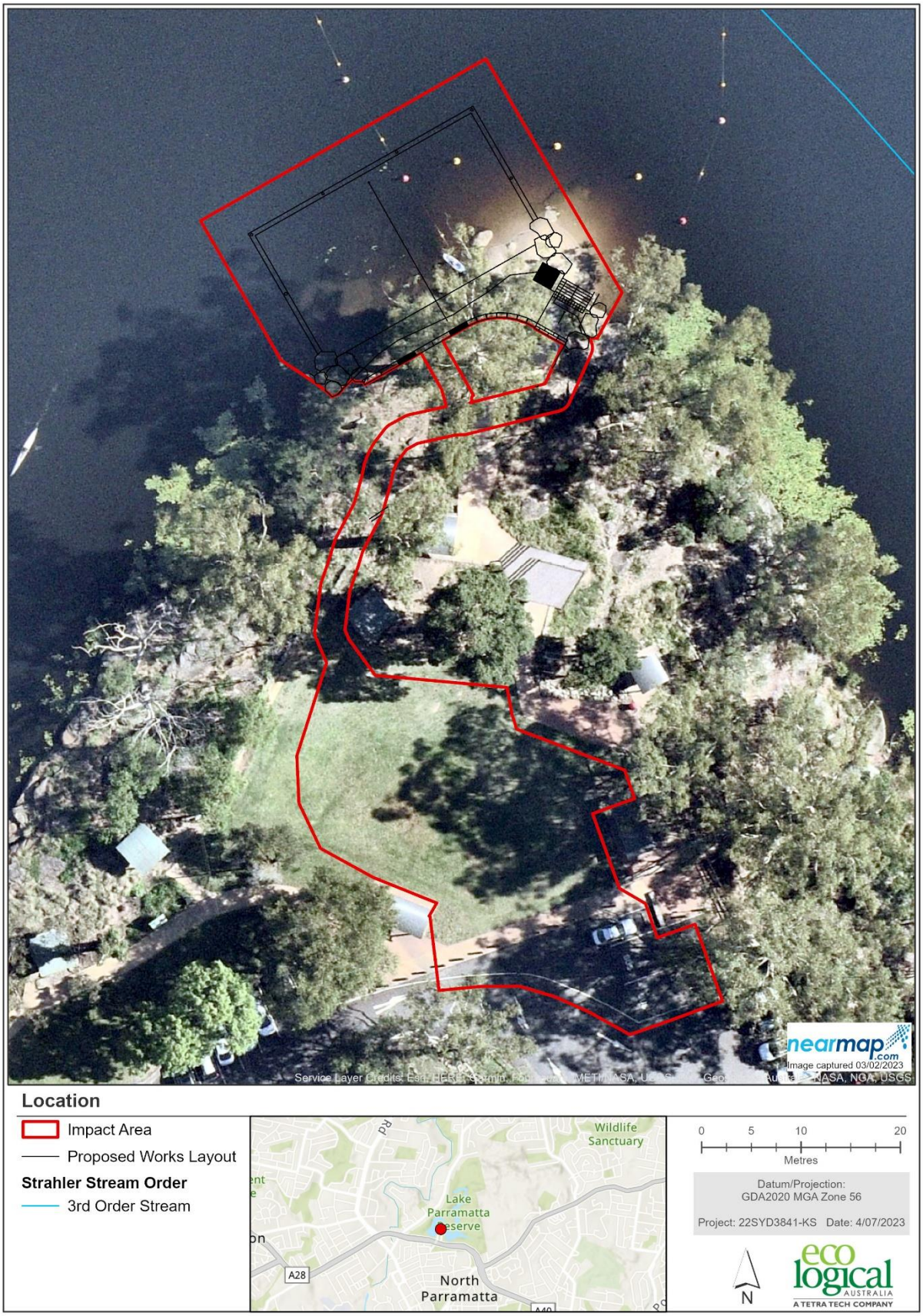

Figure 1: Study area

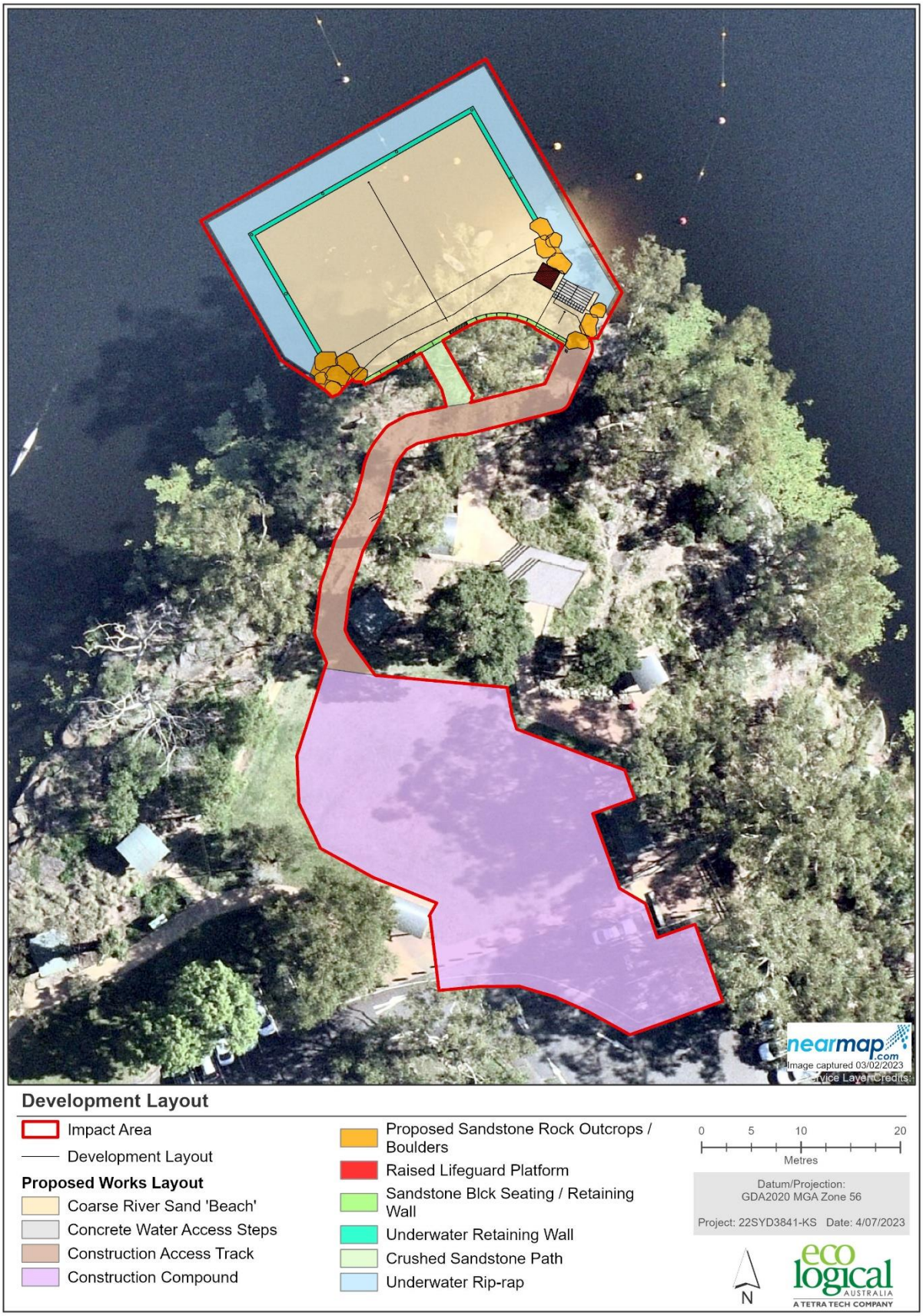

Figure 2: Proposed works layout

Figure 3: Site plan of existing site assets and locations of historic and contemporary swimming areas (Newscape 2021)

2. Site context

2.1. Site history

2.1.1. Indigenous history

The site is situated on the traditional lands of Burramattagal (or 'Burramedigal') clan of the Dharug Aboriginal language group (Tindale, 1974). *Burramatta* (or 'Parramatta') is derived from *Burra* ('eel') and *Matta* ('place'). The Burramattagal clan's neighbours are the Wangal to the east, the Warmuli to the west, the Wallumedegal to the north and the Bediagal to the south. It is not known how long the Burramattagal people lived around the Parramatta area, but there is evidence that the Darug tribe lived in the Sydney area for at least 10,000 years. As the last Ice Age came to an end, rising seas submerged large areas of Sydney's old coast and river valleys, creating the harbour and river environment first seen by Europeans in 1788. Surviving evidence of Aboriginal occupation within the boundaries of Lake Parramatta Reserve are in the form of remnant shelters, hand-stencils, and lithic artefacts. It is possible that other sites were inundated with the construction of the dam in the mid-1800s (Environmental Partnership NSW, 2012).

2.1.2. Lake Parramatta Dam

The Lake Parramatta Dam was established in 1856 with the completion of the Hunt Creek Dam Wall, which was built to provide a freshwater reservoir to the second oldest city of Australia; Parramatta (est. November 1788). The Lake Parramatta Dam was the first large dam built in Australia and the colony's first genuine storage dam which serviced Parramatta for nearly 60 years. The Hunts Creek site was chosen due to the bed of Hawkesbury sandstone within the creek which allowed cleaner drinking water compared to the shale and clayey deposits within Toongabbie Creek. The sandstone was also quarried to form the structures of the dam. The dam wall was raised 11 feet in the 1890s which doubled the storage capacity to accommodate the growing Parramatta population. In the subsequent decades, the Parramatta township had outgrown the water supply and by 1909 direct connection to Sydney's Nepean System was made (Environmental Partnership NSW, 2012; State Heritage Inventory, 2011).

2.1.3. Public Recreation and Reserve

Records as early as 1804, long before the creation of the dam, indicate that the reserve functioned as a popular recreation area from this time, and this public use continued after the decommissioning of the dam, and continues to this day. In order to maintain the water quality of the dam, the surrounding bushland was left predominately untouched and was known as "Hunts Creek Reserve" and was the first wildlife refuge created in the Sydney metropolitan area. Today, it is the largest remnant bushland in the Parramatta LGA.

From the 1920's, Lake Parramatta Reserve, as it had become recognised, enjoyed immense popularity as a recreational destination due to the bushland environment, fauna, and the lake itself. The lake was used extensively for swimming, rowing, water-skiing and other aquatic activities. A swimming club, clubhouse and lifesaving organisation were established in the 1930's and a kiosk later opened to service visitor demand in 1937. Figure 4 and Figure 5 shows Lake Parramatta in use as a swimming area in 1938. The historic swimming area is located outside of the study area and current swimming area, located to the south-west, near the dam wall (Figure 3).

A 1938 account by James Jervis depicted the historic swimming area:

> *'Several hours [may be] occupied in contemplating the natural beauties of the variegated scene, surrounded by the stately forest which protects it from the scorching summer sun, in the centre of its valley, encompassed by stupendous rocks, a murmuring stream, delectable to the taste, meanders to the untaught notes of nature's feathered care, that charm the ear with wild irregularity. Here caverns open to the untouched tribe, whose far recess forbids the approach of rude and chilling winds.'*

In 1958 Parramatta City Council adopted as its objectives for the Reserve, "the preservation and restoration of the bushland area and the maintenance and development of the recreational area" and was proclaimed a wildlife 'Complete Sanctuary' (with the exclusion of the lake proper) on October 7, 1960, under section 22 of the *Fauna Protection Act 1948*; however, this proclamation was not transferred to the current *National Parks and Wildlife Act 1974* until 2012.

Figure 4: 'Lake Parramatta' (1938) from the Sam Hood Photographic Collection (State Library of NSW), located outside the study area

Figure 5: 'Lake Parramatta' (1938) from the Sam Hood Photographic Collection (State Library of NSW), located outside the study area

2.1.4. The study area

At the point of European settlement, the study area fell within dense native bushland, utilised for public recreation as early as 1804. A 1904 parish map indicates that the study area was included within land dedicated for the public water supply by 1870 (Figure 6. The land encompassing the study area was dedicated as public reserve in 1927 and recognised as 'Lake Parramatta Reserve' from the circa 1920s. Lake Parramatta Reserve was a popular swimming spot by the 1930s, as depicted in Figure 4 - Figure 5, however, this historic swimming area is located outside the study area.

There is no documentary evidence of substantial building development having taken place within the study area. Aerial imagery from between 1943 and present-day indicates that the study area has largely remained in its current configuration (Figure 8). Minor changes to tree plantings and pathways have occurred throughout over time, however, there is no evidence of substantial structural development within the study area.

Figure 6: 1904 Parish Map showing the study area (in red) designated 'Reserve for Water Supply' in 1870 (Source: HLRV)

Figure 7: 1923 Parish Map showing the study area (in red) reserved for use as Public Recreation by 1927 (Source: HLRV)

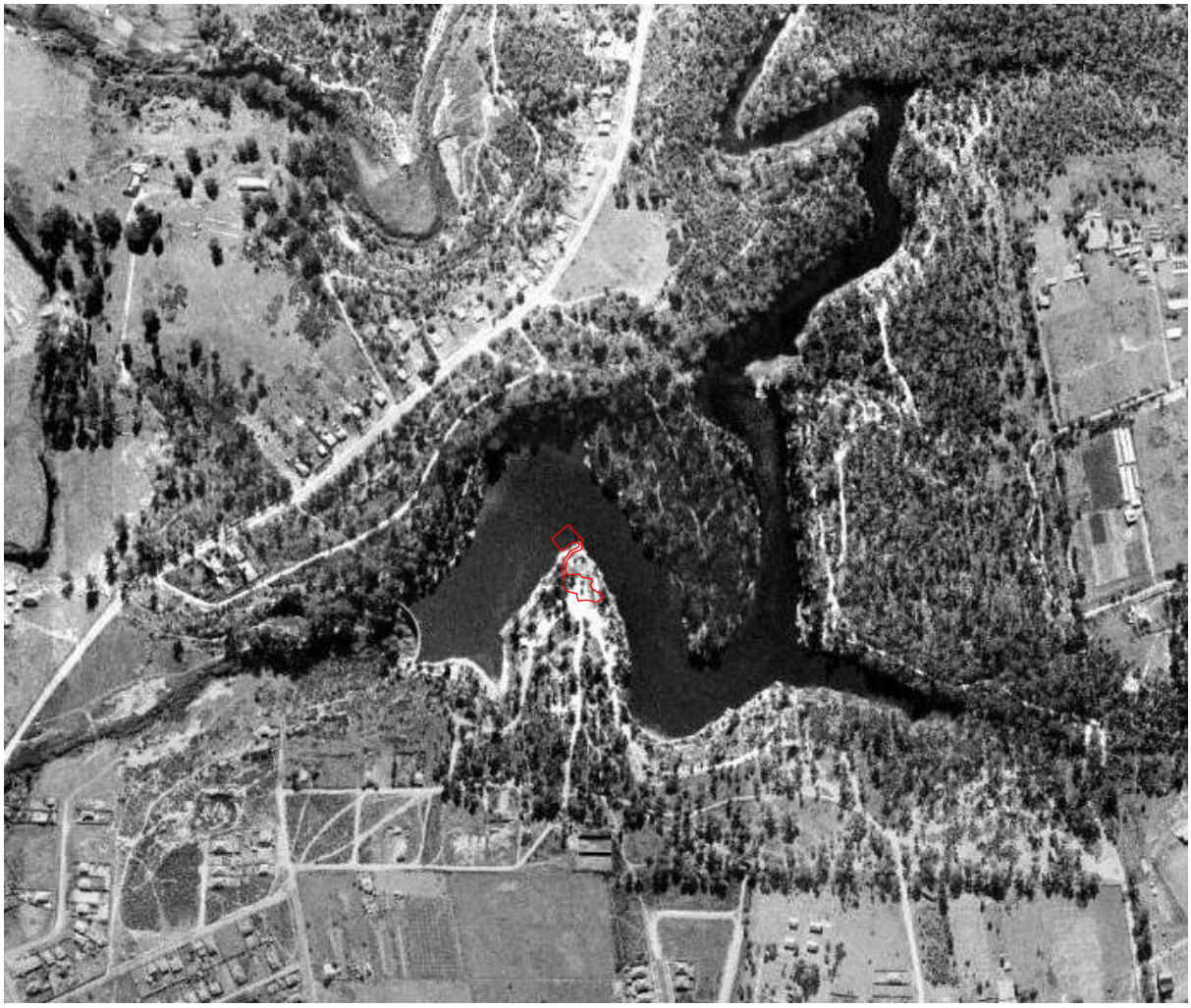

Figure 8: 1943 historic aerial imagery indicates no structures within the study area

2.2. Site description

A site visit was conducted by ELA Heritage Consultant Kate Storan and ELA Senior Heritage Consultant Jessica Horton on 11 November 2022.

The study area is located within Lake Parramatta Reserve, defined by an extensive lake system surrounded by remnant bushland interspersed with recreational facilities. The proposed construction compound area would be located within an existing carpark with adjoining grassed picnic area (Figure 11 and Figure 14), whilst the construction access track would traverse bushland to Lake Parramatta's shoreline. This bushland is interspersed with existing access tracks, and a sandstone culvert and sandstone pathway edging were encountered here during the site inspection (Figure 12 - Figure 13).

The newly accessible swimming area will be located within an existing designated swimming area along Lake Parramatta's shoreline (Figure 9 - Figure 10). This swimming area is defined by sandstone outcrops and native bushland. The setting of the place is largely regarded natural, with limited modification having occurred.

Lake Parramatta Dam lies to the west of the study area (Figure 16). It is a cylindrical masonry arch dam with vertical water face, considered to be in good condition with little evidence of weathering or spalling.

The Dam is constructed from solid sandstone blocks quarried from Hunts Creek, bonded together with Roman and Portland cement mortar. The dam wall is visible from the study area and is considered to contribute to the overall setting of the Reserve (Figure 15).

Figure 9: View northeast within Lake Parramatta Reserve towards study area

Figure 10: View north within Lake Parramatta Reserve towards study area

Figure 11: View of existing carpark within Lake Parramatta Reserve towards proposed compound area

Figure 12: View of existing sandstone culvert structure within proposed construction access track

Figure 13: View of existing sandstone pathway edging within proposed construction access track

Figure 14: View of existing grassed area within Lake Parramatta Reserve towards proposed compound area

Figure 15: View towards Parramatta Dam from study area

Figure 16: View of Parramatta Dam within Lake Parramatta Reserve (outside study area)

2.3. Archaeological assessment

Archaeology is assessed in two ways, the potential for the site to retain an archaeological resource and the significance of that resource. The significance of the resource then determines the management and approvals required. Archaeological Potential is defined as:

The degree of physical evidence present on an archaeological site is usually assessed on the basis of physical evaluation and historical research. Common units for describing archaeological potential are:

- known archaeological features/sites (high archaeological potential)
- potential archaeological features/sites (medium archaeological potential)
- no archaeological features/sites (low archaeological potential) (Heritage Office 1996).

To be considered a 'relic' under the *Heritage Act 1977* (Heritage Act), an item must have either local or State significance. A site or resource is said to be scientifically significant when its further study may be expected to help answer questions (Bickford and Sullivan, 1984 pp 23–24). For example, can the site contribute knowledge and is this knowledge relevant to general questions about associations with individuals, groups, or events of historical or social importance? While a site may have archaeological potential, the resource may not be significant if it does not have the ability to provide important information regarding a range of questions concerning way of life, taste, function, custom or process, location, setting, design, materials, and workmanship etc (Kerr 2000:8). An archaeological resource should therefore add to the knowledge of the past in an important way, rather than merely duplicating known information or information that might be more readily available from other sources such as documentary records or oral history.

An archaeological resource will form in areas where activity is concentrated. At point of European settlement, the study area fell within native bushland along the banks of Hunts Creek. Documentary evidence suggests that the study area has been utilised for public recreation purposes as early as 1804. Following the construction of the Parramatta Dam in 1856 (west of the study area), the study area was dedicated for the public water supply (1870) and later dedicated as public reserve (1927), becoming recognised as Lake Parramatta Reserve during the c1920s.

There is no evidence to suggest any archaeological resources associated with the Lake Parramatta Dam wall or its construction would be remnant within the study area. In addition, there is no documentary or aerial imagery evidence to suggest that substantial development occurred within the study area.

Imagery from the 1930s (Figure 4 - Figure 5) and documentary evidence attests that Lake Parramatta Reserve was, and continues to be, a popular swimming area, with minor infrastructure such as a sandstone pontoon/jetty, timber shed, timber benches, a kiosk and signage introduced. However, this historic swimming area is located outside the study area as indicated in Figure 3.

As such, archaeological resources associated with the study area's use for public recreation would be limited to twentieth century use including: evidence of former pathways or plantings, post holes from previous picnic facilities, and minor refuse material left by visitors. Archaeological potential within the study area is therefore considered to be low and would not reach the threshold for local significance, nor be considered 'relics.' As such, an unexpected finds procedure would be implemented ahead of works commencement as a mitigation for impacts to potential archaeological resources as outlined in Section 4.2.

Indigenous heritage has been assessed separately within the REF (ELA, 2023).

3. Heritage Impact Assessment

3.1. Listing

Before making decisions to change a heritage item, it is important to understand its values. This leads to decisions that will retain these values in the future. Statements of heritage significance summarise a place's heritage values – why it is important, why a statutory listing was made to protect these values.

The Heritage Council of NSW has developed a set of seven criteria for assessing heritage significance, which can be used to make decisions about the heritage value of a place or item. These include historical, associative, social, aesthetic, research potential, rarity, and representative.

There are two levels of heritage significance used in NSW: State and local.

The study area is located within the curtilage of one heritage item listed under Schedule 5 of the Parramatta PLEP 2023 as identified in Table 1 below.

Table 1: Parramatta Local Environmental Plan 2023 heritage items within the study area

Heritage item	Listing	Address	Significance
Lake Parramatta Reserve	PLEP 2023 Item No. I335	28A Bourke Street, Parramatta	Local

The study area is within the vicinity (200 m) of one State heritage item, as identified in Table 2 below.

Table 2: State heritage item in vicinity of the study area

Heritage item	Listing	Address	Significance
Lake Parramatta Dam	SHR Listing No. 01879 PLEP 2023 Item No. I304	28A Bourke Street, Parramatta	State

3.2. Statement of Significance

3.2.1. Lake Parramatta Reserve (Paramatta LEP Item No. I305)

The following Statement of Significance for Lake Parramatta Reserve (Item No. I305) has been taken, and amended where necessary, from the State Heritage Inventory listing for the item:

Lake Parramatta Reserve is of significance for Parramatta for historical and scientific reasons. The reserve is the first wildlife refuge in the Sydney Region and has the ability to demonstrate heritage values of a public amenity of the past, being site of former water supply for Parramatta. The area contains a large population of quite intact remnant bushland, unusual in the region, and is an important and popular recreational area close to a large population. Lake Parramatta Reserve is a related place to the Hunts Creek Dam Wall.

3.2.2. Lake Parramatta Dam (SHR Listing No. 01879)

The following Statement of Significance for Lake Parramatta Dam (SHR Listing No. 01879) has been taken, and amended where necessary, from the State Heritage Inventory listing for the item:

Lake Parramatta Dam was the first large dam built in Australia. It was 'completed in 1856, practically simultaneously with and probably independently of the modern arch dams in Europe' (Dam Technology in Australia 1850-1999, ANCOLD). As such the dam has an important place in the history of both dam technology in Australia and in the design of arch dams in the world.

In detail:

- It is the first large dam built in Australia.
- It is the only ashlar masonry arch dam in Australia (B Cole).
- The eleventh earliest single arch dam constructed in the world since antiquity.
- the only masonry dam in the world to combine the use of Roman and Portland cements in the one structure.
- It has a very slender cross section when compared with structures of similar age.
- It was the storage for one of the earliest suburban water projects in Australia and remained in service for sixty years.
- Its design and construction involved three of the most significant public works operatives of the time: Captain Percy Simpson, who was initially appointed engineer for the works and is believed to be the designer; Edward Orpen Moriarty, the supervising engineer for construction; and W Randle, the contractor.
- 'A dominant feature of the dam is its modest volume of 3,000m3 of masonry, resulting from the fact that the base is only 4.6m thick. Had it been a gravity type, it would have been about twice as thick at the base with a consequent doubling of the material required' (Dam Technology in Australia 1850-1999, ANCOLD).
- The design of the dam is thought to have been a precursor to the use of the 'cylinder' formula used by CW Darley in his design of thirteen thin arch dams constructed between 1896 and 1908 which aroused international attention.
- The raising of the dam's height in 1898 by CW Darley was part of the earliest arch dam construction programs in the world and attracted appropriate international attention.
- The raising of the dam 3.3 m by the addition of a concrete ring was achieved without diminishing the integrity of the original structure.
- The quality of the dam's design, construction and raising is demonstrated by its remaining in excellent condition and being able to withstand Probable Maximum Flood conditions.
- The dam remains the focus of an important social and recreational facility for Parramatta and surrounding district.

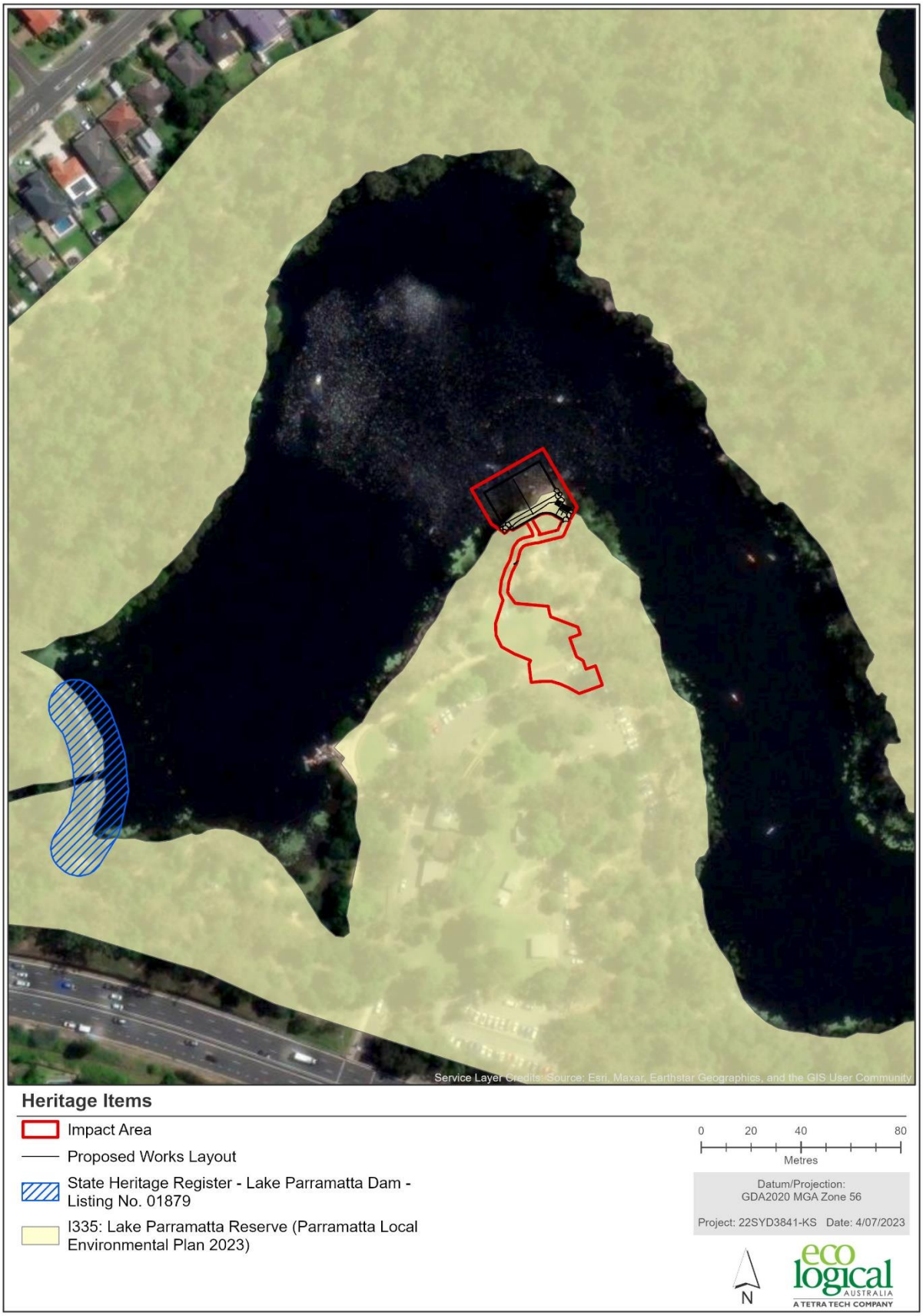

Figure 17: Heritage items

3.3. Proposal

This section provides one possible construction method and is used as a guide to assess the impacts of the works. The actual construction methods and timing will be determined by the Contractor. The final concept plan (City of Parramatta 2023) is provided in Figure 18.

3.3.1. Site Set Up

- A Dial Before You Dig Assessment (DBYD) will be undertaken prior to any excavation or construction works to locate any service infrastructure present on site.
- Transport of machinery, equipment and materials to the site and establishment of site storage and parking areas (likely to utilise existing parking).
- Installation of sediment and erosion protection measures in accordance with the 'Blue Book' *Soils and Construction, Managing Urban Stormwater* (Landcom, 2004) with reference to Chapter 5 'Erosion Control: Management of Water'.
- Installation of protection and exclusion fencing around vegetation that is to be protected and to delineate work area.
- Installation of fencing to restrict pedestrian access and temporary swimming area closure.

3.3.2. Main Works

The following main works are proposed:

- Coloured concrete pavement to improve accessibility to water's edge
- Coarse river sand 'beach' for improved level water access
- 2 x 2 m raised mod-wood lifeguard platform
- Concrete water access steps with central stainless steel handrail and tactile surface indicators
- Proposed sandstone rock outcrops/boulders
- Sandstone coloured concrete steps to match existing
- Planted native bush regeneration works
- Sandstone block seating / retaining wall
- Underwater retaining wall to 1.8 m depth with depth markers, to retain coarse river sand 'beach' material
- Backrest and armrests placed on sandstone block retaining wall
- Coloured concrete access pathway with steps and tactile surface indicators along pedestrian desire line improving accessibility to existing shelters and swimming area
- Tactile surface indicators placed at the top and bottom of existing deck steps for improved accessibility

Figure 18 shows the proposed scope of main works.

3.3.3. Post Construction Work

On completion of the main construction works, the following tasks are to be completed:

- Removal of excess materials and disposal of excavated debris as appropriate
- Reinstate any disturbed surfaces
- Reinstate access
- Removal of signage and fencing

3.3.4. Site Compound and Access

A site compound would be established prior to the commencement of site works and would be retained in place throughout the works period. The location of the proposed compound is shown in Figure 2.

3.3.5. Finishing Works

Landscaping and ancillary works would generally be completed after all other activities being completed. Landscaping of areas would take place including replanting of vegetation (including lawn) impacted during construction. Any damage from access or construction would be rectified.

3.3.6. Machinery and Equipment

A list of machinery that may be used at different points within the Project is provided below:

- Excavator
- Crane
- Barge
- Hand tools for vegetation trimming, hand digging.

Required machinery will be determined by the contractor and stored in the designated construction compound location.

Figure 18: Parramatta Swimming Area Design Plan (Landscape Architecture Capital Projects, 2023)

3.4. Impact of the proposal

The study area is located directly within a local heritage item, Lake Parramatta Reserve listed for its historic and research significance. The place is the first wildlife refuge within the Sydney region and demonstrates the heritage values of a public amenity of the past. Lake Parramatta Reserve contains a large population of intact remnant bushland and continues to operate as a popular recreational area. New elements to be introduced within the heritage curtilage would include: an underwater retaining wall, a raised mod-wood lifeguard platform, access ways, seating, and a coarse sand 'beach' with sandstone rock outcrops / boulders.

Whilst the proposed works would occur directly (physically) within the curtilage of the heritage item, these works would occur outside the original historic swimming area (Figure 3). In addition, no significant remnant bushland is expected to be removed as part of the works, whilst bush regeneration would occur, improving the amenity and outlook of the place. The works would ensure the ongoing historic use of the place as a swimming and recreational place, accessible to all local residents. The proposed works would not incur a direct (physical) impact level above negligible within the Lake Parramatta Reserve heritage curtilage.

The proposed works would introduce new visual elements within the Lake Parramatta Reserve heritage curtilage. The works are concerned with access and amenity improvements only and would ensure the ongoing historic use of the place. In addition, careful consideration has been taken in material and colouring choices including the use of sandstone and concrete, in-keeping with the existing setting of the place. Bush regeneration would occur, further improving the visual setting of the Reserve and shielding the development from various points, whilst several proposed elements would be situated underwater and therefore not visible. The proposed works would not incur an indirect (visual) impact level above negligible within the Lake Parramatta Reserve heritage curtilage.

The study area is located within the vicinity of Lake Parramatta Dam (SHR Listing No. 01879 / PLEP Item No. I304). The Dam is considered significant for its historic, associative, aesthetic, social, research potential, rarity, and representative value. As the Dam is located outside the study area, the proposed works would have no direct (physical) impact on the place or its curtilage. The Dam is located some distance from the proposed works, which would be partially obscured by vegetation, screening views to and from the proposed works. As such, the proposed works would have no indirect (visual) impact on the heritage item.

The study area has been assessed as maintaining low potential for archaeological resources to be present. These resources would not reach the threshold for local significance, nor be considered 'relics.' As such, an unexpected finds procedure would be implemented ahead of works commencement as a mitigation for potential impacts to archaeological resources as outlined in Section 4.2.

3.5. Statutory Controls

3.5.1. Heritage Act 1977 (New South Wales)

The Heritage Act provides protection of the environmental heritage of the State which includes places, buildings, works, relics, movable objects, or precincts that are of State or local heritage significance.

The NSW SHR is the statutory register under Part 3A of the NSW Heritage Act. Listing on the SHR means that any proposed works or alterations (unless exempted) to listed items must be approved by the Heritage Council or its delegates under section 60.

Section 57(2) of the Heritage Act provides for a number of potential exemptions to Section 57(1) approval requirements to reduce the need for approval of minor or regular works such as maintenance. Exempted development does not require prior Heritage Council approval. Standard exemptions do not apply to the disturbance, destruction, removal, or exposure of archaeological relics.

Archaeological features and deposits are afforded statutory protection by the 'relics provision'. Section 4(1) of the Heritage Act (as amended 2009) defines 'relic' as *any deposit, artefact, object, or material that relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and is of State or Local heritage significance.* The 'relics provision' requires that no archaeological relics be disturbed or destroyed without prior consent from the Heritage Council of NSW.

Archaeological sites that are not located within a state heritage curtilage are protected under Section 139-140 of the Heritage Act. A person must not disturb or excavate any land knowing or having reasonable cause to suspect that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, moved, damage or destroyed unless the disturbance or excavation is carried out in accordance with an excavation permit.

The Heritage Council must be notified on the discovery of a relic under Section 146 of the Heritage Act.

- The building is not a state listed heritage item nor are there any known archaeological sites. No approvals are required from the Heritage Council.

3.5.2. Environmental Planning and Assessment Act 1979 (New South Wales)

The *Environmental Planning and Assessment Act 1979* (EP&A Act) requires that consideration is given to environmental impacts as part of the land use planning process. In New South Wales, environmental impacts are interpreted as including cultural heritage impact. Proposed activities and development are considered under different parts of the EP&A Act, including:

- Major projects (State Significant Development under Part 4.1 and State Significant Infrastructure under Part 5.1) require the approval of the Minister for Planning;
- Minor or routine developments requiring local council consent are usually undertaken under Part 4 activities which, in limited circumstances, may require the Minister's consent; and
- Part 5 activities which do not require development consent. These are often infrastructure projects approved by local councils or the State agency undertaking the project.

Notwithstanding this, under Section 5.5 of the EP&A Act, a determining authority has the duty to fully consider the environmental impact of an activity and is required to "take into account to the fullest extent possible all matters affecting, or likely to affect the environment" arising from the proposal. This is facilitated through the current assessment, the purpose of which is to identify, assess, and determine the significance of potential heritage impacts, as well as mitigating actions and responsibilities that can be taken to minimise potential impacts.

- This project will be assessed under Part 4 of the EP&A Act, which applies to minor or routine developments requiring local Council consent.

3.5.3. Parramatta Local Environmental Plan 2023

The objectives of Section 5.10 are as follows:

- to conserve the environmental heritage of the City of Parramatta
- to conserve the heritage significance of heritage items and heritage conservation areas, including associated fabric, settings and views,
- to conserve archaeological sites,
- to conserve Aboriginal objects and Aboriginal places of heritage significance.

Controls under Section 5.10 of the Parramatta LEP 2023 are discussed below in Table 3.

Table 3: Section 5.10 PLEP 2023 clauses

Clause	Discussion
2) Requirement for consent Development consent is required for any of the following: • demolishing or moving any of the following or altering the exterior of any of the following (including, in the case of a building, making changes to its detail, fabric, finish or appearance): i. a heritage item, ii. an Aboriginal object, iii. a building, work, relic or tree within a heritage conservation area, • altering a heritage item that is a building by making structural changes to its interior or by making changes to anything inside the item that is specified in Schedule 5 in relation to the item, • disturbing or excavating an archaeological site while knowing, or having reasonable cause to suspect, that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, moved, damaged or destroyed, • disturbing or excavating an Aboriginal place of heritage significance, • erecting a building on land: i on which a heritage item is located or that is within a heritage conservation area, or ii on which an Aboriginal object is located or that is within an Aboriginal place of heritage significance, • subdividing land: i on which a heritage item is located or that is within a heritage conservation area, or iv. on which an Aboriginal object is located or that is within an Aboriginal place of heritage significance.	This SoHI is required to consider potential impacts to the project area and heritage items, within or adjacent to the project area. The project area is located within the curtilage of Lake Parramatta Reserve (Item No. I305) and is within the vicinity (200 m) of the State Heritage Register item Lake Parramatta Dam (SHR listing No. 01879; Parramatta LEP 2023 Item No. I304). It is considered that the proposed works would not Impact the identified heritage significance of the heritage items. The project area is not located in a conservation area. The proposed works will not disturb or destroy any known significant historical archaeological objects or relics. Aboriginal heritage has been assessed within the REF for the project (ELA, 2023).

Clause	Discussion
(4) Effect of proposed development on heritage significance The consent authority must, before granting consent under this clause in respect of a heritage item or heritage conservation area, consider the effect of the proposed development on the heritage significance of the item or area concerned. This subclause applies regardless of whether a heritage management document is prepared under subclause (5) or a heritage conservation management plan is submitted under subclause (6).	This SoHI has been prepared in order to accompany an REF for the proposed works, in order to assist the consent authority in determining the impact of them upon the heritage listed items in the vicinity.
(5) Heritage assessment The consent authority may, before granting consent to any development: (a) on land on which a heritage item is located, or (b) on land that is within a heritage conservation area, or I on land that is within the vicinity of land referred to in paragraph (a) or (b), Require a heritage management document to be prepared that assesses the extent to which the carrying out of the proposed development would affect the heritage significance of the heritage item or heritage conservation area concerned.	This document fulfils this requirement as the study area is within a heritage item and within the vicinity of an additional two heritage items.
(8) Aboriginal places of heritage significance The consent authority must, before granting consent under this clause to the carrying out of development in an Aboriginal place of heritage significance: (a) consider the effect of the proposed development on the heritage significance of the place and any Aboriginal object known or reasonably likely to be located at the place by means of an adequate investigation and assessment (which may involve consideration of a heritage impact statement), and (b) notify the local Aboriginal communities, in writing or in such other manner as may be appropriate, about the application and take into consideration any response received within 28 days after the notice is sent.	A separate report has been prepared for the project to address impacts to potential Aboriginal cultural heritage (ELA, 2023).

3.5.4. Parramatta Development Control Plan 2011

The proposed works are addressed in Table 4 below in relation to the relevant provisions in the Parramatta DCP 2011.

Table 4: Parramatta DCP 2011 provisions

Provision	Discussion
3.5.1. General **Objectives:** O.1 Appropriate management of heritage in the Parramatta LGA.	This SoHI has been prepared in order to accompany the development application for the proposed works, in order to assist the consent authority in determining the impact of them upon the subject site which is identified as a heritage item.

Provision	Discussion
O.2 Retention and reinforcement of the attributes that contribute to the heritage significance of items, areas and their settings. O.3 Maintenance and improvement to residential amenity and open space areas. O.4 Development that is compatible with the significance and character of the area.	
Design Controls – Landform / Natural characteristics C.1 Maintain the natural landform and character of the area: avoid any cut and fill to land when constructing new buildings and landscaping grounds.	Landscaping associated with the proposal will conform to existing landscaping within the area and will not have an impact on the heritage item. The character of the area will be unaffected by the proposed works and will still function as a swimming and public recreation area. Materials and colour choices have been carefully considered to match the existing setting and outlook of the Reserve, whilst the proposed works would be low in scale and partially underwater. No new buildings are proposed. Minor cutting is proposed within the bedrock which will not impact on the significance of the Lake Parramatta Reserve heritage item.

3.5.5. Lake Parramatta Reserve Plan of Management

The proposed works are addressed in Table 5 below in relation the relevant Management Principles outlined in the Lake Parramatta Reserve Plan of Management (PoM) (2012).

Table 5: Lake Parramatta Reserve PoM Management Principles

Management Principles	Discussion
4.2.3 Conserving the environment, heritage and character of the Reserve. Provide opportunities for interpretation of the Reserve's natural and cultural heritage. Conserve and promote appreciation of Aboriginal heritage sites and values in the Reserve whilst providing appropriate protection. Ensure that any changes to or development in the Reserve does not negatively impact on the natural environment of both land and water. Protect, maintain, and enhance regenerating native vegetation and areas of remnant vegetation.	Natural heritage interpretation has been considered as part of the design. Use of native vegetation is proposed to be an 'educational opportunity' for local residents to inform of aesthetically pleasing and native species for use in their private gardens. Through creating and highlighting fauna habitat, visitors are provided the opportunity to connect to the local fauna and learn abouts ways of caring and expanding their habitats. No specific interpretation of Aboriginal heritage has been implemented as part of the design. No negative impacts to the natural environment as a consequence of the proposed works are foreseen, and the protection, maintenance and enhancement of the reserve's natural heritage and values have been considered and implemented as part of the design.

3.6. Heritage Office guidelines

The proposed works have been addressed in relation to relevant questions posed in the Heritage Office's 'Statement of Heritage Impact' guidelines in Table 6 below.

Table 6: Heritage Office guidelines

Question	Discussion
The following aspects of the proposal respect or enhance the heritage significance of the item or conservation area for the following reasons:	The proposed works are consistent with the current use of the site as well as the historic use of the site. The proposed upgrades to the swimming area will improve public safety, enable increased site use by the public whilst still respecting the significance of the Lake Parramatta Reserve heritage item. Materials and colour choices have been carefully considered to match the existing setting and outlook of the Reserve, whilst the proposed works would be low in scale and partially underwater.
The following aspects of the proposal could detrimentally impact on heritage significance. The reasons are explained as well as the measures to be taken to minimise impacts:	The works would occur partially within the curtilage of Lake Parramatta Reserve The significance of the Lake Parramatta Reserve heritage item resides in the historical and research significance of the site. As the proposed works are consistent with the historic use of the site, there are no foreseen impacts to the historic or research significance of this heritage item. The assessment has found that the potential for historic archaeological resources is low. However, it is recommended that an unexpected finds procedure be adopted for the project as outlined in Section 4.2.
The following sympathetic solutions have been considered and discounted for the following reasons:	No sympathetic solutions have been considered and discounted. The 'do nothing' approach does not address the safety and accessibility issues present at the existing swimming area.
Minor additions How is the impact of the addition on the heritage significance of the item to be minimised? Will the additions visually dominate the heritage item? Are the additions sympathetic to the heritage item? In what way (e.g. form, proportions, design)?	The proposed works are consistent with the historic land use as an area of public recreation and swimming area, and therefore there are no foreseen impacts on the historic significance of the Lake Parramatta Reserve heritage item. The additions are not considered visually imposing and utilises natural sandstone surfaces and has little visual impact on Lake Parramatta. The proposed works are sympathetic with the heritage item as it is keeping with the historic land use of the site.

4. Conclusion and Recommendations

4.1. Conclusions

- The proposed works are concerned with access improvements within the Lake Parramatta Swimming Area.
- The proposed works would take place within the curtilage of one local heritage item: Lake Parramatta Reserve (Parramatta LEP 2023 Item No. I305), listed for its historic and research significance. The proposed upgrades to the existing swimming area are consistent with the current and historical land use as a place of recreation and leisure. There are no foreseeable impacts to the significance of this item.
- The proposed upgrades will maintain and facilitate the continued use of Lake Parramatta Swimming Area as a public, open space and will not impede on the relationship or historical association with Lake Parramatta Reserve nor any of the heritage items in the vicinity, including Lake Parramatta Dam (SHR Listing No. 01879; Parramatta LEP 2023 Item No. I304).
- The proposal is sympathetic to the heritage significance of the place, is low scale and will not compromise the views or character of existing heritage items or their significance. No direct or indirect impacts are anticipated for the heritage items in the vicinity of the proposed works and the scope of works is acceptable on heritage grounds.
- The assessment has found that the study area maintains low potential for historic archaeological resources to be present. These resources would not reach the threshold for local significance, nor would they be considered 'relics.'
- Listing on the SHR means that any proposed works or alterations (unless exempted) to listed items must be approved by the Heritage Council or its delegates under section 60. A Section 60 permit for impacts to local heritage items is not required. A permit is not required for the proposed works because Lake Parramatta Reserve is a locally listed item under the LEP, and there are no direct impacts to SHR listed items.

4.2. Recommendations

- A heritage toolbox talk should be provided to all contractors working on the project to ensure no inadvertent damage to heritage significant places should occur. The toolbox talk should also relay the unexpected finds procedure to all contractors.
- Sandstone culverts and access track edging is present within or within close proximity to the study area. These sandstone elements should be avoided during the proposed works and included within the heritage toolbox to avoid inadvertent damage.
- Any sandstone blocks or elements removed during the works should be reused.
- If changes are made to the design plans assessed within this report, this SoHI would require updating to reflect these changes.
- A standard unexpected finds procedure should be adopted during works associated with the proposal as a mitigation measure (see below).

4.2.1. Unexpected finds procedure

An 'unexpected heritage find' can be defined as any unanticipated archaeological discovery, that has not been previously assessed or is not covered by an existing approval under the Heritage Act or *National Parks and Wildlife Act 1974* (NPW Act). These discoveries are categorised as either:

- Aboriginal objects (archaeological remains i.e.: stone tools),
- Historic (non-Aboriginal) heritage items (archaeological remains (ie: artefacts) or movable objects),
- Human skeletal remains.

Should any unexpected historical archaeology be uncovered during any future excavation works, the following procedure must be adhered to:

- Stop all work in the immediate area of the item and notify the Project Manager.
- Establish a 'no-go zone' around the item. Use high visibility fencing, where practical. Inform all site personnel about the no-go zone.
- No work is to be undertaken within this zone until further investigations are completed.
- Engage a suitably qualified and experienced Archaeologist to assess the finds.
- The Heritage Council must be notified if the finds are of local or state significance. Additional approvals will be required before works can recommence on site.
- If the item is assessed as not a 'relic', a 'heritage item' or an 'Aboriginal object' by the Archaeologist, work can proceed with advice provided in writing.

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