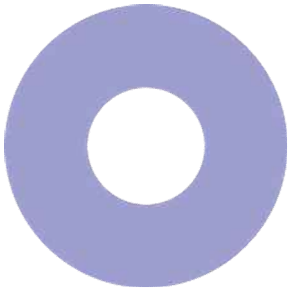
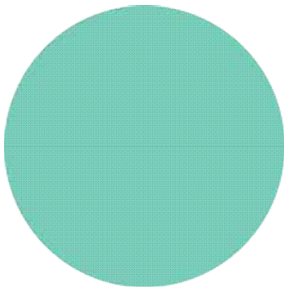
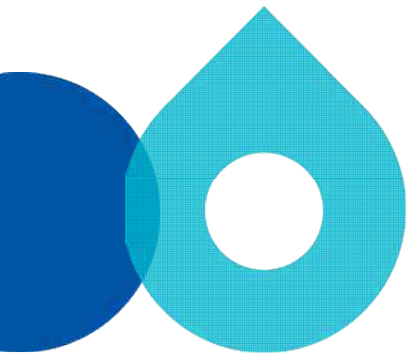
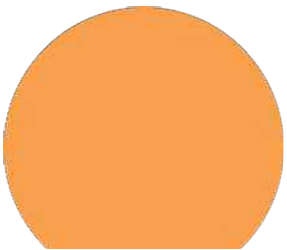
Review of Environmental Factors

Richmond System Wastewater Upgrades (December, 2021)

Sydney WATER

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Determination

This Review of Environmental Factors (REF) assesses potential environmental impacts of Richmond Precinct Wastewater Network Upgrades (the proposal) and was prepared under Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), with Sydney Water both the proponent and determining authority. The State Environmental Planning Policy (Infrastructure) 2007 allows the proposal to be carried out without development consent. The proposal has also been considered against the matters listed in clause 228 of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) (**Appendix A**).

During construction, there will be impacts to Aboriginal heritage as well as potential environmental impacts such as soil and water impacts, noise, traffic, and biodiversity. During operation, the main impacts are associated with closing and transferring flows from North Richmond Wastewater Treatment Plant (WWTP) as well as benefits of improving treated water quality from Richmond Water Recycling Plant (WRP). The assessment shows that if we adopt the measures and safeguards identified in this REF, the proposal would not have a significant environmental impact, and an Environmental Impact Statement (EIS) is not required.

The Sydney Water Project Manager is accountable to ensure the proposal is carried out as described in this REF. If the scope of work or work methods described in this REF change following determination, the REF will be reviewed for compliance and additional environmental impact assessment will be undertaken if required, in accordance with the EP&A Act.

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Executive summary

Richmond WRP and North Richmond WWTP provide water recycling and wastewater treatment within the Hawkesbury local government areas. The Richmond and North Richmond wastewater systems operate independently. North Richmond WWTP and Richmond WRP are approximately six kilometres (km) apart separated by the Hawkesbury River.

Over the next 30 years, significant population growth (residential and non-residential) is anticipated in these wastewater catchments, with equivalent population growth projected to increase by 85%.

Both Richmond WRP and North Richmond WWTP and their existing wastewater networks have capacity limitations in the current and near future and have recorded non-compliances against their environmental protection licence (EPL) requirements. The EPA has also introduced a new licencing framework, *Regulating nutrients from sewage treatment plants in the Lower Hawkesbury Nepean River catchment* (EPA, 2019). Under the framework, discharges from wastewater treatment plants will be required to meet new reduced load and concentration limits.

Existing and future flows from the North Richmond catchment will be transferred via a new pipeline to Richmond WRP for treatment. Richmond WRP will be upgraded to improve treatment performance. Richmond WRP will also be augmented to cater for the additional flows from North Richmond and growth in both catchments. North Richmond WWTP will be decommissioned and amplifications and improvements will be made across the wastewater network. The works will ensure future increased environmental performance drivers for nutrient load and concentration are met.

The proposal objectives are to:

- resolve current EPL non-compliances
- service population growth within the North Richmond and Richmond wastewater catchments
- augment the existing treatment facilities at Richmond WRP to maintain compliance with EPL 1726
- reduce combined nutrient loads discharged to the environment from both plants to meet the EPL load limits for 2024-28 (TN 7400 kg/yr and TP 70 kg/yr)
- improve reliability, availability and operability of the treatment processes
- minimise impacts to the surrounding environment and community.

Potential impacts have been identified and include impacts to Aboriginal heritage and biodiversity, and temporary erosion and sedimentation, noise, traffic and access changes during construction. During operation, the main impacts are associated with closing and transferring flows from North Richmond WWTP, as well as benefits of improving treated water quality from Richmond WRP. Our assessment concludes that the proposal is unlikely to have a significant adverse impact on the environment and an EIS is not required.

1 Introduction

1.1 Context

Sydney Water provides water, wastewater, recycled water and stormwater services to over five million people. We operate under the *Sydney Water Act 1994* and have three equal objectives to: protect public health, protect the environment and be a successful business.

We are a statutory State-owned corporation and are classified as a public authority, and a determining authority for the proposed work, under Division 5.1 of the EP& A Act. Under the *Protection of the Environment Operations (POEO) Act 1997*, our wastewater systems are licenced by the Environment Protection Authority (EPA) via an Environment Protection Licence (EPL). The Richmond and North Richmond wastewater systems are licenced under EPL 1726 and EPL 190, respectively.

The subject of this REF is to assess the potential environmental impacts associated with the decommissioning of the North Richmond WWTP, and the transfer of existing flows of North Richmond catchment to the Richmond WRP. To cater for these additional flows from North Richmond, and future growth in both catchment areas, augmentation of Richmond WRP is required. The works will ensure that future increased environmental performance drivers on both nutrient load and concentration are met.

1.2 Proposal background and need

1.2.1 Proposal background

The Richmond and North Richmond wastewater systems operate independently. They are currently serviced by the Richmond WRP and North Richmond WWTP. North Richmond WWTP and Richmond WRP are approximately six kilometres (km) apart separated by the Hawkesbury River.

North Richmond WWTP was commissioned in 1979 with a capacity of 3,000 equivalent population (EP), and was upgraded in 2000 to the current capacity of 6,500 EP. The township of North Richmond and some properties on the edge of the town are serviced by the WWTP. The North Richmond WWTP is an extended aeration activated sludge plant which disinfects wastewater using a UV system prior to discharge into Redbank Creek, a tributary of the Hawkesbury River. Settled sludge at the WWTP is transported via truck to St Marys WRP for processing.

The original Richmond WRP was commissioned in 1962 then upgraded to a new plant in 2005 which included nutrient removal. The upgrade allowed the production of recycled water and improvements to the quality of treated wastewater discharges from the WRP. The WRP services the Richmond community as well as the townships of Wilberforce, Glossodia, Freemans Reach,

Londonderry and Agnes Banks. The WRP has a current capacity of 18,000 EP. The wastewater entering the WRP passes through screening, intermittently decanted aeration lagoons (IDALs) and tertiary filtration prior to chlorine disinfection. After disinfection, the treated wastewater is sent to the Richmond Golf Course and the Western Sydney University (WSU) for recycling through irrigation or after dechlorination, discharged into an unnamed creek, which is a tributary of Rickaby's Creek and then the Hawkesbury Nepean River. Biosolids are removed during the treatment process and transported off site for beneficial re-use.

Over the next 30 years, significant population growth (residential and non-residential) is anticipated in these wastewater catchments, with equivalent population growth projected to increase from the current 24,400 EP to 36,500 EP by 2046, representing an increase of 85%.

Both treatment plants and the existing wastewater network have capacity limitations in the current and near future. North Richmond WWTP treats about 1.46 ML of wastewater per day with Richmond WRP treating about 2.61 ML/day (average dry weather flow).

Both plants operate under EPLs issued by the EPA. The EPLs regulate the nutrient loads and concentrations which can be discharged into the Hawkesbury Nepean River. The EPA has introduced a new licencing framework, *Regulating nutrients from sewage treatment plants in the Lower Hawkesbury Nepean River catchment* (EPA, 2019). Under the framework, discharges from wastewater treatment plants will be required to meet new reduced load limits, for total nitrogen (TN) and total phosphorous (TP) as well as their reduced concentration limits.

1.2.2 Proposal need

The proposal is part of the Richmond/North Richmond wastewater precinct program. North Richmond WWTP is at its operating treatment capacity and has recorded EPL non-compliances due to wet weather overflow exceedances in the network. In addition, the Richmond WRP does not have sufficient capacity to accommodate projected future flows and nutrient loads.

The new nutrient load and concentration limits will come into effect in the EPLs from 1 July 2024. The new limits aim to minimise the risk of algal blooms and aquatic weed outbreaks from treatment plant discharges that will service increased development in Western Sydney. Both Richmond WRP and North Richmond WWTP discharge to Sackville Subzone 1, defined under the framework.

Table 1 Richmond precinct treatment plants

Treatment plant	Treatment level	Discharge (ML/day)	Discharge location
North Richmond WWTP (EPL 1726)	Tertiary (includes additional phosphorus removal and disinfection)	1.46	Redbank Creek to the Hawkesbury River
Richmond WRP (EPL190)	Tertiary treatment. Richmond WRP also includes reuse, average 1ML/day	2.61	Un-named Creek to Rickaby's Creek and Hawkesbury River

Table 2 Current and future nutrient load and concentration limits

	Total Nitrogen (TN)				Total Phosphorous (TP)			
	Current load limit (kg/yr)	2024 load limit (kg/yr)	2024 load cap (kg/yr)	2024 (mg/L) 50th percentile	Current load limit (kg/year)	2024 load limit (kg/year)	2024 load cap (kg/yr)	2024 (mg/L) 50th percentile
Sackville Subzone 1	201,100	7,400	6,800	N/A	3,700	70	860	N/A
North Richmond WWTP	43,800	-	-	-	10,877	-	-	-
Richmond WRP	7,118	7,400	6,800	6	803	70	860	0.03

1.2.3 Proposal objectives

The proposal objectives are to:

- resolve current EPL non-compliances
- service population growth within the North Richmond and Richmond wastewater catchments
- augment the existing treatment facilities at Richmond WRP to maintain compliance with EPL 1726
- reduce combined nutrient loads discharged to the environment from both plants to meet the EPL load limits for 2024-28 (TN 7400 kg/yr and TP 70 kg/yr)
- improve reliability, availability and operability of the treatment processes
- minimise impacts to the surrounding environment and community during construction.

The proposal has been based on maintaining existing recycled water use (currently about 1.6ML/day), however demand for recycled water is likely to increase.

1.2.4 Consideration of alternatives/options

An options assessment was undertaken to consider the performance of the existing system (including the network and treatment plants), current risks and constraints. The assessment considered existing and future wastewater flows and characteristics, targets for treated wastewater and current and future licence conditions for both North Richmond WWTP and Richmond WRP. A variety of network and treatment investigations were undertaken to inform the options assessment.

A long list of scheme options was developed that comply with the future wastewater nutrient limits, while also achieving the requirements of the current EPL conditions and addressing the system constraints. This long list included a business as usual approach with existing and different levels

of wastewater treatment and recycling considered, as well as transfer to and augmentation of Richmond WRP.

Consolidating the wastewater treatment (transfer to and augmentation of Richmond WRP) with existing recycling was identified as the preferred scheme option. Additional sub-options for the liquid, solid and network servicing were also considered. These included different types of treatment technology and the method for stablising solids.

The analysis identified the preferred approach is to increase the capacity of the Richmond WRP (augmentation with new IDAL/SBRs) to treat wastewater from the North Richmond system and accommodate future flows from both catchments. The North Richmond network would be amplified with direct transfer to Richmond WRP. Solids will continue to be sent for recycling, however this will be reviewed after the EPA finalises review of the biosolids guidelines.

As part of the options assessment, several different new pressure main alignments to Richmond WRP were considered. The final alignment was selected to:

- accommodate design considerations; the length of the pipeline had to be suitable for the proposed wastewater pumping station, it also had to be sized to ensure sufficient capacity to meet 2056 demand
- minimise impacts to properties and the community
- minimise impacts to surrounding ecology and heritage items
- avoid the Transport for NSW (TfNSW) proposed Richmond Bypass project.

The preferred alignment and upgrade options were selected as they appropriately balanced the above considerations and included the following benefits:

- reduced operational risk as there will only be one wastewater treatment facility to operate
- by closing the North Richmond WWTP we are reducing customer impacts by treating wastewater at the Richmond WRP, which is not located in a residential area.

1.3 Consideration of Ecologically Sustainable Development

The proposal has been considered against the principles of ecologically sustainable development (ESD) (refer to **Table 3** below).

Table 3 Consideration of principles of ecologically sustainable development (ESD)

Principle	Consideration in proposal
Precautionary principle - *if there are threats of serious or irreversible environmental damage, lack of scientific uncertainty should not be a reason for postponing measures to prevent environmental degradation. Public and private decisions should be guided by careful evaluation to avoid serious or irreversible damage to the environment where practicable, and an assessment of the risk-weighted consequences of various options.*	The proposal will not result in serious or irreversible environmental damage. Mitigation measures have been incorporated into the proposal to reduce scientific uncertainty relating to potential impacts to the environment. The proposal will have positive environmental outcomes by ceasing routine discharge to Redbank Creek and improving the water quality discharging from Richmond WRP by reducing the concentrations and nutrient load.
Inter-generational equity - *the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.*	The proposal will help to meet the needs of both current and future generations by providing an improved and reliable wastewater service. Improved network capacity and treatment processes will reduce nutrients entering waterways. This will contribute to improved waterway and ecological health for future generations.
Conservation of biological diversity and ecological integrity - *conservation of the biological diversity and ecological integrity should be a fundamental consideration in environmental planning and decision-making processes.*	The proposal will remove up to 0.71 hectares (ha) of native vegetation that forms threatened ecological communities, mainly for construction of the transfer pipeline. The communities include Cumberland Plain Woodland, River-Flat Eucalypt Forest, Swamp Oak Floodplain Forest and Shale/Sandstone Transition Forest. The concept design has minimised the impact to biological diversity and ecological integrity during planning. This impact would be offset in accordance with Sydney Water's Biodiversity Offset guideline.
Improved valuation, pricing and incentive mechanisms - *environmental factors should be included in the valuation of assets and services, such as 'polluter pays', the users of goods and services should pay prices based on the full life cycle costs (including use of natural resources and ultimate disposal of waste) and environmental goals.*	The proposal will provide cost efficient use of resources and provide optimum outcomes for the community and environment by reducing nutrients discharged.

2 Proposal description

2.1 Proposal details

The proposal is to decommission North Richmond WWTP, construct a new pump station and transfer pipeline from the North Richmond site to Richmond WRP site, and upgrade the Richmond WRP to service the wastewater load of the combined catchment.

The Richmond WRP upgrade will include an upgrade of the inlet works, installation of a flow balancing tank, duplication of the secondary treatment process (IDAL/SBR), installation of new odour control facilities and upgrade of the tertiary and disinfection processes. **Figure 1** shows the location of the proposal. The Richmond WRP (Lot 1/DP1105163 and Lot 1/DP234175) is located within the suburb of Richmond in north western Sydney on Sydney Water owned land. The North Richmond WWTP (Lot 10/DP833598) is located within the suburb of North Richmond on Sydney Water owned land.

The transfer pipeline crosses multiple lots with ownership a mixture of private property, council, TfNSW and Sydney Water. Work to the wastewater network (pipelines, pumping stations, maintenance holes (MH), emergency relief structures (ERS)) would be on public, private and Sydney Water land.

2.2 Proposed activities

2.2.1 Scope of work / construction activities

Table 4 summarises the scope of works and construction methodology for the key phases of the construction program.

Broadly, construction will involve bulk earthworks, open excavation, directional drilling, pipe laying, substructure and structural works, concreting, buildings, plant and equipment, driveways, landscaping. North Richmond WWTP and Richmond WRP will remain operational during construction of the proposal. The delivery contractor will work with the operational teams at both sites to minimise disruption to operations.

Table 4 Scope of works

Works required	Description of works
Upgrade of Richmond WRP	• Prepare site (including excavation) • Install inlet pipework to connect the new North Richmond transfer line at the inlet works **Preliminary treatment** • Replace existing screens, screenings handling and washing system with two new centre flow band screens and associated screenings handling, washing and storage system

Works required	Description of works
	• Install a vortex grit tank, grit washers and wash press in the inlet and outlet channels **Secondary Treatment** • Install a new 1.7 ML balance tank and associated pipework • Install new carbon dosing systems • Install two new SBR reactors with diffused aeration system and convert existing IDALs to SBR, and retrofit with diffused aeration system in place of existing surface aerators • Construct a new equalisation basin and secondary treated wastewater pump station **Tertiary Treatment** • Install three tertiary filters and associated pipework • Install an additional 250 kL dry weather chlorine contact tank **Ancillary Works** • Decommission redundant pipework • Expand the existing chemical dosing system • Install an additional odour control system • Construct a new electrical switchroom and upgrade existing power supply.
New pumping station with increased pump capacity (90L/s to 250 L/s) to replace existing pumping station SP0096 at North Richmond WWTP	• Site preparation (including vegetation clearing) • Relocate minor services • Remove first flush system • Remove existing sludge pump system • Excavate a new wet well (approximately 20 m deep) • Construct new pumping station (250 L/s to transfer to Richmond WRP) • Replace existing pump with two new 90L/s wet weather pumps to retransfer flows to the storage lagoon in North Richmond • Connect the new pumping station to existing inlet maintenance hole.
Transfer Pressure Pipeline	The proposal includes construction of 6.7km DN560 PE/DN400 pressure pipeline to transfer wastewater flows from new SP0096 to Richmond WRP. Generally, the pipeline will be trenched, however at sensitive locations, including at Redbank Creek and the Hawkesbury River the works will use trenchless construction methods. At these locations, dual pipelines will be laid. The transfer pipeline will require the construction of surface infrastructure at various locations. This infrastructure includes air valves, odour control units, isolation valves and scour points.
Network Upgrades	• Duplicate and amplify approximately 950 m of existing gravity sewer via open trenching methods • Pipework and structure modifications to existing discharge emergency relief structures (ERS) • Replace valves in ERS • Replace maintenance hole (MH) covers • Install new diesel pumps with acoustic housing at SP0383 • Install new emergency storage (about 5m x 11m x 3.5m deep) within the existing pumping station sites at SP0913 and SP0527

Works required	Description of works
Staged decommissioning and future restoration of North Richmond WWTP	North Richmond WWTP will be decommissioned in stages, and the final use for the site will be further considered. As part of the scope of this REF, electrical equipment will be isolated, and sludge will be removed from lagoons. Areas of the site will be fenced and landscaped. The following tasks may also be undertaken: • Dispose of water and sludge from existing ponds to an appropriately licenced facility • Remove redundant equipment and machinery • Demolish and remove below ground concrete structures, pipework and cabling • Backfill below ground structures with certified material • Remove asbestos from administration building and chlorine dosing building in accordance with relevant legislation • Clean chemical dosing facilities to allow for safe removal • Demolish and remove all above ground structures including administration building • Isolate and decommission utilities (LV and HV electricity) • Landscape works.

2.2.2 Pre-construction works

Pre-construction activities would include surveying, geotechnical and contamination investigations, and locating underground services. We will also:

- Obtain regulatory approvals identified in this REF, including Aboriginal Heritage Impact Permit (AHIP)
- prepare management plans and procedures including a Construction Environmental Management Plan (CEMP), site inductions and safety plans
- establish and delineate construction footprint, material laydown and machinery storage
- set up site sheds and amenities including connection to with temporary water and electricity
- install environmental controls and clear vegetation
- deliver and store materials and equipment.

We will salvage Aboriginal heritage in North Richmond before construction commences, in accordance with an AHIP, if granted from Heritage NSW. Detail on Aboriginal heritage is provided in **Section 5.2**. Safeguards for salvage and protection of Aboriginal heritage will also be included in the CEMP.

2.2.3 Commissioning and decommissioning

Commissioning involves testing and running the new equipment to ensure the equipment is working correctly and integrated with existing plant operations. The exact commissioning steps depend on the type of the equipment but typically include:

- factory testing
- installation testing/dry testing

- training and providing operational and maintenance manuals
- performance testing

Commissioning activities and program will be determined by the delivery contractor.

As noted in the table above the decommissioning works will be staged with the initial stage designed to make the site safe for the operation of the new pump station and emergency storage. Works will include isolating the electrical equipment, removing sludge from the lagoons, fencing and some restoration work. The timing of the remaining works will be dependent on the future use of the site, which is still under consideration.

North Richmond WWTP will remain operational until SP0096 is constructed, and Richmond WRP is upgraded. Decommissioning of North Richmond WWTP will be undertaken when SP0096 has been commissioned and Richmond WRP can accept the transfer of flows.

2.2.4 Post construction and restoration

Post construction (including post-decommissioning) activities include:

- demobilising the site, clean up and restoring construction areas
- reinstating damaged roadways and ground surfaces
- removing waste materials, machinery and excess materials
- landscaping and vegetation restoration
- removing environmental controls, temporary fencing, site sheds, amenities and safety barriers
- fixing any defects during the liability period.

The work sites along the pipeline alignment will be restored to the pre-existing condition following construction in consultation with landowners.

2.3 Materials/equipment

The materials required for construction will include:

- concrete, structural steel, aluminium, timber and steel reinforcement
- pipework, ductwork and vessels made from stainless steel, PVC, glass fibre reinforced plastic (GRP), concrete or steel
- polyethylene
- colour bond sheeting
- electrical cabling and conduits
- mechanical and electrical equipment

- road base, rock rip-rap and engineered backfill
- asphalt for sealing roads
- fuel for equipment, machinery and vehicles
- ancillary construction materials.

Equipment required for construction will include:

- excavator, back hoes, bobcats, including those fitted with hydraulic hammers
- compactors, concrete vibrators and rollers
- drill rigs
- jackhammers
- chainsaws
- compressors for pneumatic equipment
- hand tools
- waste and /or recycling trucks
- skip bins
- staff and utility vehicles
- generators
- water carts
- temporary fencing, skip bins, environmental controls and portable amenities
- cherry pickers, access platforms (fixed and mobile) and scaffolding.

2.4 Worksites, access and vehicle movements.

The North Richmond WWTP is located on the corner of Bells Line of Road and Crooked Lane in North Richmond. Richmond WRP is located off Blacktown Road, Richmond. Both plants are located within Hawkesbury City Council.

Existing access to the North Richmond WWTP and Richmond WRP will be used for the duration of the works. Some modification to the North Richmond driveway will be required to facilitate access of large vehicles. Access to work sites along the transfer pipeline will utilise existing roads or driveways where possible. The works do not require the construction of permanent access tracks.

Temporary compounds will be in previously cleared and disturbed land away from drainage lines. These will include site sheds, amenities, parking and material storage. The exact location of these will be chosen by the delivery contractor, in consultation with the landowner(s) and approved by Sydney Water's Project Manager in accordance with the safeguards in **Section 6**.

2.5 Workforce and timeframe

The construction workforce is estimated to peak at 30 people per day at each site, in addition to the daily staff. This is likely to fluctuate, depending on the program of construction works, and will often be less than the maximum number. No additional operational staff will be required because of the project.

Construction will commence at all sites early 2023 and will be completed by mid 2025.

Most of the work and deliveries will be scheduled to occur during standard daytime hours:

- 7am to 6pm, Monday to Friday
- 8am to 1pm, Saturdays

No work would take place on Sundays and public holidays.

The proposal may require work outside these hours, for example if road closures are required at Pughs Lagoon or on Francis Street. Sometimes work is required at different times (eg for work in roads, for rail crossings or delivery of oversize equipment). Sydney Water's Project Manager can approve work outside of standard daytime hours, following the approval process described in the safeguards in **Section 6**.

2.6 Operational requirements

All infrastructure would be inspected, maintained and repaired as necessary in accordance with Sydney Water's standard operating procedures. As well as the standard operation and maintenance activities, the following environmental safeguards will be undertaken during operation:

- post commissioning inspection and photographs of the geomorphic condition at key sections of Rickaby's Creek (annually, for three years)
- water quality monitoring on the unnamed tributary of Rickabys Creek – one upstream and one downstream of the Richmond WRP discharge point. Monitoring and reporting will be undertaken in accordance with our sewage treatment system impact monitoring program (STSIMP) in accordance with our EPL (ongoing).
- post commissioning aquatic ecology monitoring (upstream and downstream) of Rickaby's Creek (biannually for two years) and analysis report.

Additional operational or maintenance activities would be subject to supplementary environmental impact assessments if required by Sydney Water's procedures.

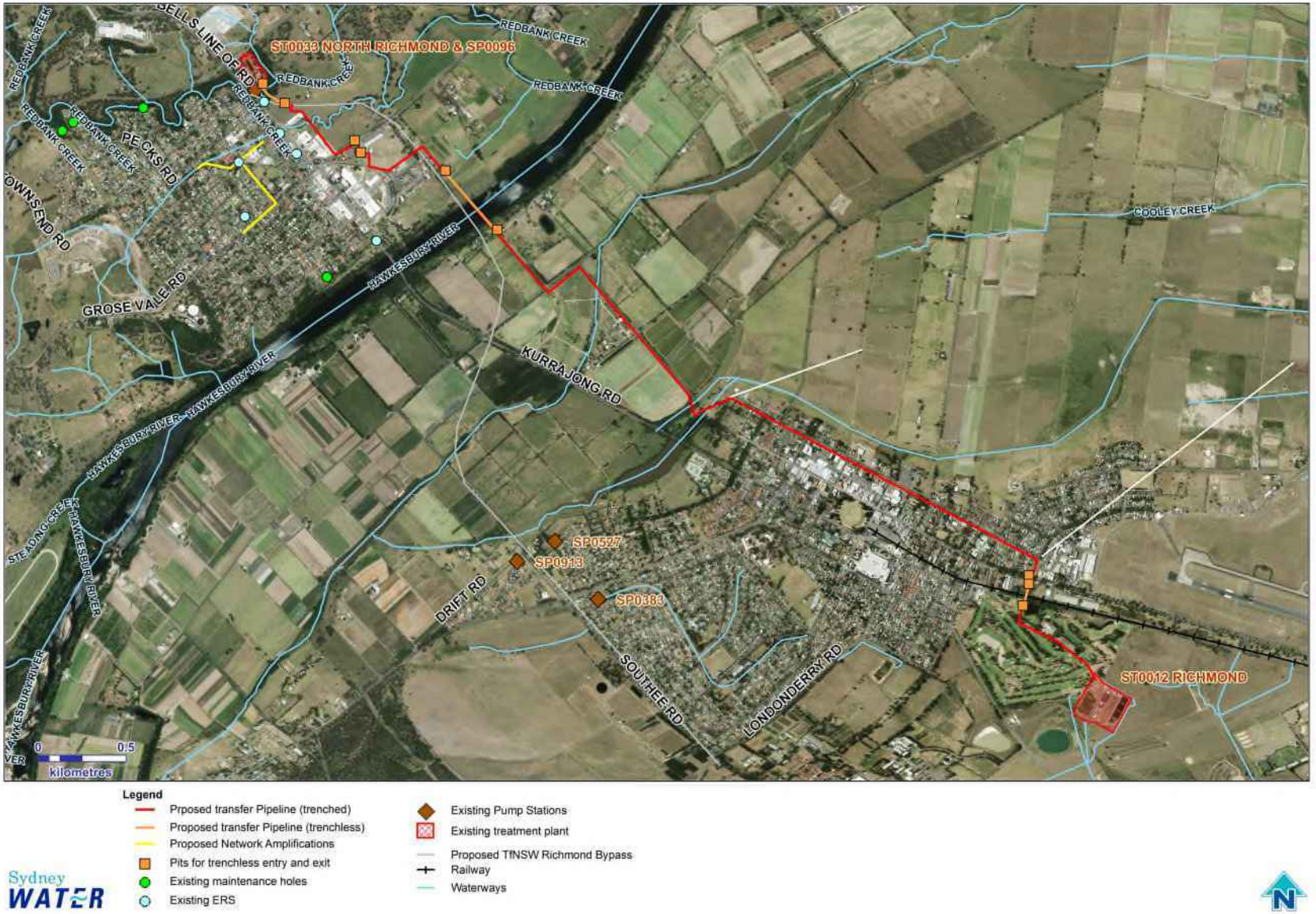

Figure 1 Location of the proposal

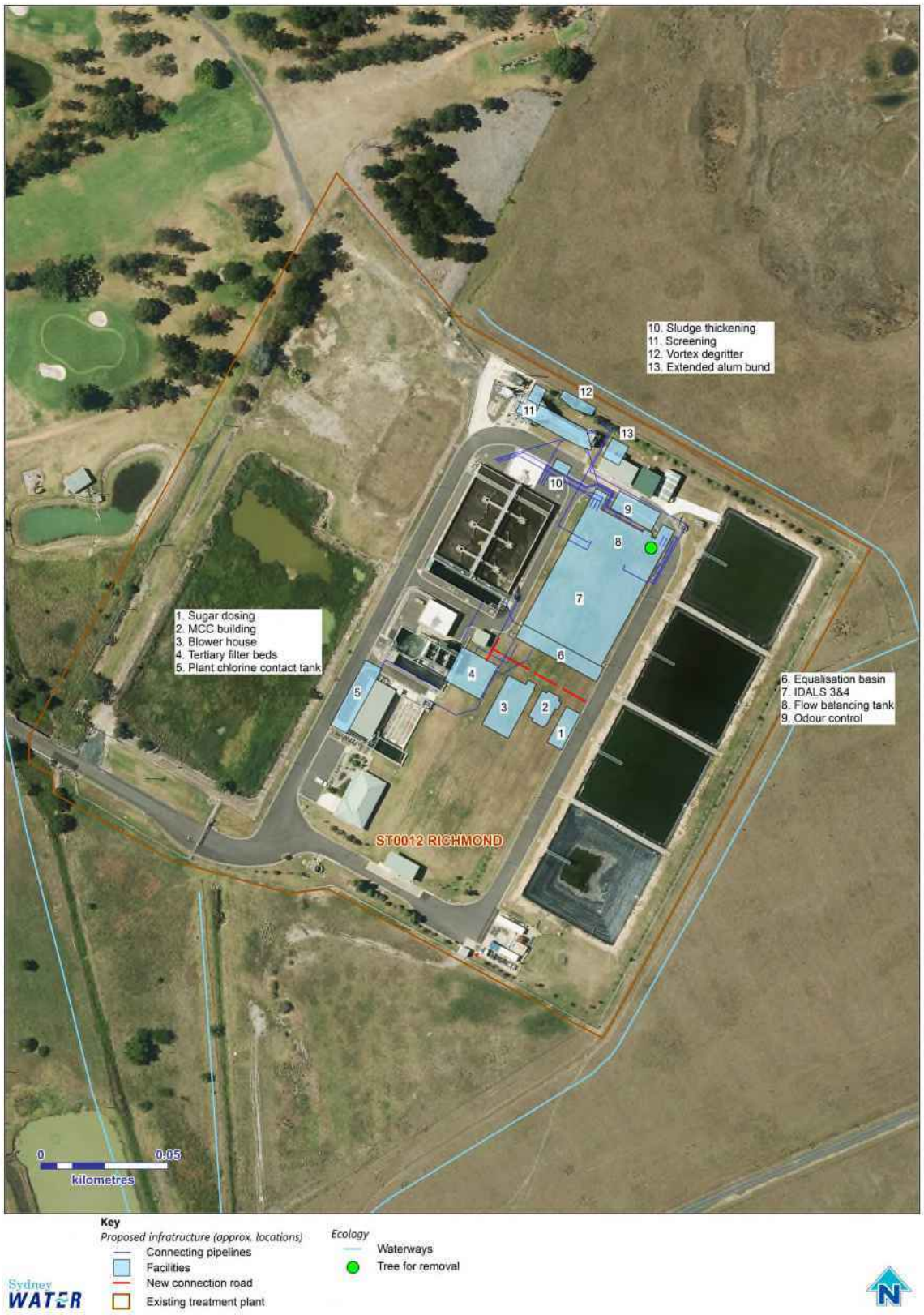

Figure 2 Richmond WRP Upgrades

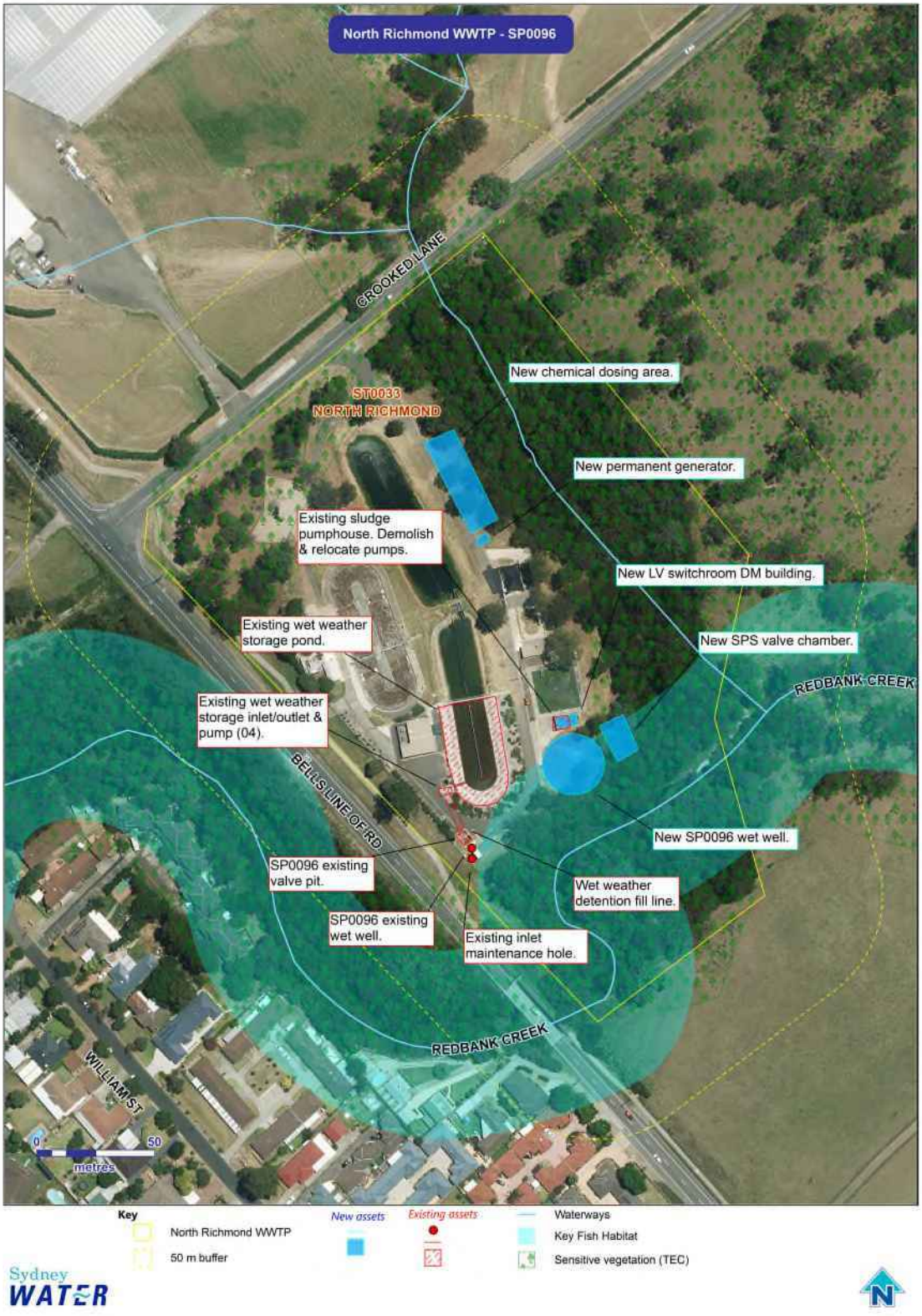

Figure 3 North Richmond WWTP and SP0096 works

2.7 Field assessment area and changes to the scope of work

The design shown in this REF is indicative and based on the latest concept design at the time of REF preparation. The final design may change during detailed design and/ or construction planning. If the design or construction methods described in this document change significantly, supplementary environmental impact assessment (such as an Addendum REF) must be prepared by the delivery contractor for the amended components in accordance with SWEMS0019. An addendum is not required provided the changed design assessed by the Environmental Representative:

- remains within the study area of the REF and has no net additional environmental impact; or
- is outside the study area of the REF but reduces the overall environmental impact of the proposal (s.5.4(a) of the Act).

Changes to the proposal outside the study area can only occur:

- to reduce impacts to biodiversity, heritage or human amenity; or
- to avoid engineering (for example, geological, topographical) constraints; and
- after consultation with any potentially affected landowners and relevant agencies.

The delivery contractor will demonstrate in writing how the changes meet these requirements and Sydney Water's Project Manager will review the request, in consultation with the environmental and communication representatives.

3 Consultation

3.1 Community and stakeholder consultation

Our approach to community and stakeholder consultation is guided by Sydney Water's Community and Stakeholder Engagement Policy.

Stakeholder and community engagement is a planned process of initiating and maintaining relationships with external parties who have an interest in our activities. Community and stakeholder engagement:

- enables us to explain strategy, policy, proposals, projects or programs
- gives the community and stakeholders the opportunity to share their knowledge, issues and concerns
- enables us to understand community and stakeholder views in our decision-making processes alongside safety, environment, economic, technical and operational factors.

If our work will impact the community in some way, we will consult with affected groups through a variety of ways and through different stages of a project. This includes engaging the broader community and stakeholders during planning or strategy development or before making key decisions.

A Community and Stakeholder Engagement Plan (CSEP) has been prepared for the proposal. The plan helps us to provide the community and key stakeholders with clear, accurate and timely information.

The delivery contractor will need to prepare an updated CSEP for detailed design and construction based on the Consultation Outcomes Report.

Consultation with key stakeholders has occurred (as detailed in **Table 5** below), and will continue throughout detailed design, construction and commissioning of the proposal. We will consult with community members where the proposal directly impacts them.

During construction, the delivery contractors responsible for delivering the proposal will consult with stakeholders and the community and, as representatives of Sydney Water, will adhere to our community relations policies and procedures. We will continually monitor the contractor's performance during proposal delivery.

3.1.1 Richmond WRP

We identified seven properties that are potentially impacted by the works, or adjacent to Richmond WRP. All construction activities related to the WRP upgrade will be conducted within the WRP.

Stakeholders we have engaged with about the plans and potential impacts caused by increased construction include:

- Richmond Golf Course
- Western Sydney University Campus
- landowners.

3.1.2 North Richmond WWTP and transfer pipeline

Stakeholder consultation commenced in May 2020 and is ongoing. All identified landowners were issued with a letter outlining the project and the intent to visit the area on 10 June 2020. Directly impacted landowners were issued with a detailed letter and were invited to contact Sydney Water to provide feedback.

So far, 294 properties have been identified as being potentially impacted by, or adjacent to the proposed design.

Sydney Water has contacted all stakeholders who may have a direct impact to their property from the amplification of local wastewater pipes and the new transfer pipeline. Stakeholders adjacent to the project (for example where the work is taking place in the road verge) will be informed prior to the works.

Key agency stakeholders that have been engaged to provide feedback and inputs into the options assessment includes:

- Hawkesbury City Council - regarding proposed alignments and potential impacts to Council owned property and roads
- Transport for NSW – Richmond Bridge duplication project
- Maritime (Roads and Maritime) – regarding crossing the Hawkesbury River
- Sydney Trains - regarding proposed options in the rail corridor that impact railway lines
- WaterNSW – regarding electric fencing adjacent to geotechnical work
- EPA – regarding proposed environmental outcomes, licence variation applications and REF progress.

Table 5 provides a summary of the consultation to date.

Table 5 Consultation summary

Stakeholder	Infrastructure, and date of engagement	Feedback received	Sydney Water action
Hawkesbury City Council	Both (pipeline and treatment plants) 1 July 2020	Council advised there may be further environmental requirements if the pipeline crosses the wetland areas, this will	Letter issued to Council General Manager, Peter Conroy, to introduce the project.

Stakeholder	Infrastructure, and date of engagement	Feedback received	Sydney Water action
	29 September 2020 20 June 2021	be followed up by council's planning/environmental team. Preference is for works to be completed within road verge rather than road carriageway, due to future settlement and restoration works. Francis Street will be rehabilitated this financial year, so separate discussions may be necessary to discuss coordinating these activities. Council provided contacts for key organisations linked to the oval (Sport Clubs) for Sydney Water to discuss impacts and timing.	Notified Council about alignment changes. Met with Council to discuss the proposed design, construction on Council land (Turnbull Oval and the change in pump station design at Drift Rd, Richmond).
Sydney Trains	Wastewater pipeline 29 September 2020 23 June 2021	Access to rail corridor Project engineer discussed requirements for underbore of the rail corridor and submitted application (13 July 2021)	Project manager to seek approvals and submit applications for construction near railway.
Richmond Golf Club	Wastewater pipeline 2 July 2020	They support the project but would like to work with the team to minimize impacts during construction.	
Water NSW	Wastewater pipeline	Initial contact has been made regarding electric fence and WaterNSW infrastructure	
Hawkesbury Environmental Network (HEN)	Both (pipeline and treatment plants) December 2020	Interest in environmental outcomes of project. Requested updates.	Keep updated on project timeframes, milestones and works that may impact residents/environment.
EPA	Both (pipeline and treatment plants) December 2020 October 2021	Interest in environmental outcomes of project. Advised requirements for licence variations. Further detail is included below.	Addressed in REF Will seek a licence variation for EPL1760 before operation commences and will likely

Stakeholder	Infrastructure, and date of engagement	Feedback received	Sydney Water action
			surrender EPL190 once decommissioning is complete – to be confirmed with EPA.
TfNSW	Wastewater pipeline June/July 2020 December 2020 and ongoing	Introduce project and advise of river crossing Project may be impacted by TfNSW's Richmond Bridge duplication project. Maritime: Crossing of Hawkesbury River	Redesigned pipeline alignment to avoid road project. Maintain ongoing contact as bridge plans are made publicly available.

Where possible the transfer pipeline alignment will be laid within the road verge or corridor to minimise community impacts, including from new easements or acquisition.

The EPA requested certain information be included in the REF. **Table 6** below identifies the matters raised by the EPA and where it is addressed in the REF.

Table 6 Matters raised by EPA during consultation

Infrastructure	Matter raised by EPA	Outcome / where addressed in REF
SP0096	• Detention time • Backup/alternate power supply • Mitigation of potential issues • Potential impact on surrounding environment due to overflows inclusive of water quality assessment of receiving waterways.	There will be 4-hour wet weather detention, in accordance with Sydney Water policies. An emergency diesel generator will be provided (refer to **Table 4**). Potential impacts to water quality are discussed in **Section 5.2.2**.
Transfer pipe	• Location of air valves • Impact assessment of odour on the community.	Air quality and odour is assessed in **Section 5.2.4**. As part of this an odour investigation was undertaken which recommended air valves or odour control units at 11 locations along the transfer pipeline as well as at SP0096 to reduce potential odour impacts.
Closure of North	• Current flows	Refer to **Section 5.2.2** Water Quality.

Infrastructure	Matter raised by EPA	Outcome / where addressed in REF
Richmond WWTP	• Changes to discharges to be clearly stated.	
Richmond WRP	• Influent volumes • Water quality assessment of receiving waterways.	Refer **Section 5.2.2** Water Quality.
Water quality and licensing	• Consistency with proposed Hawkesbury Nepean nutrient framework.	The proposal has been designed to be consistent with the Hawkesbury Nepean nutrient framework. Refer to **Section 5.2.2** Water Quality. Proposed license variations are identified in **Table 8**.

3.2 Consultation required under State Environmental Planning Policies and other legislation

Sydney Water must consult with councils and other authorities for work in sensitive locations or for work which may impact upon Council's infrastructure (such as under Part 2 Division 1 of the *State Environmental Planning Policy (SEPP) Infrastructure 2007*).

Consultation is required under clause 13(1) as the proposal involves excavation of council managed roads. While parts of the proposal will be constructed within flood liable land, the proposal is not expected to change flood patterns other than to a minor extent (clause 15(2)). Consultation will be undertaken by the delivery contractor prior to construction. Further detail is provided in **Appendix B**.

4 Legislative requirements

The following environmental planning instruments (**Table 7**) and legislation (**Table 8**) are relevant to the proposal. **Table 8** also documents any licences and permits, timing and responsibility for obtaining them.

Table 7 Consideration of environmental planning instruments relevant to the proposal

Environmental Planning Instrument	Relevance to proposal
Hawkesbury Local Environmental Plan 2012 (Hawkesbury LEP)	The proposal is in several different land use zones, including Infrastructure, Primary Production, Environmental Conservation, Residential, Special Activities, Environmental Conservation and Public and Private Recreation. Both Richmond WRP and North Richmond WWTP are zoned as SP2 Infrastructure.
State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP)	Clause 106 (2) of the Infrastructure SEPP permits development by or on behalf of a public authority for a sewage treatment plant without consent on any land in a prescribed zone. Clause 106 (3) of the Infrastructure SEPP permits development by or on behalf of a public authority for a water recycling facility without consent on any land in a prescribed zone. Clause 106 (3B) of the Infrastructure SEPP permits development for the purpose of sewage reticulation systems without consent on any land in the prescribed circumstances. Clause 106 (1) defines the prescribed circumstances if the development is carried out by or on behalf of a public authority. The proposal involves decommissioning of a sewage treatment plant, modifications to existing water recycling facility and sewerage reticulation system on land under various zones. As Sydney Water is a public authority, and both Richmond WRP and North Richmond WWTP are in a prescribed zone (SP2), the proposal is permissible without consent.
State Environmental Planning Policy 55 - Remediation of Land (SEPP 55)	The proposal is likely to involve excavation and removal of some contaminated soils and material from Richmond WRP and North Richmond WWTP. The work is not a remediation (clean-up) of land and SEPP 55 does not apply. However, contaminated soils or materials will be managed in accordance with section 5.2.1.
State Environmental Planning Policy (Coastal Management) 2018 (Coastal Management SEPP)	Sections of the proposed pipeline are within areas mapped as coastal wetland, coastal wetland proximity area, coastal use area

Environmental Planning Instrument	Relevance to proposal
	and coastal environment area under the Coastal Management SEPP (see **Figure 6**). In particular the transfer pipeline alignment is within: • a small section of Old Kurrajong Road which is mapped as coastal wetland, and • Old Kurrajong Road which crosses Pughs Lagoon (Pughs Lagoon is a mapped coastal wetland). At Old Kurrajong Road, the road is incorrectly mapped as a coastal wetland. Sydney Water has requested that DPIE update the mapping to reflect the existing road infrastructure (see **Figure 4** below) and DPIE are considering the request. A safeguard has been added to confirm the mapping of the coastal wetland/road is amended before construction commences. At Pughs Lagoon, Old Kurrajong Road crosses an area of mapped coastal wetland. The road at this area is not mapped as coastal wetland (it is within the coastal wetland proximity area), and there is sufficient area for the transfer pipeline to be laid in the road verge (away from the wetland area). Where the road narrows, the transfer pipeline may be located within the road, to avoid impacts to the wetlands (see **Figure 5**). Most work within coastal wetlands requires development consent (designated development) to ensure the biophysical, hydrological and ecological integrity of the wetland is protected. The alignment of the transfer pipeline has been planned to avoid impacting the wetlands, by locating the pipeline within existing road verges and roads. This also means development consent is not required for the work, in accordance with clause 11 of the Coastal Management SEPP. **Section 5.2.1** and **Section 5.2.2** includes information about the wetland, ground conditions and groundwater associated with Pughs Lagoon. If additional investigations in detailed design alter the alignment of the transfer pipeline through a coastal wetland, additional environmental impact assessment will be undertaken. Safeguards will be in place to ensure the coastal wetlands and adjacent wetland areas are protected during construction (refer to **Section 5.2.2**).

Environmental Planning Instrument	Relevance to proposal
	 **Figure 4** Old Kurrajong Road and wetland area. Source: Google Street View (2021)  **Figure 5** Old Kurrajong Road at Pughs Lagoon Source: Nearmap (2021)
State Environmental Planning Policy (Vegetation in Non-Rural Areas) 2017	This SEPP applies as it is in an area listed in Clause 5.1a and/ or land within the zones listed in Clause 5.1b. However, section 6.1 states: '*This Policy does not affect the provisions of any other SEPP….*' As the works are permissible under SEPP

Environmental Planning Instrument	Relevance to proposal
	(Infrastructure) a Council permit to clear vegetation under this SEPP is not required.
State Regional Environment Policy No 20 Hawkesbury-Nepean River (SREP 20)	The proposal is located on land to which the SREP 20 applies. The proposal does not require consent under the SREP 20, however Sydney Water is required to consider the matters listed under clauses 5 and 6 that apply to the proposal. This REF functions to address these considerations, which relate to protecting sensitive environmental areas (including rivers and wetlands), water quality, cultural heritage and flora and fauna. The project would serve to protect the Hawkesbury-Nepean River and its values by improving the current treatment level for discharges in line with EPA's nutrient framework. The project has been designed, including the transfer pipeline to avoid sensitive environmental areas and the other matters under clauses 5 and 6 where possible.

Table 8 Consideration of key environmental legislation

Legislation	Relevance to proposal	Permit/ approval and timing, responsibility
Environmental Planning and Assessment (EP&A) Act 1979	Sydney Water is the proponent and determining authority under this Act. The proposal does not require development consent, and is not classified as State Significant Infrastructure. We have assessed this proposal under Division 5.1 of the EP&A Act. This REF has concluded that the proposal is unlikely to have a significant impact on the environment.	REF Pre-construction, Sydney Water
Protection of the Environment Operations Act 1997	The proposal will ensure Richmond WRP and North Richmond WWTP comply with their EPLs and can meet the limits in the new Hawkesbury Nepean nutrient framework for 2024. EPL 190 for North Richmond WWTP includes a pollution reduction program for wet weather overflow abatement, to address non-compliance of the wet weather overflow limit. This proposal is designed to address the pollution reduction program; however, a licence variation may be sought to extend the timeframe (currently 31 March 2023) until the proposal is in operation (anticipated mid 2025). Prior to operation of the proposal, a variation to EPL 1726 for Richmond WRP will be sought to accommodate the flow from North Richmond system and the network components (including	EPL variation Prior to operation, Sydney Water

Legislation	Relevance to proposal	Permit/ approval and timing, responsibility
	SP0096). After North Richmond WWTP is decommissioned, EPL 190 can be surrendered.	
Biodiversity Conservation Act 2016	Schedules 1 and 2 of the BC Act list terrestrial species, populations, and ecological communities threatened in NSW. We are required to assess impacts to listed items according to Section 7.3 of the Act. An assessment has been completed which considered the impact of the proposal on threatened species, communities and their habitats (**Appendix D**). The biodiversity assessment found that the proposal may result in an impact to 0.71 ha of threatened ecological community (TEC) (see **Section 5.2.3** and **Appendix D**). These impacts will be rehabilitated or offset in accordance with Sydney Water's Biodiversity Offset guidelines. The impacts are not considered to be significant impacts and therefore a Species Impact Statement (SIS) and / or approvals under this Act is not required.	N/A – no formal offsets required. The delivery contractor will follow Sydney Water's Biodiversity Offset guideline during detailed design.
National Parks and Wildlife Act 1974	Under Section 86 of this Act, it is an offence to harm or desecrate an Aboriginal place or object unless authorised by an Aboriginal heritage impact permit (AHIP), or where it is reasonably determined that no Aboriginal object will be harmed. Test excavations undertaken along the transfer pipeline in the North Richmond area identified areas of Aboriginal heritage. In these areas, the proposal is unable to avoid impacts to the Aboriginal heritage. An AHIP under Section 90 of the Act is required prior to the commencement of work (refer to **Section 5.2.6**).	AHIP Post REF, pre-construction, Sydney Water
Heritage Act 1977	Under Section 57(1) of the *Heritage Act 1977*, approval must be granted to development on land listed on the State Heritage Register. A permit under Section 60 of the *Heritage Act 1977* is required for works that may impact a site listed on the State Heritage Register, except for that work which complies with an exemption under 57(2). Section 139 of the *Heritage Act 1977* prohibits a person from disturbing or excavating any land on which the person has discovered or exposed, or is likely to disturb a relic, except in accordance with an excavation permit or a notification granting exception for the permit. As per **Section 5.2.6** of this REF no impacts are expected to state heritage items and therefore no exemption or approval is required.	N/A

Legislation	Relevance to proposal	Permit/ approval and timing, responsibility
Fisheries Management Act 1994	For a public authority to undertake works in Key Fish Habitat, we are required to give the Minister notification of the works and consider any matters raised within 21 days of giving the notice. Hawkesbury River is identified as Key Fish Habitat. The construction methodology will involve underboring for crossing of waterways which will avoid any impacts.	Notification Pre-construction, Sydney Water
Water Act 1912/ Water Management Act 2000	Section 60A of the *Water Management Act* states that it is an offence to take water without a licence. A water supply work (WSW) approval is required under Section 90(2) of the Act to pump groundwater. The proposal would likely encounter groundwater during excavation works and therefore a WSW approval would be required. A Water Access Licence (WAL) is required under section 61 where groundwater extraction will be greater than 3 ML per year. There is potential for groundwater in excess of 3 ML to be extracted during construction and so a WAL is required with a temporary allocation of the estimated volume of water to be extracted.	WSW Approval and WAL Detailed design. Pre-construction, Sydney Water based on delivery contractor details and volumes
Roads Act 1993	Section 138 specifies that if an applicant for works in roads is a public authority, consultation must be given prior to the start of works. Old Kurrajong Road at Pughs Lagoon will require temporary road closure and there is potential for other areas to require temporary lane or road closures and a road occupancy licence, and TfNSW notification or approval for the set-up of temporary facilities on road or road verge.	Road Occupancy Licence Pre-construction, Contractor
Contaminated Land Management Act 1997	Under Part 5 of this Act, the EPA is required to keep a record of current and former contaminated sites. The Act also requires that landowners and persons which carry on contaminating activities notify the EPA of land contamination in certain circumstances. There are no sites which are listed on the EPA's contaminated site register in the suburbs of Richmond or North Richmond. However, it is possible that excavation in disturbed areas may encounter contamination. Precautions are detailed in **Section 5.2.1** in this REF with regards to disturbing contaminated material.	N/A
Environment Protection and Biodiversity	Actions that are likely to have a significant impact on matters of national environmental significance, Commonwealth lands or actions carried out by the Commonwealth are subject to assessment and approval. Under the EPBC Act, a person must	N/A

Legislation	Relevance to proposal	Permit/ approval and timing, responsibility
Conservation Act 1999	not take an action that has, will have or is likely to have a significant impact on any of the matters of environmental significance (MNES) without approval from the Australian Government Minister for the Environment. The EPBC Act outlines the environmental assessment and approval process. The vegetation to be removed for the proposal does not meet the condition thresholds for EPBC listings of TECs and therefore there will be no significant impacts and a referral to the Minister is not required. There are no other MNES impacted by this proposal.	

5 Environmental assessment

The potential environmental aspects and impacts associated with construction, operation and decommissioning of the proposal are identified in this section as well as safeguards to minimise these. These safeguards will be incorporated into contract documents and a Construction Environmental Management Plan (or similar) to be developed by the delivery contractor prior to commencement of work.

Risk assessments (including environmental risks) have been undertaken during project development and will continue through detailed design and prior to construction, in accordance with Sydney Water's Enterprise Risk Management Framework.

5.1 Existing environment

The proposal area comprises of North Richmond WWTP, Richmond WRP and the transfer pipeline which connects both properties. The proposal is characterised by low rolling hills and valleys with heights generally of 20m Australian Height Datum (AHD), but dips to 16m AHD on the banks of the Hawkesbury River and 10m AHD at the Richmond Lowlands (Francis Street).

North Richmond WWTP is overlain on medium to very coarse-grained quartz sandstone, minor laminated mudstone and siltstone leases part of the Hawkesbury Sandstone formation from the Middle Triassic period. Richmond WRP is overlain on clay, patched of ferruginized, consolidated sand part of the Londonderry Clay formation from the Tertiary period. The area in between is overlain by sections of Hawkesbury sandstone and Ashfield shales of the Wianamatta group characterised by dark-grey to black claystone-siltstone and fine sandstone-siltstone laminate.

The proposal area is within the Hawkesbury - Nepean Catchment. The North Richmond WWTP discharges into the nearby Redbank Creek which then meanders approximately 3 km before discharging into the Hawkesbury River. The Richmond WRP discharges treated wastewater not used for irrigation into an unnamed creek which then travels to Rickaby's Creek before reaching the Hawkesbury River. The Hawkesbury River supports many agricultural properties throughout the region and is used by the surrounding communities for recreation purposes.

Vegetation throughout the area has been previously cleared for agricultural, residential and industrial uses, resulting in isolated patches of native plant communities with connectivity restricted to the riparian corridors.

While the proposal area and surrounds is dominated by rural land uses, the North Richmond WWTP is surrounded by the following land use zones:

- Primary production (RU1)
- Low density residential (R2).

The Richmond WRP is surrounded by the following land use zones:

- Special activities (SP1) (Western Sydney University and TAFE NSW)
- Private recreation (RE2).

Land use along the transfer pipeline comprises low-medium density residential along Francis Street as well as rural properties along Old Kurrajong Road and the Hawkesbury River.

5.2 Environmental aspects, impacts and safeguards

5.2.1 Topography, geology and soils

Potential impacts

Some of the key construction activities for the proposal have the potential to result in erosion of soils and offsite sedimentation of waterways. These activities include:

- excavation for the construction of semi-buried structures at Richmond WRP (up to 5m deep) including the reactors and tertiary filters
- open trenching and trenchless construction to install the transfer pipeline
- stockpiling of soils
- removal of vegetation
- decommissioning of North Richmond WWTP.

The proposal lies on the Cumberland Plain in western Sydney. Salinity and erodibility of the area was identified as an area of localised salinity hazard (OEH, 2002). Inappropriate management of saline soils could result in potential impacts to surrounding land and waterways from off-site leaching saline soils.

The proposal area is subject to Class 5 acid sulphate soils (ASS) as indicated on the Hawkesbury LEP 2012 ASS Risk Maps and detected in soil samples conducted for the DSI. Excavation and ground disturbance works may expose ASS. Exposed ASS can result in the formation of sulphuric acid which can cause odour, acidification of groundwater, wetlands and waterways.

The transfer pipeline would be installed in stages, with disturbed areas being rehabilitated as the work moves along the pipeline. This will minimise the risk of erosion as excavations will be backfilled and stabilised as the work progresses. The excavations will be backfilled to existing ground level and landscaped.

A detailed site investigation (DSI) was conducted in 2020 for the transfer pipeline alignment. Sampling detected heavy metals (nickel) and polyaromatic hydrocarbons (PAH) in various locations. Inappropriate management of these contaminated soils has the potential to impact on human health and surrounding land and waterways from off-site leaching of contaminants.

Previous contamination studies at Richmond WRP identified the potential for contaminants relative to the proposal, including elevated concentrations of heavy metals and nutrients in the groundwater surrounding the former oxidation pond in the south west corner of the site (unlikely to

be disturbed by the proposal), asbestos contaminated material (ACM) fragments in the north-eastern portion of the site (near the proposed upgrade works), and PFAS at low concentrations within soil and groundwater across the site, likely due to offsite impacts from the RAAF Base Richmond. All PFAS concentrations were low and did not exceed any adopted human health or ecological guideline values. These are discussed further in section 5.2.5.

The DSI was limited to the pipeline only, and further investigations at the Richmond WRP and North Richmond WWTP will be conducted during detailed design. If additional contamination is identified during the further investigations, then management of that contamination will be included in the Contamination Management Plan (see below).

We do not anticipate any impacts to soils and topography during operation.

Safeguards – topography, geology and soils
Prevent sediment moving offsite in accordance with Managing Urban Stormwater, Soils and Construction, Volume 1 and 2A (Landcom 2004 and DECC 2008), including: • develop a Soil and Water Management Plan (SWMP) as part of the CEMP • divert surface runoff away from disturbed soil and stockpiles • install sediment and erosion controls before construction starts • reuse topsoil where possible and stockpile separately • inspect controls at least weekly and immediately after rainfall • rectify damaged controls immediately remove controls once surfaces have been stabilised, including removing trapped sediment in drainage lines.
Minimise ground disturbance and stabilise disturbed areas progressively.
Stop work in the immediate vicinity of unexpected/previously unknown suspected contamination. Indicators of contamination include discoloured soil, anthropogenic fill material, asbestos, strong chemical or petrol odours and leachate. Contain disturbed material on an impermeable surface and cordon areas off. Notify the Sydney Water Project Manager and the Environmental Representative. Sydney Water Project Manager to contact Property Environmental Services for advice regarding management options. Appropriately qualified Environmental Consultant to attend site to assess the unexpected find and provide advice for management.
A Contamination Management Plan (CMP) would be prepared by a suitably qualified Environmental Consultant as part of the CEMP and reviewed by Sydney Water's Environmental Representative in consultation with Property Environmental Services. The CMP must be prepared in accordance with relevant legislation and guidelines, including the National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013), and the NSW EPA (2020) Consultants Reporting on Contaminated Land Guidelines. The plan would identify the type and location of known/potential contamination, management/remediation required and disposal measures. The CMP would identify how contamination on the site will be remediated to leave it suitable for the relevant land use, for example commercial/industrial land use.

Safeguards – topography, geology and soils
A Detailed Site Investigation for the WRP/ WWTP sites will be undertaken during detailed design to provide updated soil and groundwater conditions. Any new contamination findings must be incorporated into the CMP.
Stop work during heavy rainfall or in waterlogged conditions when there is a risk of sediment loss off site.
Sweep up any sediment/soil transferred off site at least daily, or before rainfall.
Eliminate ponding and erosion by restoring natural landforms to the pre-works condition.
Manage acid sulfate soils in accordance with the Acid Sulfate Soils Management Advisory Committee: Acid Sulfate Soils Assessment Guidelines (ASSMAC, 1998).
The delivery contractor will ensure imported material is certified for intended use and is free from contamination including asbestos.
Adopt appropriate soil salinity mitigation measures in accordance with Western Sydney Salinity Code of Practice (Western Sydney Regional Organisation of Councils, 2003). This may include: • (if relevant) treat existing salinity with gypsum • (if relevant) establish salt tolerant species in existing or potential salinity problem areas after construction • stabilise existing areas of erosion • minimise water use on site • avoid rotation and vertical displacement of the original soil profile • backfill excavations deeper than one metre in the same order, or treat or use this material as fill at depths more than one metre from the finished level.

5.2.2 Water and drainage

Existing environment

Richmond WRP and North Richmond WWTP are within the Hawkesbury River catchment. The Hawkesbury–Nepean River catchment covers an area of 22,000 km², flowing from south of Goulburn to Broken Bay. The Hawkesbury River flows from the confluence of the Grose and Nepean Rivers and is tidal for its entire length. The Hawkesbury/Nepean River is the largest river/estuary system in the Sydney Region, providing habitat for a complex ecosystem. The Hawkesbury River is identified as key fish habitat by Department of Primary Industries (Fisheries).

Water quality in the Hawkesbury-Nepean is affected by pollution from urban and agricultural runoff, and discharges from seventeen licensed wastewater treatment plants (fifteen operated by Sydney Water).

A large proportion of the study area adjacent to the Hawkesbury River, including Richmond WRP is mapped as flood prone land.

Water quality

North Richmond WWTP discharges treated wastewater to an unnamed tributary of Redbank Creek which flows to the Hawkesbury River. Redbank Creek is identified as key fish habitat. Water quality in both the tributary and Redbank Creek is poor, with nutrient enrichment, riparian weeds, and soil erosion present along the banks. Where the unnamed tributary meets Redbank Creek, in the south-eastern corner of the site, there is an accumulation of an orange iron-bacterial growth. There is variable aquatic habitat in Redbank Creek, with bedrock and silty substrates in the pools, runs and short riffles present. Macrophytes and large woody debris habitats are present, though habitat connectivity is poor, with manmade weirs and culverts forming barriers to fish passage (GHD, 2019).

Richmond WRP provides recycled water (chlorinated tertiary treated wastewater) to WSU and Richmond Golf Course for irrigation. Excess treated wastewater (after being dechlorinated) discharges into an unnamed watercourse, which subsequently flows to Rickaby's Creek, a minor tributary of the Hawkesbury River. Treated wastewater discharge from Richmond WRP, to the creek, is intermittent. During dry weather in summer, WSU and Richmond Golf Course use most of the treated wastewater. In winter, irrigation demand decreases and discharge to Rickaby's Creek is required. During wet weather flows, treated wastewater can overflow the holding tanks and discharge into Rickaby's Creek. Water quality and aquatic ecology in Rickaby's Creek has been assessed as poor (GHD, 2019). The creek is influenced by a range of land uses in the catchment including stormwater from WSU, the golf course, urban and agricultural areas, and other commercial and industrial activities. The effects of discharge from Richmond WRP on Rickaby's Creek are considered minor.

Both Redbank and Rickaby's creeks flow to the Hawkesbury River within reaches that are tidally influenced, although are predominantly fresh, in terms of salinity.

Geomorphology

While the overall condition of Redbank Creek is poor, at the unnamed tributary, the waterway is in good condition. It is a confined valley with relatively intact vegetation cover. Condition generally decreases towards the confluence of Redbank Creek with Hawkesbury River because of poor vegetation cover and the presence of livestock which have caused bank erosion and channel widening.

The unnamed tributary of Rickaby's Creek is overall in poor geomorphic condition due to a lack of riparian vegetation, the presence of stock grazing, and erosion. An eroded section is present about 2.3km downstream of Richmond WRP which has been migrating upstream over time (GHD, 2019).

Groundwater

Desktop geotechnical investigations indicate that the groundwater level varies across the project and indicates a flow pattern towards the Hawkesbury River, with depths controlled by the river level. Groundwater at North Richmond WWTP was at one metre below ground level (bgl). At Richmond WRP, groundwater was between 3.1 and 13.5 meters bgl. Across the project the groundwater table varies between 1.2m and 7.0m bgl south of the Hawkesbury River (equivalent to

a reduced level of 6.8m and 4m AHD respectively). To the north of the Hawkesbury River, the groundwater table is between 8m and 11m (equivalent to 14m and 13m AHD respectively).

Potential impacts – construction

Construction activities have the potential to impact surface water and groundwater quality. Potential impacts during construction include:

- sedimentation impacts on local waterways/ stormwater system from poor management of excavations, stockpiles, unsealed access roads
- spills and frac-out during the trenchless crossing of Redbank Creek and the Hawkesbury River
- excess volumes of surface and groundwater requiring management during construction in the road crossing of Pughs Lagoon
- part of SP0096 (wet wells) and work to Richmond WRP will be constructed within the 1:100 year flood area which could increase movement of spoil offsite if stockpiles are inappropriately located
- contamination from spills or inappropriate storage of chemicals, fuels and lubricants
- dewatering of groundwater from trenches and pits along the alignment, and at SP0096 (further details below).

Safeguards to manage these potential impacts are identified below, and in **Section 5.2.1**.

Water quality

Construction activities are not expected to impact the quality of treated wastewater discharges. Construction works will be scheduled to maintain operation of the North Richmond WWTP and Richmond WRP and comply with the EPLs. Recycled water will continue to be supplied from Richmond WRP to ensure that recycled water commitments to existing customers will be met. North Richmond WWTP will continue to operate until Richmond WRP has been upgraded and it can accept flows from the North Richmond catchment.

Geomorphology

The proposed transfer pipeline will cross Redbank Creek and the Hawkesbury River. It also crosses Pughs Lagoon, and a section of Old Kurrajong Road (near Richmond Green Nursery) about 650m from the Hawkesbury River which is mapped as coastal wetland under SEPP (Coastal Management) 2018. These features are shown on **Figure 6.** Redbank Creek and the Hawkesbury River will be under-bored using trenchless horizontal directional drilling, minimizing risks to these waterways. Construction impacts to Pughs Lagoon coastal wetland will be avoided by constructing within the road corridor.

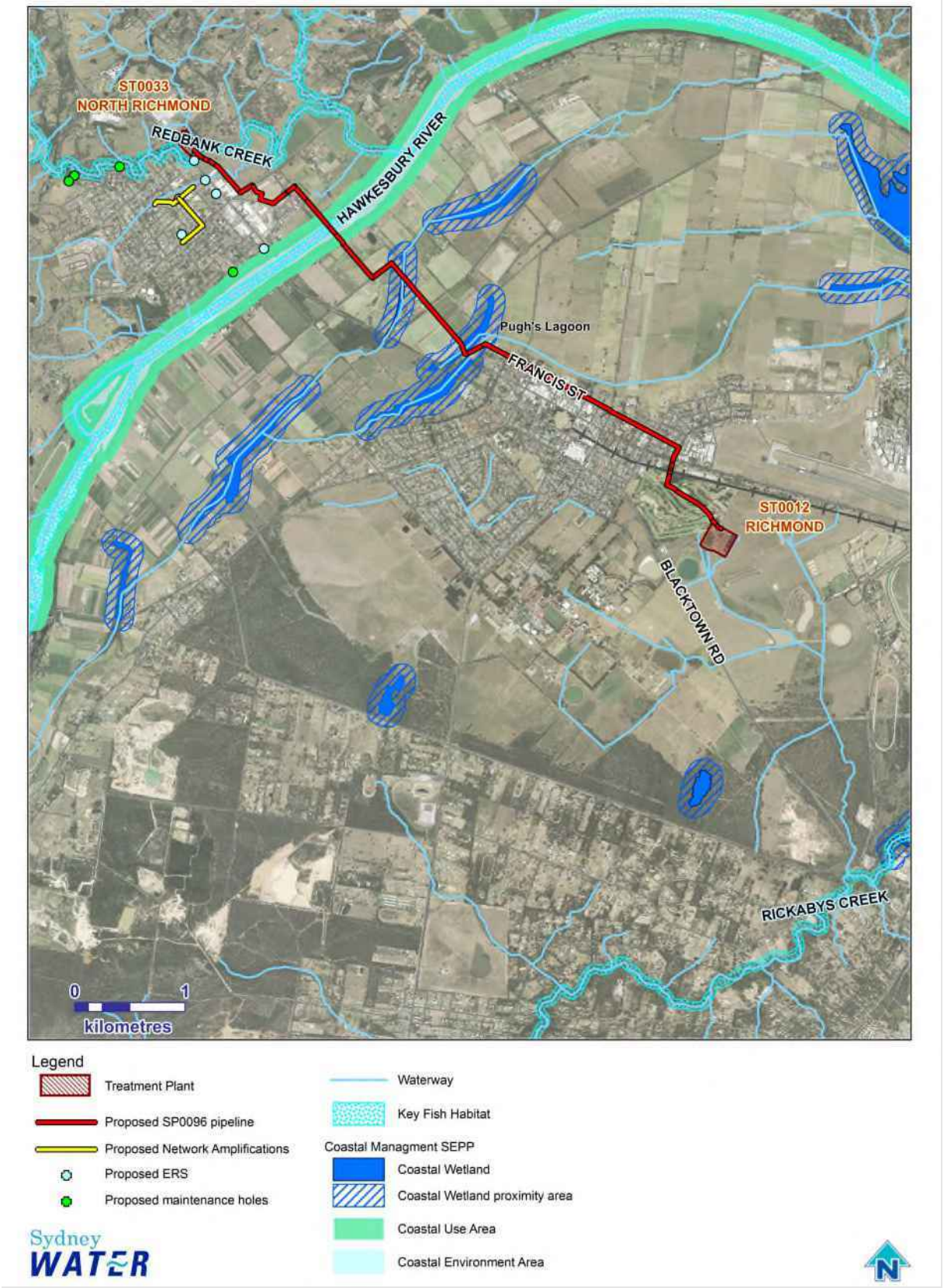

Figure 6 Water and drainage

Groundwater

Groundwater will be encountered during construction of the proposal, and groundwater seepage will require management. Dewatering from trenches and pits will be needed, particularly for the trenchless waterway crossings (Redbank Creek and Hawkesbury River) and for the road crossing at Pughs Lagoon. Excavations will be about 2–3m for trenching of the transfer pipeline, 4– 6m for the shafts in the trenchless sections, and up to 25 m for construction of the pump station. Preliminary estimates of groundwater inflows have been undertaken and include:

- 0.36 m^3/s total inflow to the trenches for the full alignment
- 0.32m^3/s total inflow for the shafts in the trenchless crossings

Estimates will be confirmed during detailed design, and construction techniques will be developed to reduce groundwater inflow, such as lining shafts with impermeable material to prevent long-term dewatering. Changes in surface water levels and bank storage from the Hawkesbury River into the adjacent geology will influence the groundwater level and rate of inflow.

A water supply work approval (WSWA) will be sought from the Natural Resource Access Regulator (NRAR) before construction. The water from dewatering is likely to be sediment laden and will be treated if needed prior to discharge to ensure the impact to downstream waterbodies is minimal. It is anticipated that the volume of groundwater extracted will exceed 3ML and a water access license (WAL) will be required. This will be confirmed during detailed design.

Potential impacts - operation

Water quality

Hydrodynamic and water quality modelling was undertaken to assist understanding of the potential impacts from the proposal on water quality in the receiving waterways of the Hawkesbury River (**Appendix C**). The water quality modelling was based on that prepared for Sydney Water's proposed Upper South Creek Advanced Water Recycling Centre (USC AWRC), which is currently being assessed as a State Significant Infrastructure Project with the Department of Planning, Industry and the Environment (DPIE).

The modelling used three time horizons:

- 2020 representing current baseline conditions (no upgrade or flow transfer)
- 2036 representing forecast land use change and population growth (upgrade and transfer of flows included)
- 2056 representing forecast land use change and population growth (upgrade and transfer of flows included).

The modelling incorporated representative release conditions from all WWTPs and WRPs which release treated water to the Hawkesbury Nepean river system.

The modelling of future water quality scenarios considered the proposed upgrade to the Richmond WRP, as well as planned upgrades for the Winmalee WWTP, Picton WRP, Penrith WWTP, West

Camden WRP, Castle Hill WWTP and Rouse Hill WRP, and a potential new WRP at Wilton. The modelling for this project did not include the proposed USC AWRC. The modelling is also based on no changes to the current reuse rate of recycled water from Richmond WRP, which used the current average of about 1.6 ML/day.

The proposal has been designed to address the requirements of the EPA's Hawkesbury Nepean nutrient framework (refer to **Section 2.2**), Under the new framework, future EPLs are likely to include 'upper limits for discharge' nutrient concentration targets for release to receiving waters, with a proposed 50%ile target of 6.0 mg/L for total nitrogen and 0.1 mg/L for total phosphorous. The proposal has been designed to meet these criteria.

Projected flows for the Richmond and North Richmond systems are summarised in **Table 9** below.

Table 9 Projected flows

Treatment Plant	Average Dry Weather Flow (ML/day)				
	2021 current flows	2026	2036	2046	2056
North Richmond WWTP	1.464	-	-	-	-
SP0096 (North Richmond catchment)	-	*1.812**	*2.217**	*2.271**	*N/A*
Richmond WRP	2.613	2.863	3.41	3.538	*N/A*
Total Flows	**4.08**	**4.68**	**5.62**	**5.81**	**5.99**

**predicted flows for each catchment that will be transferred and treated at Richmond WRP as part of the proposal*

Analysis was undertaken for the following water quality parameters:

- Nitrogen (including ammonia, oxidised nitrogen, total nitrogen)
- Phosphorus (including filterable reactive phosphorus, total phosphorus)
- Chlorophyll-*a* (adopted as the primary indicator of phytoplankton abundance and biomass).

The modelling also assessed potential impacts for wet and dry rainfall years.

Results of the modelling and analysis for the Hawkesbury River show:

- Flows within the combined catchments are predicted to increase by ~47% and ~55% over the 2036 and 2056 time horizons, relative to the 2020 flows.
- Nutrient loads are expected to increase from Richmond WRP as follows:
    - total nitrogen: increases of 7% (2036), and 14% (2056)

- total phosphorus: increases of 27% (2036), and 35% (2056).

This is a lower rate of increase than flow volume due to the improved treatment performance of Richmond WRP as a result of the upgrade.

- Impacts from the discharge of treated wastewater and associated nutrient contribution to Redbank Creek will cease. This is because the treated wastewater from North Richmond WWTP, currently dominating much of the flow in parts of the creek, will be transferred to Richmond WRP. We expect that overall stream health in Redbank Creek to improve because of the proposal.
- Increased flows and nutrient loads from Rickaby's Creek (and the associated releases from the upgraded Richmond WRP) can also be observed. There is limited water quality data for Rickaby's Creek including existing and future water quality and flow conditions. Flow in Rickaby's Creek is likely to become more consistent with the increased flow and improved quality of discharge, however this will be partially dependent on weather patterns and reuse rates by WSU and Richmond Golf Club. We expect that the more consistent and higher quality flow will also improve stream health in Rickaby's Creek. A program of pre and post commissioning water quality and aquatic ecology monitoring will be undertaken, with water quality monitoring to continue in operation (under the STSIMP).
- The increased flows and nutrient loads predicted in the Hawkesbury Nepean River are less than impacts from the North Richmond WWTP releases under current conditions. This is due to the upgrade of Richmond WRP and the lower comparative loading discussed above, as well as to greater tidal influence and flushing. It is also due to the nutrient loading from South Creek that becomes more influential with distance downstream of Rickaby's Creek.
- The other planned upgrades, in particular Winmalee WWTP (~14 km upstream) and Penrith WWTP (~22 km upstream) positively influence ambient nutrient concentrations, and the potential for greater compliance with many of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC) (2018) Default Guideline Values is predicted. This is also predicted for Chlorophyll-*a* concentrations and algal growth.

Overall, the proposal would improve the quality of treated wastewater entering local waterways by reducing nutrient levels in treated wastewater, as well as ceasing discharge into one local creek, Redbank Creek. We will undertake an aquatic ecology monitoring program for two years pre and post commissioning of the proposal. We will also install water quality monitoring for Rickaby's Creek to inform our EPL reporting. We will look for additional opportunities for recycled water reuse, as this will also contribute to further water quality improvements.

Geomorphology

The proposal would result in a decrease in water discharge from the North Richmond WWTP to the unnamed tributary of Redbank Creek. This is unlikely to impact the stability or geomorphic condition of the creek (GHD, 2019).

The proposal would increase the frequency and volume of treated water discharge from Richmond WRP to the unnamed tributary of Rickaby's Creek. Given the poor existing condition of this creek

and lack of stabilizing vegetation it is possible that the increased flows could exacerbate the erosion already occurring. There is also the potential for the flows to increase the rate of the migration of the headcut. Separate to the project, Sydney Water will work with WSU on measures to reduce the both the existing and future erosion potential of Rickaby's Creek including considering measures such as limiting livestock and planting additional riparian vegetation.

During operation and after work sites are reinstated, the proposal is not expected to impact upon flooding or coastal wetlands.

Flooding

Richmond WRP is located on the edge of the Probable Maximum Flood and 1:100 year flood events in Hawkesbury City Council's Flood Extent Maps (2011). A recent regional flood study by Infrastructure NSW identified that the site could become inundated during a 1 in 500 year event at a level of 19.7m AHD. We have adopted the 1:100 ARI flood level to be RL 18.60m AHD, which has been incorporated into the concept design.

At North Richmond WWTP, SP0096 is adjacent to Redbank Creek. Parts of the pump station (including valve pit and wet well) are located within the 1:100 year event, which is identified at a level of 17.55 m AHD (Hawkesbury Nepean Flood Report). There is currently no specific flood study for Redbank Creek, however; Hawkesbury City Council are reviewing their Hawkesbury Floodplain Risk Management Study and Plan 2012. The delivery contractor will consider flooding during detailed design and if needed consult with Hawkesbury City Council.

The transfer pipeline is within floodway areas, however as the pipeline is below ground, once construction is completed impacts are not anticipated from the pipeline during operation.

Chemical storage

The operation of Richmond WRP will require storage of fuels and chemicals on site. These chemicals can be managed through standard environmental safeguards and the existing bunding/first flush infrastructure.

Safeguards – water and drainage
Minimise groundwater ingress during detailed design.
Sydney Water will obtain groundwater approvals including a Water Supply Approval and if needed a Water Access Licence. The delivery contractor is responsible for: • providing expert hydrogeological technical information to obtain the approvals preparing a Dewatering Management Plan • complying with the approval conditions (such as protecting water quality; minimising aquifer extraction volumes, monitoring extraction with flow meters and recording volumes).
Sydney Water will consult with Department of Primary Industries if any excavation in waterways is proposed, and in accordance with section 199 of the *Fisheries Management Act 1994*.

Safeguards – water and drainage
Dewater excavations in accordance with the Delivery Management Guidance Standard 9.1 Excavation Dewatering.
Monitor the weather forecast and predicted rain in creek catchments. In advance of heavy rain: • remove all plant and equipment from creeks and flood zones • stabilise the creek bed and banks.
Use appropriate controls to avoid potential sedimentation to waterbodies.
If minor creeks are encountered, minimise the impacts to creeks where creek crossings are required. Prior to construction the methodology will be assessed based on: • geotechnical and constructability issues (eg depth of cover, potential for future scouring) • construction footprint and duration • ease of reinstatement • environmental issues (flora and fauna, geomorphology, contamination, heritage, water quality and hydrology) • any issues raised during consultation with Department of Primary Industries. The decision and reasons for the decision would be documented by the Contractor in consultation with the Sydney Water Environmental Representative. Stabilise all creek banks on completion of works.
Bund potential contaminants and store on robust waterproof membrane, away from drainage lines.
Discharge all water in accordance with Sydney Water's Discharge Protocols Standard Operating Procedure (WPIMS5021), including erosion controls, discharge rate, dechlorination, monitoring. Re-use potable / groundwater water where possible.
Keep functioning spill kit on site for clean-up of accidental chemical/fuel spills. Keep the spill kits stocked and located for easy access.
Store all chemicals and fuels in accordance with relevant Australian Standards and Safety Data Sheets. Record stored chemicals on site register. Bunded areas to have 110% capacity of stored liquid volume. Chemicals and fuels in vehicles must be tightly secured. All chemicals to be clearly labelled.
Conduct refuelling, fuel decanting and vehicle maintenance in compounds where possible. If field refuelling is necessary, designate an area away from waterways and drainage lines with functioning spill kits close by.
Locate portable site amenities away from watercourses or drainage lines.
Plant, equipment and materials will not be stored in flood prone areas to minimise this risk.

Safeguards – water and drainage
Ensure equipment is leak free. Repair oil/fuel leaks immediately or remove from site and replace with a leak-free item.
Confirm that the SEPP mapping of the coastal wetland on the road at Old Kurrajong Road has been amended. No work to be undertaken in areas mapped as coastal wetland, in accordance with SEPP (Coastal Management) 2018.
Develop site specific controls at Pughs Lagoon (proximity to coastal wetlands area) to ensure there are no impacts on the biophysical, hydrological or ecological integrity of the adjacent coastal wetland or the quantity and quality of surface and groundwater flows to and from Pughs Lagoon.
The delivery contractor will consider flooding during detailed design and if needed consult with Hawkesbury City Council.
Prior to construction, Sydney Water will undertake a geomorphic assessment of the creek in relation to the proposed flow regime, and work with WSU/stakeholders on measures to reduce erosion potential of the recycled water and treated wastewater discharge.
Pre and post commissioning inspection (including photographs) of the geomorphological condition at key sections of Rickaby's Creek will be undertaken. Post commissioning inspection will be undertaken annually for three years.
Establish water quality monitoring sites on the unnamed tributary of Rickabys Creek – one upstream and one downstream of the Richmond WRP discharge point. Monitoring and reporting will be undertaken in accordance with our sewage treatment system impact monitoring program. An upstream and downstream aquatic ecology monitoring site will also be established. Monitoring will be undertaken biannually for two years pre and post commissioning to confirm the impact of the proposal. A pre and post commissioning monitoring report will also be prepared.

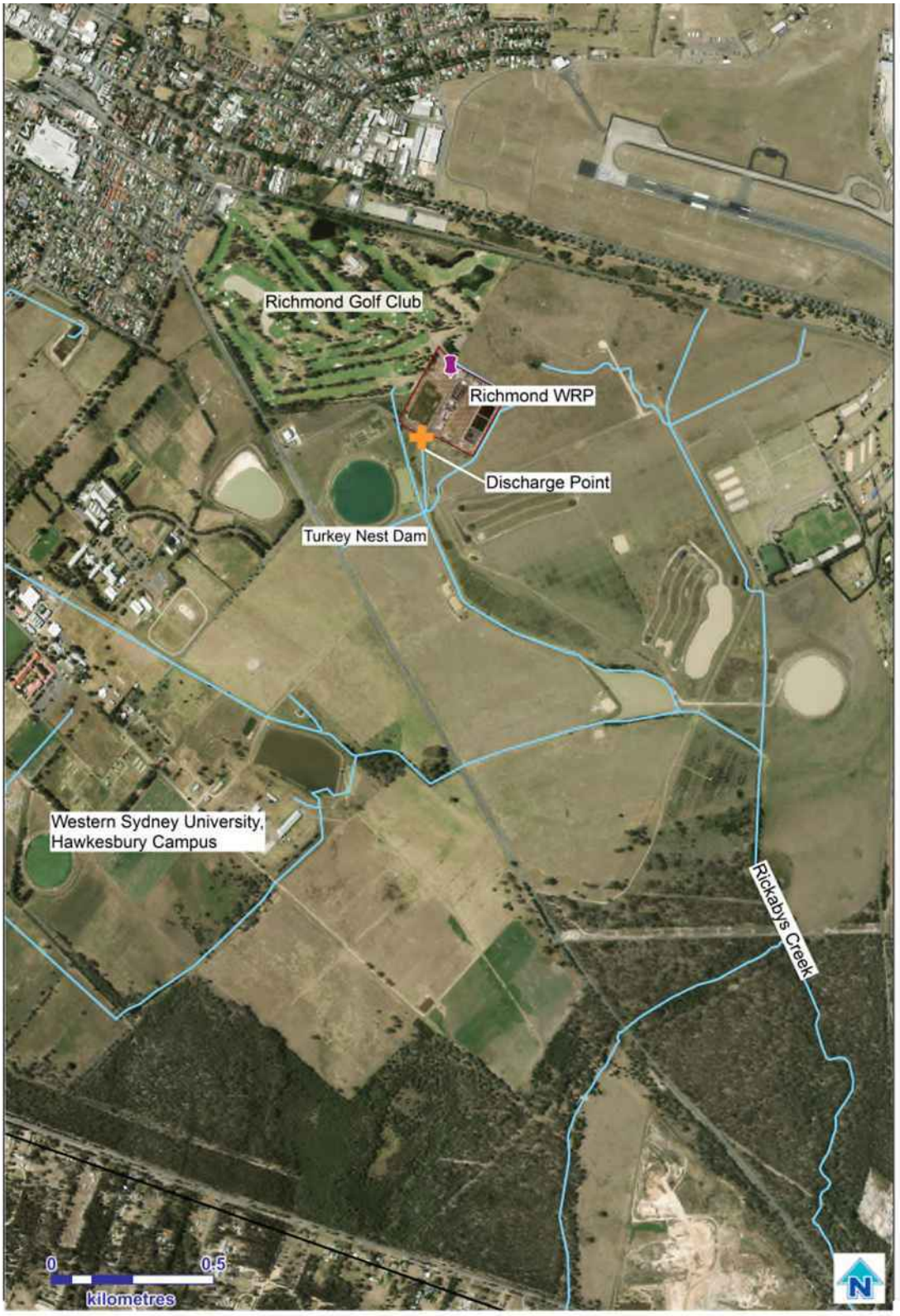

Figure 7 Richmond WRP discharge point and Rickaby's Creek

5.2.3 Flora and fauna

Potential Impacts

Terrestrial ecology

A biodiversity assessment was prepared by Biosis and is provided in **Appendix D**. The study area considered for this assessment included the North Richmond WWTP, the Richmond WRP and a 30 m corridor along the transfer pipeline.

The assessment confirmed that six vegetation communities are present within the study area. Five of these communities are either endangered ecological communities (EEC) or critically endangered ecological communities (CEEC) under state and federal legislation. These communities and their status under the BC Act and the EPBC Act and the amount proposed to be cleared is outlined in **Table 10**.

Table 10 Vegetation communities identified within the study area

Vegetation Community	BC Act status	EPBC Act status	Impact area (hectares)
Cumberland Plain Woodland (PCT 849)	CEEC	CEEC	0.31
River-Flat Eucalypt Forest (PCT 835)	CEEC	EEC	0.27
Swamp Oak Floodplain Forest (PCT 1232)	EEC	EEC	0.02
Shale/Sandstone Transition Forest (PCT 1395)	CEEC	CEEC	0.11
Urban Native/ Exotic	-	-	6.27

This vegetation is identified as providing habitat for the following fauna species:

- Koala (vulnerable under the BC and EPBC Acts)
- Grey-headed Flying-fox (vulnerable under BC and EPBC Acts)
- Little lorikeet (vulnerable under the BC Act)
- Swift Parrot (endangered under the BC Act and critically endangered under the EPBC Act)
- Glossy Black Cockatoo (vulnerable under the BC Act)
- Hollow-dependent microbats (listed as vulnerable under the BC and/or EPBC Acts).

During construction, we will clear native and exotic vegetation at North Richmond WWTP, along the transfer pipeline, and a mature tree from within Richmond WRP. An area of up to 0.71 hectares of threatened native vegetation and 6.27 hectares of urban native or exotic vegetation will require removal for the overall proposal, based on a worst case assessment for a 10-15m impact construction corridor. Some of this vegetation has been identified as a threatened ecological

community (TEC) as shown in **Table 10.** Approximately four hollow bearing trees will be removed as part of the proposal which could provide habitat for fauna. Pre-clearance surveys will be conducted and the safeguards below followed to ensure no animals would be directly impacted by their removal.

Tests of Significance (BC Act)/Assessments of Significance (EPBC Act) were undertaken for the species and communities which had a moderate or higher likelihood of impact due to the proposal. These assessments have concluded that the proposal would not represent a significant impact to threatened species or TECs for the following reasons:

- the area to be impacted is small
- no critical habitat will be impacted for these species
- the proposal will not fragment or isolate any fauna habitat
- large amounts of similar habitat are available within the survey area and adjacent to the direct impact areas
- the habitat is likely to be used in a transitory nature as no key breeding habitat is likely to be present within the field assessment area.

The removal of up to 0.71 hectares of TEC vegetation, and the native vegetation component of the 6.27 hectares of urban native/exotic vegetation and approximately 5 trees (four hollow bearing) will be offset in accordance with Sydney Water's Biodiversity Offset Guideline. A species impact statement is not required for the works.

Indirect impacts are those impacts that do not directly affect habitat and individuals but that have the potential to interfere through indirect action. Indirect impacts considered for this assessment include site impacts such as noise, light and weed invasion or spread; and downstream or downwind impacts such as edge effects, sedimentation, dust, accidental spills and leaks resulting in soil or water pollution.

During 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 to clear vegetation and construct the infrastructure. These impacts are short term only and therefore are unlikely to significantly impact fauna.

Aquatic ecology

An aquatic ecology and geomorphology assessment (GHD, 2019) was prepared to accompany the Richmond Precinct Options Plan (ENSure JV, 2018). The report assessed the extent and condition of aquatic habitat within the study area.

There is variable aquatic habitat along Redbank Creek and its tributaries, with bedrock and silty substrates in the pools, runs and short riffles present. Macrophyte and large woody debris habitats are present, though habitat connectivity is poor, with manmade weirs and culverts forming barriers to fish passage.

Redbank Creek shows evidence of iron precipitates both upstream and downstream of the North Richmond WWTP licensed discharge point which could result in smothering of benthic habitats. There is also evidence of nutrient enrichment, which is likely a combined impact from the treated wastewater discharge and runoff from adjacent grazing lands, which can lead to eutrophication and the development of algal blooms.

Aquatic habitat in the unnamed tributary of Rickaby's Creek is largely in poor condition. Sections of the creek have been artificially channelised for previous projects. The creek is unlikely to provide suitable habitat for sensitive aquatic species due to the lack of substrate variability and the intermittent flows. The HRWS' stormwater detention basin provides more consistent aquatic habitat, though is likely prone to eutrophication, considering the combined nutrient inputs from Richmond WRP, WSU and cattle grazing on surrounding lands. Further downstream the aquatic habitat improves with woody riparian exotic vegetation providing shading and habitat variability, however fish habitat is still poor due to lack of pools and barriers to fish passage.

The following species listed as threatened under the EPBC Act have the potential to occur within the aquatic habitat within the study area:

- Macquarie Perch (also listed under the FM Act)
- Australian Grayling (also listed under the FM Act)
- Giant Burrowing Frog (also listed under the BC Act)
- Green and Golden Bell Frog (also listed under the BC Act)

None of these species have been previously recorded within the study area (OEH BioNET Wildlife Atlas).

Poor site management during construction may lead to potential erosion, sedimentation or pollution of these waterways and therefore compromise the aquatic habitat. These impacts can be mitigated with standard erosion and sediment control measures as outlined in Section 5.2.2.

During operation, the proposal will result in a change to the volume and quantity of discharges from both North Richmond WWTP and Richmond WRP which has the potential to impact on aquatic species. The decrease in treated water discharges from North Richmond WWTP would likely result in improved stream health in Redbank Creek. Aquatic habitat connectivity could be impacted during low flow conditions however there is already existing barriers to fish passage in Redbank Creek so this impact is considered minor.

The proposal will result in increased treated water discharges to the unnamed tributary of Rickaby's Creek from Richmond WRP. Minor impacts on aquatic ecology are expected, considering the poor aquatic habitat and nutrient enrichment observed throughout the creek. A program to monitor aquatic ecology impacts has been proposed (refer to safeguards in **Section 5.2.2**)

Safeguards – flora and fauna
Vegetation clearing should be limited that that documented in this REF (Table 11). However, provided it is essential for delivering the project, Sydney Water's Project Manager can approve the following vegetation removal and tree trimming, without additional environmental assessment (but only after consultation with Sydney Water's Environmental and Community Representatives and affected landowners). Sydney Water considers vegetation removal in these circumstances has minimal environmental impact. • Any minor: o vegetation trimming or o removal of exotic vegetation or o removal of planted native vegetation where the vegetation is not a threatened species (including a characteristic species of a threatened community or population), heritage listed, in declared critical habitat or in a declared area of outstanding biodiversity value. • Any removal of remnant vegetation where there is no net change to environmental impact (eg a different area of vegetation is removed but the total area is the same or less than assessed in the EIA). Written explanation of the application of this clause (including justification of the need for trimming or removal and any proposed revegetation) should be provided when seeking Project Manager approval. Any impacts to native vegetation and trees must be offset in accordance with the Biodiversity Offset Guideline (SWEMS0019.13).
Residual impacts to native vegetation and trees will be offset in accordance with the Biodiversity Offset Guideline (SWEMS0019.13). Indicative offsets to be provided for the proposal are 2.73 hectares for the TEC vegetation and 15 trees, as well as the native vegetation component of the urban native/exotic vegetation (a maximum of 12.54 hectares). Potential offset locations could include areas along the unnamed creek from Richmond WRP to help stabilise the banks (in consultation with WSU), and planting Cumberland Plain vegetation at North Richmond WWTP. The delivery contractor will develop an offset plan during detailed design which confirms amount to be rehabilitated, location and indicative species selection.
Minimise vegetation clearance and disturbance, including impacts to standing dead trees and riparian zones. Where possible, limit clearing to trimming rather than the removal of whole plants.
Physically delineate vegetation to be cleared and/or protected on site and install appropriate signage prior to works commencing.
Potentially affected residents will be notified of any tree removal.
Retain dead tree trunks, bush rock or logs in-situ unless they are in the disturbance corridor and moving is unavoidable. Reposition material elsewhere on the site or approved adjacent sites. If native fauna is likely to be present, a licenced ecologist should inspect the removal and undertake fauna relocation.

Safeguards – flora and fauna
Inspect vegetation for potential fauna prior to clearing or trimming. If fauna is present, or ecological assessment has determined high likelihood of native fauna presence, including removal of hollow bearing trees, engage a licenced ecologist to inspect and relocate fauna before works.
If native fauna is encountered on site, stop work and allow the fauna to move away unharassed. Engage a licenced ecologist if assistance is required to move fauna.
If any damage occurs to vegetation outside of the approved study area (as shown in the CEMP), notify the Sydney Water Project Manager and Environmental Representative so that appropriate remediation strategies can be developed.
Manage biosecurity in accordance with: • *Biosecurity Act 2015* (see NSW Weedwise), including reporting new weed infestations or invasive pests • contemporary bush regeneration practices, including disposal of sealed bagged weeds to a licenced waste disposal facility. Record Pesticides and Herbicides use in accordance with SWEMS00017.
In TOBAN period: 1. Check specific TOBAN notice to confirm whether the work can be carried out under standard exemptions (Govt Gazette No18 Feb 2018) 2. If not, apply to RFS for specific exemption
Prepare a landscape /restoration plan during detailed design to address the closure of North Richmond site as a treatment facility.

5.2.4 Air and energy

North Richmond WWTP is surrounded by rural properties to the north and east and low density residential areas to the west. The closest sensitive receivers are approximately 100m to the west. Richmond WRP is surrounded by Western Sydney University and TAFE NSW, parkland and Richmond Golf Course. Neither site has a history of odour complaints.

The transfer pipeline traverses a rural-residential area. Potential sensitive receivers include residents and businesses as well as users of Richmond Golf Course.

Potential impacts - Construction

During construction, the proposal will potentially result in odour, dust and air pollution from:

- dust generated during excavation, earthworks and concrete cutting
- dust generated by construction vehicles travelling on disturbed/ unsealed access routes
- emissions from machinery, equipment and vehicles used during construction

- odour generated construction activities including potentially encountering ASS which may oxidise to produce sulphuric acid (rotten egg gas); as well as potential release of odours for connections to existing infrastructure.

Potential impacts - Operation

The operation of the proposal would result in potential additional odour sources which could result in odour impacts to sensitive receivers. The potential odour impacts of the project have been assessed in the Odour Investigation Technical Note (Arup, November 2020). Potential odour sources from the proposal include:

- network infrastructure including SPS0096, transfer pipeline and air release valves
- wet weather storage
- operation of the upgraded Richmond WRP.

Pump Station SPS0096, transfer pipeline and air release valves

The new pump station SPS0096 is estimated to run for 2 hours per day (intermittently), at approximately 120 – 250L/s. Modelling undertaken showed an average retention time in the pipeline ranging from 2 – 13 hours and up to 30 hours during low flow events. In general, retention times greater than 6 hours represent a risk for odour generation in wastewater networks, as the system is highly susceptible to oxygen depletion which results in the development of a septic environment and generation of hydrogen sulfide gas. Therefore, there is a risk of odourous air being released to the nearby receptors along the new transfer pipeline at the air release valves. The air valves are required along the transfer pipeline to release any trapped air pockets caused by the start-up, shutdown and maintenance of the system. Carbon canisters will be used for odour control along the transfer pipeline to reduce the risk of odour impacts to nearby receptors.

Wet weather storage

Wet weather (emergency) storage is proposed at SP0913, SP0527, North Richmond WWTP (conversion of the sludge lagoons) and at Richmond WRP. Storage of peak wet weather flows in the wastewater system of more than 1-2 days presents greater odour generation risk as the retained wastewater may turn septic. The hydraulic model developed as part of the North Richmond concept design outlines that the retention time in the wet-weather storage will be less than 24 hours. This presents a low risk of septicity and odour generation during these infrequent peak wet-weather events.

Richmond WRP

Base level odour modelling assessment was undertaken for Richmond WRP in 2016 (EnSure, December 2016) to compare existing odour levels with predicted impacts. The existing dominant odour sources were identified as the sludge lagoons and the intermittently decanted aeration lagoons (IDALs). The updated modelling results showed that odour concentrations greater than 2 odour units (OU), at the 99th percentile, do not extend to any off-site sensitive receptor locations,

though it is noted that the contours extend slightly into the southeast portion of the Richmond Golf Club.

The new potential odour sources at the upgraded Richmond WRP include:

- new 1.7ML flow balancing tank
- inlet works
- grit chamber
- new vent stack (emitting treated air from the new odour control unit).

To mitigate these potential impacts, an additional odour control system has been included in the design for the Richmond WRP. The additional odour control system would primarily manage odour from the new flow balancing tank, with odour from the inlet works and grit chamber mitigated by the existing odour control unit.

A comparison of these results with those undertaken in the base level assessment (EnSure, December 2016) shows that the future air quality will be approximately equivalent to the air quality currently experienced at and around the WRP and no significant additional air quality impacts are expected. The performance of the new odour control system will be confirmed during commissioning of the proposal.

Energy

WRPs have high energy demands to treat and recycle water. Existing and proposed energy consumption is shown **Table 11**.Overall energy use is expected to reduce at both sites, by about 30%, and result in a saving of around 395MWh/yr, based on current consumption and flows. While this will increase as population growth in the catchment increases, the proposal involves replacing and upgrading old assets and components with newer more energy efficient technologies. In addition, the transfer of the processing operations from two separate plants to one upgraded facility will streamline the treatment process which will assist in minimizing energy consumption.

Table 11 Existing and proposed energy consumption

Treatment plant	Current energy consumption (2020/2021) MWh/year	Proposed consumption MWh/year*
Richmond WRP	1025	1,000
North Richmond / SP0096	430	60
Combined consumption	1455	1060

**estimate based on current flows*

Efficient construction practices through implementation of safeguards in this REF will also enable reduced energy and resource consumption during the construction phase.

The compliance upgrades at Richmond WRP will ensure continued off-site use of recycled water can be maintained and our recycled water quality targets are achieved. This aligns with Sydney Water's 2020-2030 Strategy to embrace circular economy practices and support sustainable cities as they grow.

Safeguards – air and energy
Maintain equipment in good working order, comply with the clean air regulations of the *Protection of the Environment Operations Act 1997*, have appropriate exhaust pollution controls, and meet Australian Standards for exhaust emissions.
Switch off vehicles/machinery when not in use.
Implement measures to prevent offsite dust impacts, for example: • water exposed areas (using non-potable water source where possible such as water from excavation pits) • cover exposed areas with tarpaulins or geotextile fabric • modify or cease work in windy conditions • modify site layout (place stockpiles away from sensitive receivers) • vegetate exposed areas using appropriate seeding.
Cover all transported waste.
Minimise the potential for odours during construction and operation (eg minimise the number of open access chambers, close maintenance holes overnight.)
During commissioning phase, undertake odour monitoring to ensure the odour control unit is operating effectively
Select energy efficient pumps and equipment during detailed design in accordance with Sydney Water's *Best Practice Energy in Design Guide*
Use alternatives to fossil fuels where practical and cost-effective
Track energy use as per Sydney Water's National Greenhouse and Energy Report SWEMS0015.28

5.2.5 Waste and hazardous materials

Potential impacts

Hazardous materials

The Detailed Site Investigation (DSI) undertaken in 2020, assessed soil analytical results and desktop information to determine possible sources of contamination that, if exposed as a result of

the project, could present a risk to human and ecological health. The DSI was limited to the pipeline only, and further investigations at the Richmond WRP and North Richmond WWTP will be conducted. The results of the DSI are summarized in **Table 12** below. If additional hazardous material is identified during the further investigations, these will be managed in accordance with the waste and hazardous materials safeguards (see below).

Table 12 Contamination within the proposal area

Location	Findings
North Richmond WWTP	• Asbestos fragments have previously been identified within the WWTP approximately 35 m northwest of the proposed pump station site • Hazardous building materials from former structures may still be present on site and present a risk • Elevated heavy metal concentrations have been detected in the groundwater. Construction of the pump station down to a depth of 25m has the potential to expose these contaminants
Transfer pipeline	• The overall risk of encountering contaminants is low along the proposed transfer pipeline alignment • No asbestos was detected however a potential asbestos cement pipe section was observed but could not be accessed. • There is the potential to encounter acid sulphate soils in proximity to the waterways and waterbodies • Low concentrations of PFAS mainly within fill but also in some natural layers. All detections were negligible and did not exceed any adopted guidelines
Richmond WRP	• Elevated heavy metal concentrations have been detected in the groundwater surrounding the former oxidation pond in the south western portion of the site • Asbestos fibres and high concentration of nickel and PAH were also detected in soils and fill material along the north-western border of the site. Construction of the rising main entry into the Richmond WRP may expose these contaminants • PFAS within soil and groundwater. All PFAS concentrations were low and did not exceed any adopted human health or ecological guideline values • HBMs at the former STP in the north-western portion of Richmond WRP.

Spoil and waste

Waste expected to be generated during the construction phase includes:

- excavated rock and spoil that is deemed unsuitable for reuse, such as for backfilling excavations

- uncontrolled fill material including contaminated materials
- vegetation waste from clearing activities
- general construction waste
- demolition waste and materials from decommissioning North Richmond WWTP and other existing structures with the potential to contain HBM
- groundwater where dewatering is required and where extracted groundwater cannot be used for dust suppression.

The proposal would require the excavation of large amounts of spoil, including approximately:

- 12,600m^3 for the works at Richmond WRP
- 35,700m^3 for the construction of the transfer pipelines and new pump station

Our goal is to divert waste from landfill, where alternatives exist through recycling and reuse and to encourage our suppliers to minimise waste. Natural material from excavations may meet the definition of Excavated Natural Material (ENM) and could be reused on or off-site subject to further testing.

Our preference is to reuse suitable material onsite. Where spoil cannot be reused on site under appropriate beneficial reuse conditions we would look for options to reuse it offsite (eg as ENM) or for soil recycling. If these options are unavailable, it may be disposed of offsite to a licensed waste facility in accordance with the NSW EPA Waste Classification Guidelines and Sydney Water licensed waste facility requirements and waste policy.

The DSI (2020) assessed the soil analytical results against the NSW EPA Waste Classification Guidelines (2014). The analysis found that much of the spoil excavated from along the transfer pipeline meets the classification of General Solid Waste (non-putrescible). As noted above, the spoil will be tested for potential reuse or recycling opportunities. However, any contaminated soils or asbestos containing materials would be classified as Restricted Solid Waste and 'Special Waste –Asbestos Waste' and would need to be handled of and disposed of appropriately.

Given the large volume of waste likely to be generated by the proposal, the Delivery Contractor will prepare a Stockpile Management, Waste and Resource Recovery Plan (SMWRP) to appropriately manage and classify any materials including soils or construction / demolition wastes and associated stockpiles. Opportunities to reduce, recycle and reuse on this project will be sought prior to and during delivery and documented in the CEMP.

During operation, no new waste streams will be generated after commissioning of the proposal. New chemical storage tanks and dosing facilities would be in bunded areas within Richmond WRP. New signs will be installed and staff trained on any extra/new safe handling practices.

Safeguards – waste and hazardous materials
A Stockpile Management, Waste and Resource Recovery Plan (SMWRP) is to be prepared by the delivery contractor which outlines the classification and fate of all materials including soils or construction /

Safeguards – waste and hazardous materials
demolition wastes and associated stockpiles and waste materials. The plan will be prepared by the Contractor (or nominated suitably qualified environmental consultant) and approved by the Sydney Water Project Manager in consultation with the Sydney Water Environmental Representative and Property Environmental Services
Test in-situ/excavated materials against criteria for Excavated Natural Material (ENM) and/or Virgin Excavated Natural Material (VENM) to inform and prioritise reuse opportunities. Classify soils in accordance with the NSW EPA Excavated Natural Material Order 2014.
Manage excess spoil and waste in accordance with the NSW EPA Waste Classification Guidelines. Dispose wastes at an appropriately licenced facility.
Manage waste in accordance with relevant legislation and maintain records to show compliance eg waste register, transport and disposal records. Record and submit SWEMS0015.27 Contractor Waste Report.
Provide adequate bins/stockpiling areas for general waste, hazardous waste and recyclable materials.
Minimise the generation of waste, sort waste streams to maximise reuse/recycling in accordance with the *Waste Avoidance and Resource Recovery Act 2001*.
Wastes or resources must not be mixed or stockpiled together. Wastes and resources must be identified prior to excavation activities where reasonably practical to do so.
Prevent pollutants from escaping including covering skip bins.
Dispose excess vegetation (non-weed) that cannot be used for site stabilisation at an appropriate green waste disposal facility.
Consult Sydney Water Material Stockpile Dashboard and Register for reuse opportunities.
Track waste as required using the EPA's WasteLocate online tracking system.
If fibro or other asbestos containing material is identified, restrict access and follow Sydney Water's Asbestos Management – Minor Works procedure, Document Number 746607. Contact Sydney Water Project Manager (who will consult with Property Environmental Services propertyenvironmental@sydneywater.com.au).
Manage lead paint in accordance with the WHS Regulation (2017) Part 7.2 and the Australian Standard Lead Paint Management Guidelines. Contact Property Environmental Services for advice. Develop a Lead Management plan if required.
Review existing hazardous building materials (HBM) report and implement relevant safeguards. Conduct hazardous materials survey prior to commencement where works could impact hazardous materials not surveyed in the HBM. Consult Sydney Water's Hazardous Building Materials Management Plan (HBMMP) for further guidance.

5.2.6 Heritage

Potential Impacts

Aboriginal Heritage

Kelleher Nightingale Consulting (KNC) were engaged by Sydney Water to undertake an archaeological assessment of the proposal. The assessment included review of background research, existing Aboriginal archaeological data, environmental context and a comprehensive archaeological field survey.

The proposal area to the east of the Hawkesbury River, including the transfer pipeline and Richmond WRP are highly disturbed and unlikely to contain Aboriginal objects. AHIMS database searches and the archaeological field survey by KNC, did not identify any Aboriginal objects, archaeological sites or areas of Aboriginal archaeological potential within the study area east of the Hawkesbury River. No impacts to Aboriginal heritage were identified east of the Hawkesbury River and no further archaeological work was recommended for this portion of the proposal.

The portion of the proposal area west of the Hawkesbury River (including works at pumping station SP0096, remaining transfer pipeline, and proposed work areas at existing manholes and an emergency relief structure on Redbank Creek) was found to intersect landforms exhibiting Aboriginal archaeological sensitivity. These required further assessment to determine likelihood of these areas to contain Aboriginal objects.

KNC prepared an Aboriginal cultural heritage assessment report (CHAR) (**Appendix E**). The purpose of the CHAR was to assess the impacts of the proposal on Aboriginal heritage features for the section of the study area to the west of the Hawkesbury River. There are no previously recorded AHIMS sites within the CHAR study area.

The assessment identified five areas of Aboriginal archaeological sensitivity along the proposed SP0096 pressure main route (**Figure 8**). These were identified due to the landform and lower levels of disturbance, representing well-defined, elevated areas above the Hawkesbury floodplain or associated with Redbank Creek and its tributary.

An archaeological test program was undertaken along the proposed pipeline in August 2021. The test excavation program was undertaken within four of the five locations of archaeological sensitivity to collect information about the nature and extent of subsurface archaeological deposits. Area 2 was not tested as it had been affected by recent severe flooding. Results established the presence of three subsurface archaeological deposits at Areas 3, 4 and 5 with moderate significance. Area 1 was found not to contain any cultural material. The remainder of the study area and proposed work areas have been assessed as displaying low archaeological potential due to less favourable landforms and /or extensive land use disturbance related to road construction, installation of existing utilities and buried infrastructure.

Where possible, Sydney Water aims to identify Aboriginal heritage constraints early in the design process and avoid impacts where possible. For this project the proposed route is largely constrained by topography/hydrology and the location of current and future infrastructure including road corridors, the WWTP, and existing wastewater infrastructure along the creek valleys.

Therefore, some level of impact is unavoidable due to the construction of the proposed wastewater infrastructure. Excavation associated with installing the transfer pipeline and pump station will disturb the ground surface and subsequently the buried archaeological items.

All three subsurface archaeological sites are expected to be partially impacted by the construction of the proposal. The use of existing infrastructure/disturbance corridors where possible has reduced the overall impact footprint of the project and its effect on Aboriginal heritage.

An Aboriginal Heritage Impact Permit (AHIP) will be obtained under section 90 of the *National Parks and Wildlife Act 1974* for the impact area of the proposal. The AHIP should include Aboriginal objects associated with the impacted portions of the sites listed in **Table 13**.

Table 13 Proposed impact to Aboriginal archaeological sites within the study area

Site name	AHIMS ID	Type of harm	Degree of harm	Consequence of harm	Significance of harm
Information removed out of respect for Aboriginal culture and community - contact Sydney Water for more details if required.		Direct	Partial	Partial loss of value	Moderate
		Direct	Partial	Partial loss of value	Moderate
		Direct	Partial	Partial loss of value	Moderate

The AHIP will include provision for archaeological salvage excavation within the impacted site areas. Salvage excavation would be completed prior to any disturbance works which may harm at these locations. The measures outlined below are recommended to prevent any additional impacts to Aboriginal heritage.

Historical Heritage

The Hawkesbury Region, including Richmond and North Richmond, was one of the earliest colonial settlements in Australia. Much of the buildings in the region have remained, providing a time capsule to these early days of Australian colonial settlement. There are multiple local and state listed heritage items adjacent to the proposed pipeline alignment (refer to **Figure 8** and **Table 14**).:

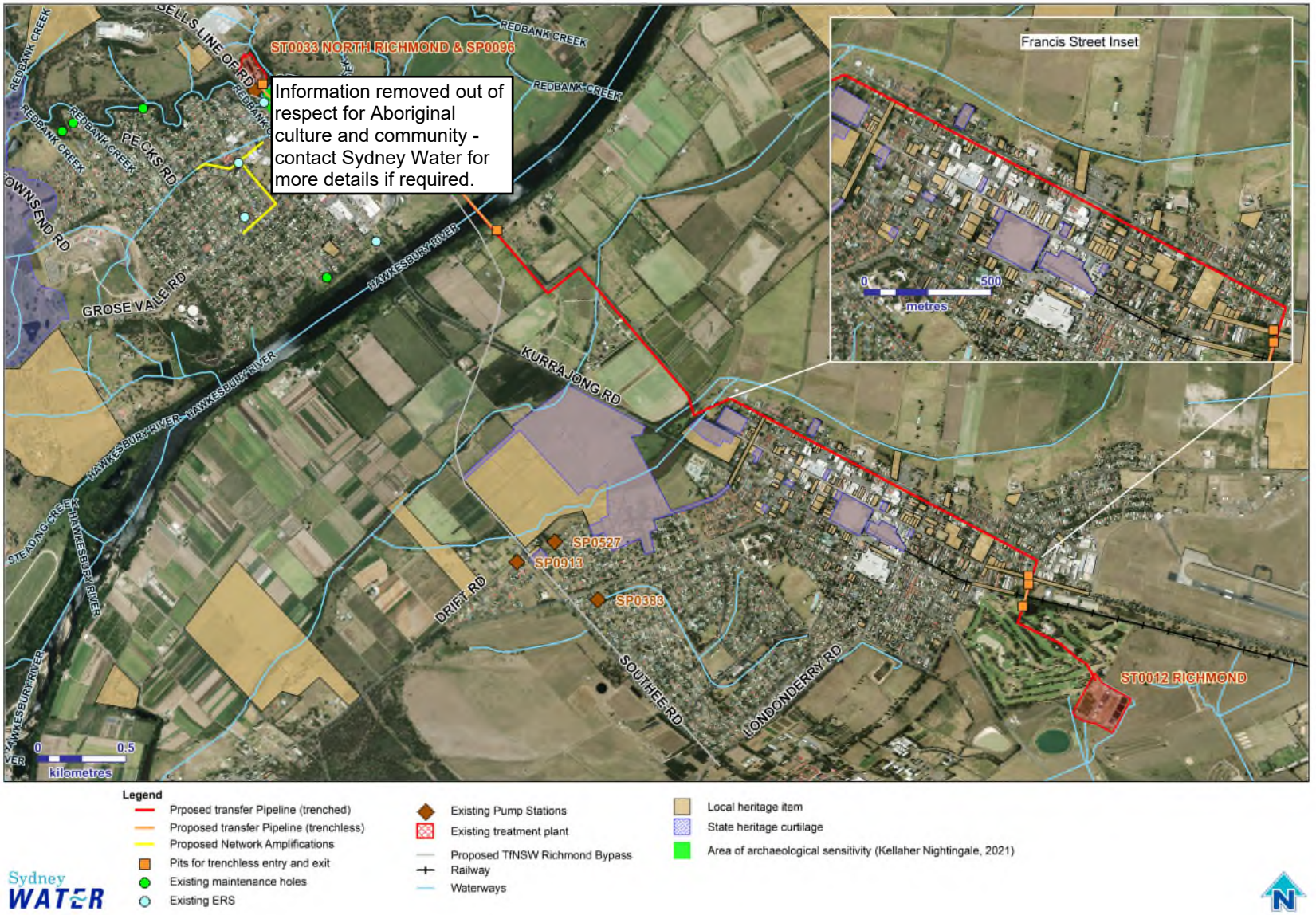

Figure 8 Heritage

Table 14 Historical heritage

Item	Address	Heritage listing	Relationship to project
Avenue of Plane Trees along eastern approach to Richmond	Windsor Street and Chapel Street	Local	Pipeline crosses under this item
Clear Oaks Moxey's Farm House	135 Francis Street	Local and State	Pipeline is adjacent to this item
St Peter's Anglican Church Group	384 Windsor Street	Local and State	Pipeline is in the vicinity, possible construction compound nearby
Heritage houses (13)	Francis Street	Local	Pipeline within the road / road verge, adjacent to this item
St Monica's Roman Catholic Church and The Presbytery	!A Bourke Street	Local	Pipeline within the road / road verge, adjacent to this item
Seventh Day Adventist Church	54 Bells Line of Road	Local	Pipeline is in the vicinity of this item.
Heritage houses	Bells Line of Road	Local	Pipeline is in the vicinity of these items

Clear Oaks also known as Moxey's Farm House is a heritage homestead complex located on Francis Street. Previous research suggests the farmhouse was built during the early 1800's. Clear Oaks is significant as it is a good representative of the Colonial Georgian farmhouse of the Hawkesbury Valley. The heritage listing (curtilage) for Clear Oaks is to the road.

St Peter's is significant as a rare surviving example of a Colonial Georgian style church and an associated burial ground. The church dates from the original planning of Richmond township in 1810. The construction of the church in 1841 created an important landmark which has maintained its importance in the surrounding landscape and townscape since that time. The burial ground is important, having remained in use since 1809 to the present day and provides information on the history of the area (Hubert, 2001).

Due to the history of the site, Richmond is also considered an area of high archaeological potential (non-Aboriginal) as covered by the relics provisions of the *Heritage Act 1977*. KNC provided advice on the potential impacts to heritage and archaeology for the proposal.

The works at North Richmond WTP and Richmond WRP are in previously disturbed areas, and unlikely to impact items of historical heritage. Therefore, these works are not considered further.

The transfer pipeline has been situated in existing roadways or alongside areas of development. These previously disturbed areas are unlikely to still contain historical relics. By situating the trenching and construction of the transfer pipeline in the roadway, construction personnel will not have to enter any heritage listed property, including Clear Oaks and St Paul's Anglican Church, and therefore listed properties, and their curtilage will not be impacted or otherwise affected by the works.

During consultation, Hawkesbury Council identified historic sandstone kerbs along Francis Street. Further review by KNC found that the sandstone kerbs and gutters are not a listed historical heritage item listed in relevant statutory instruments. Survey confirmed the location of the sandstone kerbs, in discontinuous sections between 128 Francis Street (Lot 1 DP1008837) and 2 Chapel Street (Lot 1 DP634986). The remnant sections of sandstone kerbs and gutters occur only along the southern side of the road. Sydney Water has designed the proposed alignment of the transfer pipeline to be on the northern side of Francis Street to avoid impact to the sandstone kerbs/gutters. No impact to the sandstone kerbs/gutters or to listed historical (non-Aboriginal) heritage along Francis Street will occur as a result of the proposal.

Given the distance and the shallow minor nature of excavations it is unlikely that vibration impacts will impact heritage listed items.

Safeguards will be implemented during construction works to ensure no impacts to any historical listed items will occur.

Safeguards - heritage
Do not make publicly available or publish, in any form, Aboriginal heritage information on sites / potential archaeological deposits, particularly regarding location.
Repeat the basic AHIMS search if it is older than 12 months. Conduct additional assessment if new sites are registered and could be impacted by the works.
If any Aboriginal object or non-Aboriginal relic is found, cease all excavation or disturbance in the area and notify SW Project Manager in accordance with SWEMS0009.
Harm to any Aboriginal objects and declared Aboriginal places is only permitted once an Aboriginal Heritage Impact Permit (AHIP) has been granted and all AHIP conditions will be complied with.
Install protective hard barriers (ie. ATF fencing, concrete barriers or water-filled barriers) and signage around heritage items at risk of inadvertent damage before construction, to protect them from damage
All site personnel must be inducted by a heritage specialist before starting work on site. The induction should include clear explanation of heritage constraints, go and no-go areas, processes and measures to avoid impacts, stop work procedures, and contact details to obtain further heritage guidance if needed.
All listed historical and areas outside of the AHIP are to be considered as a no-go area and should be avoided by the proposed works and personnel. Protection measures should include identification in the

Safeguards - heritage
CEMP as environmentally sensitive “no-go zones” on maps and workers inducted as to appropriate protection measures.
Salvage excavation would be required within the AHIP area at sites Terrace Road Redbank Creek AFT 1, Terrace Road Hawkesbury River AFT 1 and Norfolk Place Hawkesbury River AFT 1. Salvage excavation must be completed prior to any activities (including pre-construction activities) which may harm Aboriginal objects at these locations. Salvage excavation activities would be undertaken in accordance with the methodology attached as Appendix D of the CHAR.
The approved AHIP boundary will be delineated with temporary protective fencing that is difficult to move/reposition during construction work.
Local heritage listed trees on Windsor Street are to be protected and retained during construction, in consultation with Council.
Conduct a dilapidation survey / asset condition assessment prior to works which have potential to damage existing structures.
Monitor vibration to ensure construction activities do not pose a structural risk to any adjacent heritage items.

5.2.7 Noise and vibration

Potential Impacts – construction

The proposal will generate noise and/or vibration from excavations and general construction activities. Works will mostly occur during standard daytime hours, however some out of hours works may be required for work adjacent to roads to minimise traffic impacts. The works have the potential to exceed the Interim Construction Noise Guideline and impact on sensitive receivers.

The closest sensitive receivers include:

- North Richmond WWTP – residents on William Street, approximately 100m to the west
- Transfer pipeline – a range of rural, residential, businesses and existing infrastructure (roads) are located close to the alignment. Specific sensitive receivers include St Monica’s Primary School, St Monica’s Catholic Church, Richmond Public School on Francis Street and St Peter’s Anglican Church
- Richmond WRP – Richmond TAFE approximately 1km to the south west.

Richmond WRP

Given the distance of sensitive receivers from the Richmond WRP, noise and vibration impacts from construction are unlikely. There will be a temporary increase in traffic along Blacktown Road which would result in additional traffic noise, however given the lack of sensitive receivers along

this road, impacts would be negligible. No vibration impacts are anticipated from the upgrade works at Richmond WRP.

Transfer pipeline and network asset upgrades

For the transfer pipeline and for the network asset upgrades construction will occur near sensitive receivers including residents, schools and places of worship. Works will progress linearly along the pipeline and so impacts will be relatively short in duration. All reasonable and feasible measures will be implemented to reduce noise impacts during construction.

The most effective measure for minimising noise impacts is scheduling activities during less sensitive time periods and providing residences with notification of the potential for impacts and responding to complaints. The trenchless pipe installation for this project would be undertaken during standard construction hours which minimises any potential sleep impacts. For construction works during the day higher ambient noise levels typically mask the audibility of noise emissions.

Construction would result in a temporary increase in construction vehicles in Francis Street and Old Kurrajong Road and other suburban streets. Since these roads are quieter and currently dominated by light vehicles the receivers along these roads will be more sensitive to increases in traffic noise. Safeguards listed below, including consultation initiatives will reduce these impacts.

Construction equipment such as vibratory rollers, hydraulic hammers and excavators may result in temporary vibration impacts. Given the proximity of sensitive receivers as well as heritage buildings, measures will be in place for these properties to manage these vibration impacts.

North Richmond WWTP

The demolition and decommissioning works at North Richmond WWTP would result in some temporary increases in noise. Given the distance of the nearest sensitive receivers this is expected to be minor and can be managed with the safeguards listed below. Increases in traffic noise from these works is also expected to be minor since Bells Line of Road adjacent to North Richmond WWTP is already a busy road frequented by light and heavy vehicles.

The demolition works associated with decommissioning of North Richmond WWTP would result in some vibration impacts on nearby sensitive receivers. For decommissioning works the nearest sensitive receivers are approximately 100m away which is outside the recommended working distances for most vibration intensive equipment.

Potential impacts - operation

During operation, there will be permanent changes to background noise levels at Richmond WRP because of the additional and upgraded equipment. In general, the impacts from these additional assets are unlikely to negatively impact on any sensitive receivers given their distance from the plant. The upgrades have been designed to ensure that noise generated during operation will not exceed the noise criteria as per the Noise Policy for Industry (EPA, 2017). This will be confirmed during commissioning.

Short term and minor noise may be associated with infrequent ongoing maintenance of the transfer pipeline and use of the maintenance holes.

It is expected that once North Richmond WWTP is decommissioned, noise levels would overall be less than current levels due to the lack of operating equipment. The proposed pump station would operate intermittently as required however the submersible design means noise emissions would be negligible.

Safeguards – noise and vibration
The CEMP should document all reasonable and feasible safeguards to manage the noise emissions from the site and any complaints which may occur due to construction noise, including the following: • identification of nearby residences and other sensitive land uses • description of approved hours of work • description and identification of all construction activities, including work areas, equipment and duration • description of what work practices (generic and specific) would be applied to minimise noise and vibration • a complaint handling process • overview of community consultation required for identified high impact works.
Works must comply with the Interim Construction Noise Guideline (DECC 2009), including schedule work and deliveries during standard daytime working hours of 7am to 6pm Monday to Friday and 8am to 1pm Saturday. No work to be scheduled on Sundays or public holidays. The Proposal will also be carried out in accordance with: • Sydney Water's Noise Management Procedure SWEMS0056 • Noise Policy for Industry (EPA, 2017). Reasonable and feasible noise mitigation measures should be implemented to mitigate noise impacts.
Incorporate **standard daytime hours noise management safeguards** into the CEMP: • identify and consult with the potentially affected residents prior to the commencement: o describe the nature of works; the expected noise impacts; approved hours of work; duration, complaints handling and contact details. o determine need for, and appropriate timing of respite periods (eg times identified by the community that are less sensitive to noise such as mid-morning or mid-afternoon for works near residences) o acceptance by the community of longer construction periods in exchange for restriction to construction times. • implement a complaints handling procedure for dealing with noise complaints

• plant or machinery will not be permitted to warm-up near residential dwellings before the nominated working hours. • appropriate plant will be selected for each task, to minimise the noise impact (eg all stationary and mobile plant will be fitted with residential type silencers) • engine brakes will not be used when entering or leaving the work site(s) or within work areas. • regularly inspect and maintain equipment in good working order • arrange work sites where possible to minimise noise (eg generators away from sensitive receivers, minimise use of vehicle reversing alarms). • schedule noisy activities around times of surrounding high background noise (local road traffic or when other noise sources are active).
If works beyond standard daytime hours are needed, the Contractor would: • justify the need for out of standard daytime work • consider potential noise impacts and: implement the relevant standard daytime hours safeguards; Sydney Water's Noise Management Code of Behaviour (SWEMS0056.01) and other reasonable and feasible management measures • identify community notification requirements • seek approval from the Sydney Water Project Manager in consultation with Sydney Water's Environment and communications representatives.
Conduct a dilapidation survey / asset condition assessment prior to works which have potential to damage existing structures.
Monitor compliance with the recommended vibration levels in DIN 4150-3 1999: Structural Vibration – Part 3; Effects of vibration on structures.
The delivery contractor will design the project to meet the EPA's NPI (2017). Noise levels of the upgraded Richmond WRP and SP0096 will be verified during commissioning to ensure they meet EPA's NPI (2017).

5.2.8 Traffic and access

Potential Impacts – construction

North Richmond WWTP

The main access to North Richmond WWTP is located on Crooked Lane and an alternative smaller access gate on Bells Line of Road. Bells Line of Road is a state road and Crooked Lane is local road. There is no street parking on either Crooked Lane or Bells Line of Road however there is five formal parking spaces within the treatment plant boundary. Bells Line of Road is a key thoroughfare for local residents and businesses connecting the North Richmond area with

surrounding suburbs. A pedestrian footpath runs along the southbound side of Bells Line of Road and adjacent to North Richmond WWTP.

The section of Bells Line of Road within the study area represents the start of the road as it connects further west. This road plays an important role as a route for transporting freight, operating as a secondary route to the Great Western Highway and as such is prone, at times, to congestion and poor levels of service.

There will be a temporary increase in heavy and light vehicles travelling to and from North Richmond WWTP during the decommissioning works. In particular, additional heavy vehicles will be required to remove waste materials from the site. These have the potential to exacerbate existing congestion issues on Bells Line of Road. In addition, there is the potential for construction activities to block the access to the main site entrance on Crooked Lane. The alternative gate on Bells Line of Road will be used in these instances. Construction vehicles turning in and out of this entrance may temporarily delay traffic along Bells Line of Road and also block pedestrian movement along the footpath. Temporary lane closures may be required to allow for oversize vehicle entry and exit at the site. There are limited parking spaces within North Richmond WWTP property boundary and so some worker vehicles may be required to park on surrounding local roads. A traffic management will be prepared and appropriate road occupancy licenses will be obtained to manage these impacts.

Richmond WRP

Access to Richmond WRP is via a sealed internal access road from Blacktown Road. Blacktown Road is a state road. There is no street parking available on Blacktown Road surrounding Richmond WRP, however there are is parking for approximately 8 light vehicles within the treatment plant boundary. The local area is serviced by Richmond Railway Station located approximately 1km to the north west. The agricultural nature of the surrounding properties means that pedestrian traffic is rare. There is a cycle way on the northbound lane of Blacktown Road. Traffic along Blacktown Road is generally free flowing and not prone to congestion.

During construction, additional light and heavy vehicles will be travelling to and from Richmond WRP, transporting equipment, materials and construction workers. This increase is not expected to significantly impact surrounding local and connecting roads given that these roads currently experience relatively good levels of service. There are some formal parking spaces within the Richmond WRP boundary as well as informal cleared areas ensuring no impacts to surrounding areas. No pedestrian impacts are anticipated. Access to the Richmond WRP will be via the existing access road from Blacktown Road, no additional access will be required.

Transfer pipeline

The transfer pipeline will be constructed along or across the following roads:

- Terrace Road
- Beaumont Avenue
- Old Kurrajong Road

- Francis Street
- Bourke Street
- Pitt Street

These are all local roads. Francis Street is mostly a residential street and light commercial street with street parking on both sides of the road and a pedestrian footpath along the southbound side of the road. Belmont Avenue, Terrace Road and Bourke Street all display similar characteristics to this. Old Kurrajong Road is a narrow two way undivided road with no parking or pedestrian access and generally runs adjacent to large rural residential properties.

The transfer pipeline will be constructed within the road and or road verge. The construction methodology through these roads will be mostly be open trenching. Temporary, partial road closures will be required to ensure worker safety. Sydney Water will consult with Hawkesbury Council and TfNSW and obtain road occupancy licenses as required. The delivery contractor will also work with Council to avoid impacts to heritage listed kerbs on Francis Street.

The construction workforce for the pipeline work and network upgrades would generate traffic to and from the site each day. Given the existing low traffic volumes on the residential streets, an increase in traffic volumes will be expected. However, the works will be temporary and move progressively along the pipeline minimising the extent of impacts to respective receivers. Overall, the volume of traffic is not expected to significantly affect the level of service along these roads. The availability of street parking and pedestrian footpaths will be temporarily impacted at some locations during the work. Works will move progressively along the pipeline and so impacts will be short term.

There are minor network upgrade works proposed along or adjacent to the following roads:

- Bells Line of Road (state road)
- Flinders Place (local road)
- Grose Vale Road (regional road)
- Pecks Road (local road)

These are generally residential streets with parking on one or both sides of the road and some pedestrian footpaths. The characteristics of Bells Line of Road is described above.

Potential impact – operation

Truck movements for regular chemical deliveries and waste out-loading will continue and are expected to increase slightly at Richmond WRP because of the proposal. This could include an extra six sludge trucks per week and an extra chemical delivery per month, with vehicles being 20kl tankers. This is expected to have a minimal impact on the surrounding road network. There will be intermittent and minor vehicles movements along the rest of the pipeline and network upgrades for ongoing maintenance activities (eg replacing carbon cannisters at the air valve locations).

Once decommissioned, vehicle movements to North Richmond WWTP would decrease, alleviating some of the congestion strain at Bells Line of Road.

Safeguards – traffic and access
Ensure work vehicles do not obstruct vehicular or pedestrian traffic, or private driveway, public facility or business access unless necessary and only if appropriate notification has been provided.
Prepare a Traffic Management Plan (TMP) in consultation with the relevant traffic authority. Meet NSW Roads and Maritime Service's Traffic Control at Worksites Manual v5 requirements for TfNSW roads. The Contractor will obtain a Road Occupancy Licence (ROL) from TfNSW, including if works are within 100m of traffic signals when construction commences.
Minimise traffic impacts near residential properties, schools and businesses by consulting with them (eg no major materials deliveries at school drop off or pick up times etc.).
Manage sites to allow people to move safely past the works, including alternative pedestrian, bicycles, pram and wheelchair access.
Consult with the relevant traffic authority about managing impacts to pedestrian traffic, signposting, meters, parking, line-marking or if traffic control or pavement restoration is required.
Erect signs to inform road users of the proposed works and any temporary road closures.
Schedule construction traffic movements outside of peak periods where possible to minimize impacts on the surrounding road network performance
Conduct a dilapidation survey / asset condition assessment prior to works which have potential to damage existing roads/structures.

5.2.9 Social and visual

Potential impacts – construction

North Richmond WWTP is set back from the edge of the property and is surrounded by mature trees and shrubs which acts as a visual screen for surrounding sensitive receivers. Richmond WRP is set back from the road and so is not visible from the road. There are however lines of sight from Richmond Golf Course users and the Hawkesbury District Agricultural Association. Along the transfer pipeline and network upgrade routes, receivers which may be impacted socially and visually include local residents and businesses, as well as St Monica's Primary School, St Monica's Catholic Church and Richmond Public School on Francis Street.

During construction, there is potential for impacts to nearby receivers from construction impacts such as noise, air quality and visual amenity due to the establishment of worksites and construction compounds. Works for the construction of the transfer pipeline will be in close proximity to residents, businesses and other sensitive receivers. Consultation with these receivers would be undertaken to keep them informed of work progress and incorporate mitigation measures

appropriate to these receivers. Impacts would be temporary and move progressively as works continue. Works occurring within North Richmond WWTP and Richmond WRP are offset from main thoroughfares to minimize the social and visual impacts. Receivers will be notified of upcoming works.

Potential impacts – operation

The new infrastructure to be built at Richmond WRP would be consistent with existing infrastructure and would not result in additional visual impacts. New above ground features would be limited to the substation, switch room and chemical dosing unit which are consistent with the existing visual landscape. **Figure 9** shows an impression of the upgraded Richmond WRP.

The transfer pipeline alignment would result in some impacts to properties associated with air valves (and carbon cannisters) and due to easement requirements, as discussed in **Section 3**. Where possible this has been minimized by preferentially using the road verge or road corridor to contain the new alignment. Routine maintenance and inspection of the infrastructure will be undertaken in consultation with respective stakeholders.

As part of this project, North Richmond WWTP will be decommissioned, with the new SP0096 remaining onsite. Future use of the remainder of the site is still being considered by Sydney Water.

Overall, the proposal will provide a positive ongoing social benefit by locating infrastructure away from residential areas and providing a reliable wastewater service for the future population of the area.

Figure 9 Impression of upgraded Richmond WRP

Safeguards – social and visual
Undertake works in accordance with Sydney Water Communications policies and requirements including: • notify impacted residents and businesses • erect signs to inform the public on nature of work • personnel treat community enquiries appropriately.
Minimise visual impacts (eg retain existing vegetation where possible).
Direct artificial light away from sensitive receivers where possible (ie residents, fauna or roadways).
Maintain work areas in a clean and tidy condition.
Worksites will be restored to the pre-existing condition or better following construction

5.2.10 Cumulative impacts

Major Projects

A review of DPIE's major project website indicates that the key future projects which may be occurring in the proposal area are:

- Hawkesbury Centre of Excellence – a new educational facility within the Western Sydney University (Hawkesbury Campus). The proposed development site is on the south western boundary of the campus property, approximately 1.6km from the Richmond WRP. The project is currently in the Response to Submissions stage and the expected construction timeframe is not identified.
- St John of God Richmond Hospital Redevelopment – the upgrade and expansion of existing facilities, demolition of buildings and landscaping works. The site is located approximately 2.3km south west of the North Richmond WWTP. The proposal is currently awaiting more information before determination and the expected construction timeframe is not identified.

Richmond Bridge Duplication project

TfNSW are proposing the Richmond Bridge Duplication and traffic improvements project to provide additional capacity for servicing the Richmond Road corridor and its connections between the Hawkesbury Region and the Central West of NSW. The new two-lane bridge across the Hawkesbury River will also include a bypass of Richmond and North Richmond town centres, and upgrade major intersections. The key objective of this project is to reduce congestion between Richmond and North Richmond and provide for future growth. The project would also aim to improve journey time reliability and connectivity between Bells Line of Road and the main road network. This project is in the planning phase and while some investigation and early works may be undertaken concurrently, it is anticipated that the construction of the Richmond Bridge Duplication Project will commence after this project is complete.

Sydney Water Projects

Redbank development and reservoir

Sydney Water is providing drinking water and wastewater infrastructure to service population growth in Redbank (North Richmond). There may be some cumulative impacts during construction associated with increased traffic and noise disruption in the broader region however this would be temporary and works would be progressive, minimizing any ongoing impacts. It is anticipated that this project will commence in September 2022 and finish mid 2024.

Safeguards – cumulative impacts
Sydney Water will work with TfNSW to manage cumulative impacts associated with this project.
Consult with Council in regard to construction timing and any other proposed work within the area which has the potential to result in cumulative impacts.

5.2.11 General Construction Environmental Management

The following general environmental management safeguards will be implemented as part of the proposal.

Safeguards – general construction environmental management
Prepare a Construction Environmental Management Plan (CEMP) addressing the requirements of this environmental assessment. The CEMP should specify license, approval and notification requirements. Prior to the start of work, all project staff and contractors will be inducted in the CEMP. The CEMP should be readily available on site and include a site plan which shows: • no go areas and boundaries of the work area • location of environmental controls (such as erosion and sediment controls, fences or other measures to protect vegetation or fauna, spill kits) • location and full extent of any vegetation disturbance.
Sydney Water's Project Manager (after consultation with Sydney Water's environment and community representatives and affected landowners) can approve temporary ancillary construction facilities (such as compounds and access tracks), without additional environmental assessment or approval if the facilities meet the following principles: • limit proximity to sensitive receivers • no disruption to property access • no impact to known items of non-Aboriginal and Aboriginal heritage • outside high-risk areas for Aboriginal heritage

Safeguards – general construction environmental management
• use existing cleared areas and existing access tracks • no impacts to remnant native vegetation or key habitat features • no disturbance to waterways • potential environmental impacts can be managed using the safeguards in this REF • no disturbance of contaminated land or acid sulphate soils • will be rehabilitated at the end of construction. The Delivery Contractor must demonstrate in writing how the proposed ancillary facilities meet these principles. Any facilities that do not meet these principles will require additional environmental impact assessment. The agreed location of these facilities must be shown on the CEMP site plan and appropriate environmental controls installed.
Prepare an Incident Management Plan (IMP) outlining actions and responsibilities during: • onset of heavy rain during works • spills • unexpected heritage finds • other potential incidents relevant to the scope of works. All site personnel should be inducted into the IMP.
Immediately notify the Sydney Water Project Manager and Community Relations Representative of any complaints.
To ensure compliance with legislative requirements for incident notification (eg. *Protection of the Environment Operations Act 1997*), Sydney Water's employees and contractors will follow SWEMS0009.

6 Conclusion

Sydney Water has prepared this REF to assess the potential environmental impacts of Richmond Precinct wastewater upgrade project. The proposal is required to address EPL compliance requirements for meeting current and future nutrient limits under the EPA's Hawkesbury Nepean nutrient framework, address wet weather overflow compliance requirements in the North Richmond network, and cater for additional growth in the catchment.

During construction, there will be impacts to Aboriginal heritage as well as potential environmental impacts such as soil and water impacts, noise, traffic, and biodiversity. During operation, the main impacts are associated with closing and transferring flows from North Richmond WWTP, as well as benefits from improving treated water quality from Richmond WRP. It is considered that, given the nature, scale and extent of impacts and implementation of the safeguards outlined in this REF, the proposed work is unlikely to have a significant impact on the environment and an environmental impact statement is not required under Division 5.1 of the EP&A Act.

The proposal has been considered in accordance with the principles of ESD. The proposal will result in positive long-term environmental improvements. The proposal will not result in the degradation of the quality of the environment, and will not pose a risk to the safety of the environment.

7 References

GHD (2019) Ensure JV – *Richmond Precinct Options Plan 2019 Aquatic ecology and geomorphology assessment.* Prepared for Sydney Water. January 2019.

EPA (2019) *Regulating nutrients from sewage treatment plants in the Lower Hawkesbury Nepean River catchment* State of NSW and Environment Protection Authority. July 2019

8 Appendices

Appendix A – Clause 228 checklist

Clause 228 checklist	REF finding
Any environmental impact on a community	There may be short-term impacts on the community from noise, traffic impacts associated with construction vehicle movements and road closures and access changes. During operation, there will be environmental improvements by closing North Richmond as a treatment plant (reducing potential for noise and odour impacts) and improving treated wastewater quality released to waterways.
A transformation of a locality	The proposed work will not result in the transformation a locality.
Any environmental impact on the ecosystem of the locality	There will be some vegetation clearing associated with construction of the proposal, however this will not affect the ecosystems of the locality. Revegetation will be completed in accordance with Sydney Water's biodiversity offsetting guideline. Treated wastewater quality will improve, contributing to future healthier waterways and associated ecosystems.
Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of the locality	There may be temporary reductions in the aesthetic, recreational and environmental value during construction of the transfer pipeline, for areas such as crossing the Hawkesbury River, Pughs Lagoon and in Richmond Golf Course. However, once construction is complete, the proposed work will not result in a reduction of the aesthetic, recreational, scientific or other environmental quality or value of the locality.
Any effect upon a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or any other special value for present or future generations	The proposed work will require impacts to some Aboriginal heritage within North Richmond. An Aboriginal heritage impact permit will be sought which would include a program to salvage the heritage. The proposal will not have any other effect upon a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or any other special value for present or future generations.
Any impact on the habitat of any protected animals (within the meaning of the *Biodiversity Conservation Act 2016*)	The proposed work will involve clearing a small amount of five threatened ecological communities listed under the BC Act and EPBC Act. Potential habitat impacts have been minimised through design. The removal has been assessed to be not significant (see **Section 5.2.3**) and vegetation cleared will be offset.
Any endangering of any species of animal or plant or other form of life, whether living on land, in water or in the air	The proposed work will not be endangering any species of animal, plant or other form of life, whether living on land, in water or in the air.

Clause 228 checklist	REF finding
Any long-term effects on the environment	The proposed work will not have any long-term impacts on the environment but will have a long-term benefit by providing a more reliable wastewater system, and improved treated water quality to local waterways.
Any degradation of the quality of the environment	The proposed work will not cause the degradation of the quality of the environment.
Any risk to the safety of the environment	The proposed work will require construction within residential streets, private properties and recreational areas. The proposal will also result in a temporary increase of traffic movements along residential streets for work at Richmond WRP and North Richmond WWTP and as construction progresses along the transfer pipeline. Consultation and signage will mitigate this potential risk to the safety of the environment. The proposed work will not increase risk to the safety of the environment during operation.
Any reduction in the range of beneficial uses of the environment	The proposed work will not have any reduction in the range of beneficial uses of the environment. The proposal responds to both current and future EPL requirements aimed at minimising pollution of the environment.
Any pollution of the environment	Environmental safeguards will mitigate the potential for the proposed work to pollute the environment.
Any environmental problems associated with the disposal of waste	The disposal of wastes will be conducted in accordance with the environmental safeguards, and no environmental problems associated with the disposal of waste are expected.
Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply	The proposed work will not increase demand on resources, that are, or are likely to become, in short supply.
Any cumulative environmental effect with other existing or likely future activities	The proposed work is to service future growth in the area and some development activities are likely to be occurring when the proposal is being construction. The proposal has minimal potential to create cumulative environmental effect with other existing or likely future activities. The safeguards identified for the proposal will reduce the potential for cumulative environmental effects.
Any impact on coastal processes and coastal hazards, including those under projected climate change conditions	The proposed work will not have any impact on coastal processes or hazards.

Appendix B – Consideration of Infrastructure SEPP consultation

ISEPP clause	Yes	No
Clause 13, council related infrastructure or services – consultation with council		
Will the work:		
Potentially have a substantial impact on stormwater management services provided by council?		N
Be likely to generate traffic that will strain the capacity of the road system in the LGA?		N
Involve connection to, and have a substantial impact on, the capacity of a Council owned sewerage system?		N
Involve connection to, and use of a substantial volume of water from a Council owned water supply system?		N
Involve installation of a temporary structure on, or enclosing, a public space under council's control that will cause a disruption to pedestrian or vehicular traffic that is not minor?		N
Involve excavation of the surface of, or a footpath adjacent to, a road for which the council is the roads authority that is not minor or inconsequential?	Y	
Clause 14, local heritage – consultation with council		
Is the work likely to affect the heritage significance of a local heritage item, or of a heritage conservation area (not also a State heritage item) more than a minor or inconsequential amount?		N
Clause 15, flood liable land – consultation with council		
Will the work be located on flood liable land (that is land that is susceptible to flooding by the probable maximum flood event) and will they alter flood patterns other than to a minor extent?		N
Clause 15AA, flood liable land – consultation with State Emergency Services		
Will the work be located on flood liable land (ie. land that is susceptible to flooding by the probable maximum flood event) and undertaken under a relevant provision*, but not the carrying out of minor alterations or additions to, or the demolition of, a building, emergency works or routine maintenance? * (e) Div.14 (Public admin buildings), (g) Div. 16 (Research/ monitoring stations), (i) Div. 20 (Stormwater systems)?		N
Clause 15A, development with impacts on certain land within the coastal zone– council consultation		
Is the work on land mapped as coastal vulnerability area and inconsistent with a certified coastal management program?		N
Clause 16 – consultation with public authorities other than councils		
Will the proposal be located on land adjacent to land reserved under the *National Parks and Wildlife Act 1974* or to land acquired under Part 11 of that Act*? If so, consult with OEH.*		N
Will the proposal be located on land in Zone E1 Nationals Parks and Nature Reserves or in a land use zone that is equivalent to that zone? *If so, consult with OEH*		N
Will the proposal be adjacent to an aquatic reserve or a marine park declared under *Marine Estate Management Act 2014? If so, consult with the Department of Industry.*		N
Will the proposal be in the foreshore area within the meaning of the *Sydney Harbour Foreshore Authority Act 1998? If so, consult with Sydney Harbour Foreshore Authority*		N
Will the proposal comprise a fixed or floating structure in or over navigable waters? consult *RMS*		N
Will the proposal be located on land in a mine subsidence district within the meaning of the *Coal Mine Subsidence Compensation Act 2017*? *If so, consult with Subsidence Advisory NSW.*		N
Will the proposal involve clearing of native vegetation on land that is not subject land (ie non-certified land)? *If so, notify DP&E at least 21 days prior to work commencing.*		n/a

Appendix C – Water quality modelling

North Richmond WWTP/ Richmond WRP Review of Environmental Factors

Receiving Water Quality Modelling

Sydney WATER

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Figures

Tables

1 Introduction

1.1 Background

The Richmond Water Recycling Plant (WRP) and the North Richmond Wastewater Treatment Plant (WWTP) currently service two independent systems separated by the Hawkesbury River.

Both plants and their systems will have capacity limitations in the near future as the population growth in the Richmond and Upper Hawkesbury area is projected to increase by 70% over the next 30 years.

Sydney Water is planning to upgrade its wastewater infrastructure in North Richmond and Richmond to meet the needs of Richmond's growing population, meet current regulatory requirements and provide sufficient flexibility to meet more stringent regulatory requirements in the future.

Key elements of the planned upgrade include:

- the diversion of flows from the North Richmond WWTP to the Richmond WRP via a 6.9 km long transfer pipeline
- upgrade the Richmond WRP to receive the additional flows from the North Richmond catchment and to meet future growth.

The overall objective of the upgrade is to increase the combined plant capacity by 80% and at the same time will ensure Sydney Water meets its EPA license requirements.

1.2 Study purpose and scope

To support the Review of Environmental Factors (REF), hydrodynamic and water quality modelling has been applied to assist understanding of the potential impacts from the planned upgrade on water quality in the receiving waterways of the Hawkesbury River.

More specifically, the modelling has allowed for analysis of key water quality parameters across three time horizons:

- 2020 representing current baseline conditions (no upgrade/diversion)
- 2036 representing forecast land use change and population growth (upgrade/diversion included)
- 2056 representing forecast land use change and population growth (upgrade/diversion included).

In addition to these scenarios, the modelling has also assessed the potential impacts over both representative wet and dry rainfall years.

2 Methodology

2.1 Approach

The modelling results used for analysis in the REF were generated as part of the Environment Impact Statement (EIS) for the Upper South Creek Advanced Water Recycling Centre (USC AWRC). In the process of developing the EIS, a significant upgrade to the Hawkesbury Nepean Water Quality Response Model (WQRM) was undertaken. A fundamental focus of the upgrade was to ensure the modelling system had the capacity to realistically evaluate far field hydrodynamic and water quality impacts within the river from Sydney Water assets.

As a high-level summary, the model development tasks included:

- updates to the modelling software versioning to apply latest advances in modelling hardware and software
- updates of various model datasets and model elements, including updates to WWTP/WRP data and extending all boundary condition datasets to cover more recent time periods
- updates to the catchment conditions including land use through application of updated Source catchment models
- review of biogeochemical and sediment parameter descriptions, units and assigned values based on local evidence, or otherwise relevant literature.

The WQRM was subsequently calibrated and validated across four independent years based on an assessment of each year's representative climatic conditions and an audit/comprehensive review of available hydrodynamic and water quality monitoring data.

For brevity, further details regarding the model development and its application for the EIS have not been included in this document but can be accessed at the following link:

Appendix F in https://www.planningportal.nsw.gov.au/major-projects/project/38261

2.2 Scenario descriptions

An extensive suite of scenarios was run for the EIS in order to assess the potential hydrodynamic and water quality impacts from treated water releases from the USC AWRC. These scenarios included the following scenario types:

- Baseline scenarios representative of current conditions (circa 2020) in terms of all catchment conditions e.g. land use, existing WWTP/WRP releases (no upgrade/diversion), extractions, etc.
- Background scenarios which represent the two future time horizons (circa 2036 and 2056) with representative adjustments to land use, WWTP/WRP releases adjusted with respect to population growth, diversion and upgrades, extractions, etc.

- Impact scenarios which correspond to the aforementioned background scenarios with inclusion of treated water releases from the AWRC.

For the purposes of this REF, analysis has been restricted to the Baseline and Background scenario types, thereby excluding any modelled effects from the AWRC releases.

2.2.1 Scn00 - Baseline Scenario (circa 2020)

With respect to the Baseline scenario, releases from the North Richmond WWTP and Richmond WRP are configured as they are currently (refer
Figure 2-1). More specifically, this includes the following release locations:

- North Richmond WWTP - Treated water is released to Redbank Creek.
- Richmond WRP - Treated water (in excess of recycling) is released to Rickabys Creek.

Both these creeks flow to the Hawkesbury River within reaches that are still tidally influenced, although are predominantly fresh in terms of salinity.

The release rates and treated water quality from each of these treatment plants were also defined in the model so as to be representative of current conditions. Temporal variations in daily release rates and treated water quality were incorporated into the modelling based on historical data and responses to different rainfall conditions. Please refer to Table 2-1 and Table 2-2 for further details.

2.2.2 Scn01 and Scn02 - Background Scenarios (circa 2036 and circa 2056)

With respect to the Background scenarios, the configuration of the plants was modified so as to be representative of the 2036 and 2056 time horizons i.e. all flows from North Richmond WWTP diverted to Richmond WRP, which includes improved treated water quality due to the planned upgrade.

Similar to the Baseline scenario, the release rates and treated water quality from each of these treatment plants were defined within the model so as to be representative of relevant future conditions, assuming the diversion, upgrade and forecast recycling rates. Temporal variations in daily release rates and treated water quality were again incorporated into the modelling based on historical data and responses to different rainfall conditions. Table 2-1 and Table 2-2 present further details.

2.2.3 Other WWTPs/WRPs

Also of note, the modelling incorporated representative release conditions from all other WWTPs and WRPs which release treated water to the Hawkesbury Nepean river system (except for the proposed USC AWRC as noted above). This is discussed in detail in Section 4.6.3.5.4 of the EIS modelling report, with summaries of some key elements provided below:

Planned upgrades and new WRPs

In addition to the upgrade to the Richmond WRP, planned upgrades for the following plants were also incorporated into the modelling of the future scenarios: Winmalee WWTP, Picton WRP, West Camden WRP, Castle Hill WWTP and Rouse Hill WRP. In addition to these upgrades, the new

Wilton WRP was also represented in the future scenarios. Further details are presented in Section 4.6.3.5.4 of the EIS modelling report.

High and low loading

All future scenarios were run under two different loading options that would address the requirements of the EPA framework, *Regulating nutrients from sewage treatment plants in the Lower Hawkesbury Nepean River catchment* (EPA, 2019). More specifically, different release conditions were considered for five treatment plants, namely, Penrith WRP, Picton WRP, West Camden WRP, Wilton WRP and Winmalee WWTP. In line with the EIS, the "low loading" results have been presented for the purposes of this REF. Further details are again presented in Section 4.6.3.5.4 of the EIS modelling report.

Table 2-1 Assumed treatment standards for the baseline and future scenarios

Treatment plant	Median TN concentrations (mg/L)			Median TP concentrations (mg/L)		
	Scn00 (circa 2020)	Scn01 (circa 2036)	Scn02 (circa 2056)	Scn00 (circa 2020)	Scn01 (circa 2036)	Scn02 (circa 2056)
North Richmond	6.0	N/A	N/A	0.11	N/A	N/A
Richmond	6.0	4.0*	4.0*	0.03	0.04*	0.04*

Table 2-2 Assumed ADWF for the baseline and future scenarios

Treatment plant	Average Dry Weather Flow (ML/d)		
	Scn00 (circa 2020)	Scn01 (circa 2036)	Scn02 (circa 2056)
North Richmond	0.90	N/A	N/A
Richmond	2.60	5.63^	5.99^

Table notes:

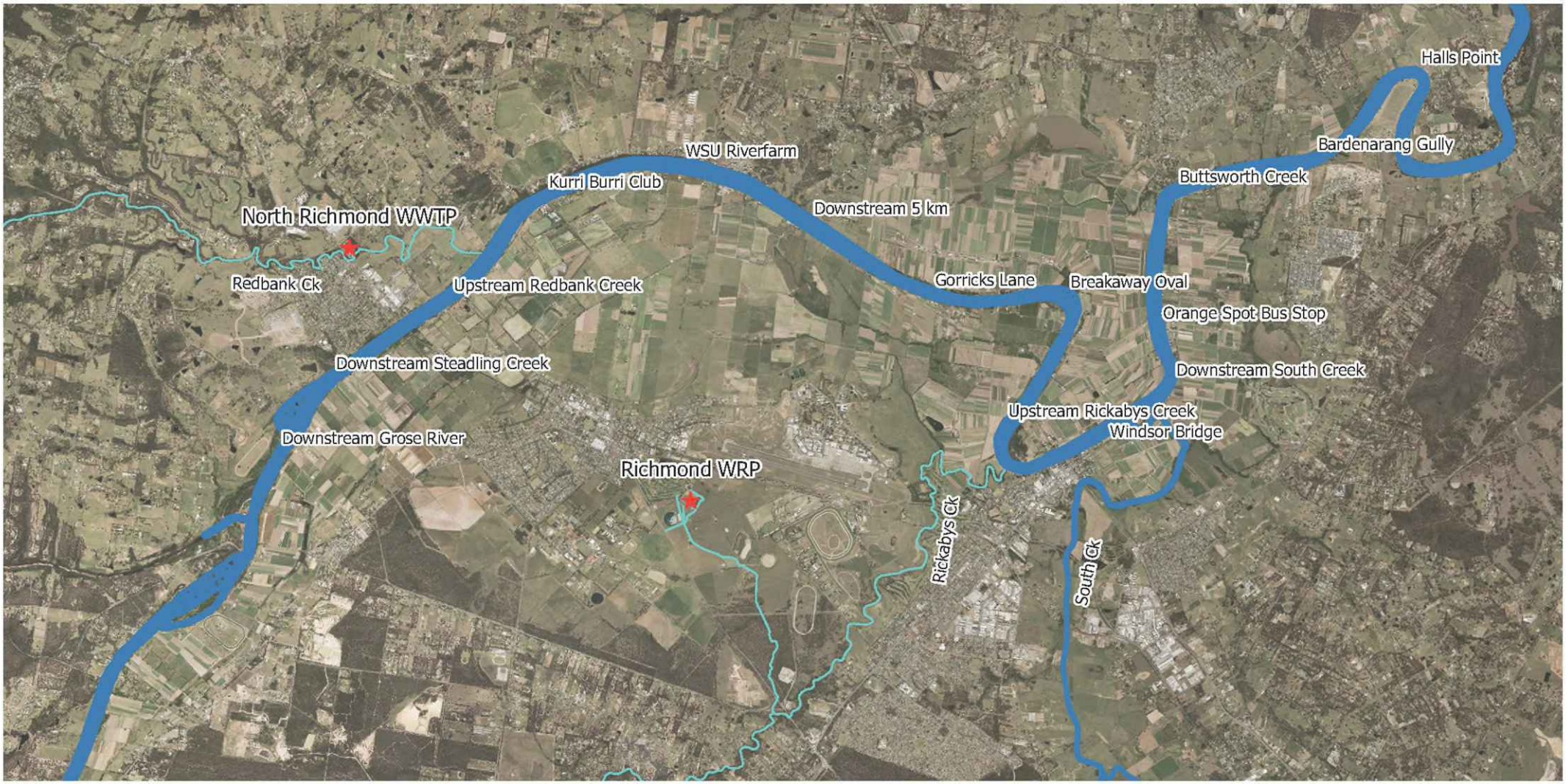
** Treated water quality assuming planned upgrade to the WRP*

^ Flows assuming current level of recycling (~1 ML/d)

2.3 Parameters

For the purposes of the REF, analysis was undertaken with respect to the following range of primary water quality parameters:

- Nitrogen (including ammonia, oxidised nitrogen, total nitrogen)
- Phosphorus (including filterable reactive phosphorus, total phosphorus)
- Chlorophyll *a* (adopted as primary indicator of phytoplankton abundance and biomass).



Sources: Arup, Sydney Water, Nearmap, DPIE, Esri
Date: 11/11/2021

Legend

- WWTP/WRP
- Creek
- WQRM Mesh

1:55000 Scale at A3

0 1.5 3 km

Projection: GDA94 MGA Zone 56

North Richmond WWTP/ Richmond WRP | Receiving Water Quality Modelling

FIGURE 2-1: Location of the WWTP/WRP release points

2.4 Analysis formats

The results are presented as longitudinal profiles of annual median concentrations for each parameter.

As well as the comparative analysis of the results for each time horizon, the relevant water quality objectives are also plotted on the graphs. For the Hawkesbury Nepean River, the most locally accredited and relevant Default Guideline Values (DGVs) are taken from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).

3 Load analysis

Figure 3-1 presents the predicted ADWF (including estimated recycling rates) for the three time horizons analysed for this REF. Similarly, Figure 3-2 and Figure 3-3 present the estimated annual nutrient loads for Total Nitrogen and Total Phosphorus respectively. These loads are based on a product of the estimated ADWF, and the assumed treatment standards presented previously in Table 2-1 and Table 2-2. The load estimates exclude the estimated recycling stream.

From this analysis, the flows within the combined catchments are predicted to increase by ~47% and ~55% over the 2036 and 2056 time horizons, relative to the 2020 flows.

As a result of the diversion and the upgrade to the Richmond WRP, the nutrient loads increase by the following lower proportions:

- Total Nitrogen: increases of 7% (2036), and 14% (2056)
- Total Phosphorus: increases of 27% (2036), and 35% (2056)

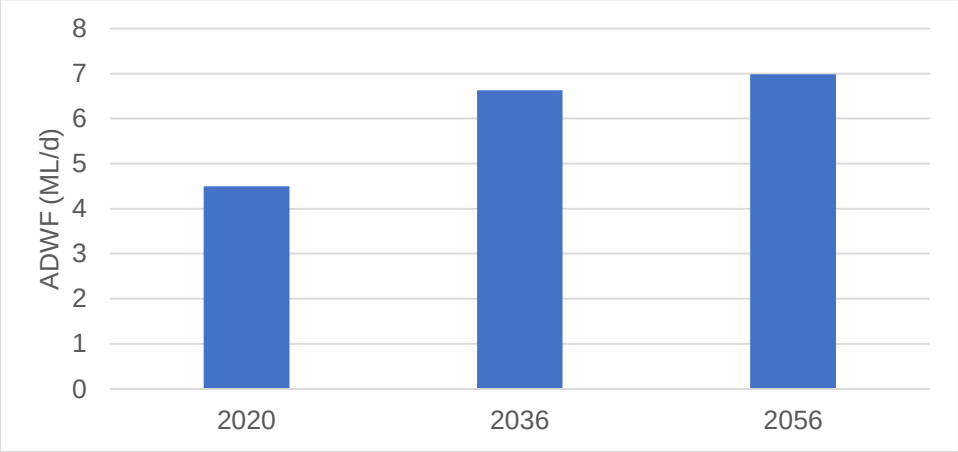


Figure 3-1 Predicted ADWF (combined catchments)

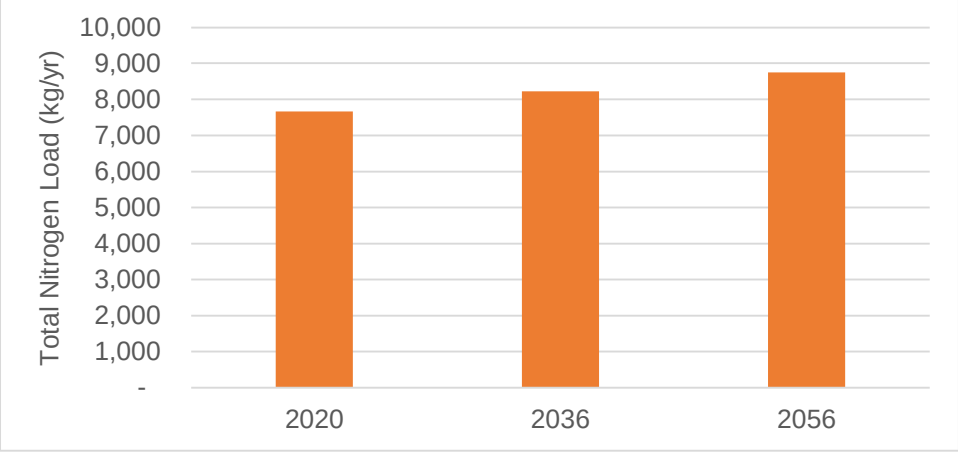


Figure 3-2 Predicted Total Nitrogen Load (combined catchments)

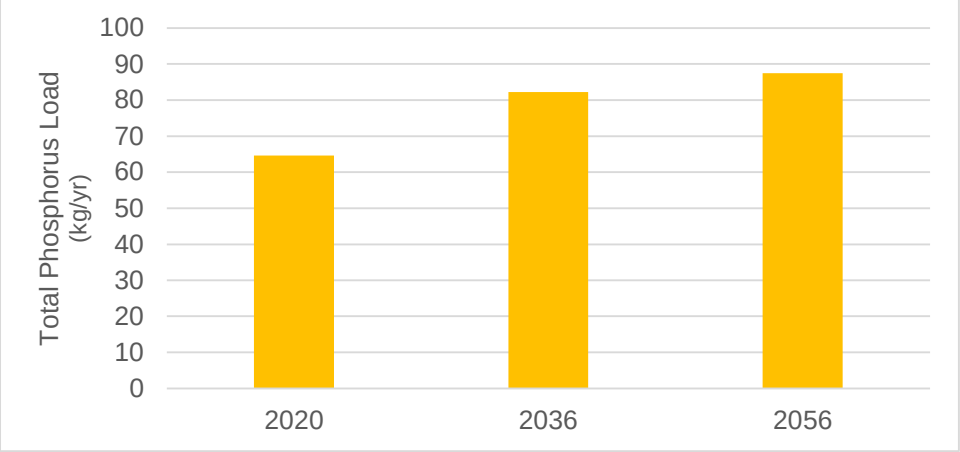


Figure 3-3 Predicted Total Phosphorus Load (combined catchments)

4 Model Results

4.1 Nitrogen

4.1.1 Total Nitrogen

The longitudinal profiles for Total Nitrogen are presented in Figure 4-1 and Figure 4-2 for the dry and wet year respectively. In both sets of profiles, increased concentrations are predicted in the vicinity of the North Richmond WWTP releases under current conditions. These localised increases are not predicted in either of the future scenarios Scn01 (circa 2036) or Scn02 (circa 2056), due to the closure of the North Richmond WWTP and diversion of flows to Richmond WRP.

Minor elevations in the annual median concentrations are predicted downstream of the Richmond WRP releases. These elevations are expected to be partly driven by the increased loading at the WRP as well as the nutrient loads flowing from South Creek.

Also of note, are the influences on the nitrogen profile from the other planned upgrades, most notably the upgrade of the Winmalee WWTP (~14 km upstream) and the Penrith WWTP (~22 km upstream). With the combined effects of the upgrades, the potential for greater compliance with the ANZG DGV is predicted, particularly in a dry year.

4.1.2 Ammonia and Oxidised Nitrogen

The longitudinal profiles for Ammonia are presented in Figure 4-3 and Figure 4-4 for the dry and wet year respectively. Similarly the profiles for Oxidised Nitrogen are presented in Figure 4-5 and Figure 4-6.

With respect to predicted annual median Ammonia and Oxidised Nitrogen concentrations, the influence of the releases from the North Richmond WWTP, under current conditions, is predicted to be far more significant than shown for Total Nitrogen. This is due to the higher proportion of inorganic and more bioavailable forms of nitrogen in the treated water releases from the WWTP.

For the future scenarios Scn01 (circa 2036) and Scn02 (circa 2056), these localised elevations in ambient concentrations near Redbank Creek are again not seen in the model results due to the diversion of flows to the Richmond WRP. For Ammonia, the predicted impacts of the diversion are particularly evident with concentrations downstream of Redbank Creek estimated to be up to 0.015 mg/L lower than the Baseline (circa 2020) conditions.

Further downstream, in the vicinity of Rickabys Creek (and the associated release from the Richmond WRP), concentrations again begin to rise but to a lesser extent than predicted for the existing North Richmond WWTP releases. These lower levels of impact could be attributed to greater tidal influence and flushing, as well as the nutrient loading from South Creek that is seen to become influential with distance downstream of Rickabys Creek.

The potential for greater compliance with the relevant ANZG DGV for Ammonia, relative to the existing baseline conditions, is again predicted due to the combined effects from the planned upgrades (Penrith, Winmalee and Richmond) and the North Richmond flow diversion.

4.2 Phosphorus

4.2.1 Total Phosphorus

The results for Total Phosphorus are presented in Figure 4-7 and Figure 4-8 for the representative dry and wet year respectively. The influence of the existing North Richmond WWTP releases can be observed in the model results in the vicinity, and downstream, of Redbank Creek. This is particularly evident in the dry year results.

The influence is however not as pronounced as that shown in the nitrogen results and this is considered to be a result of the comparatively lower concentrations in the treated water releases relative to ambient concentrations in the river. Nonetheless, the combined effects of the diversion and planned upgrades to the Richmond, Penrith and Winmalee treatment plants is predicted to have an overall beneficial reduction in Total Phosphorus levels within the river reaches analysed. While the annual median concentrations are still not predicted to be compliant with the ANZG DGV, the lower ambient levels are closer to, or below, the guideline values, particularly under the dry year simulation.

4.2.2 Filterable Reactive Phosphorus

Annual median profiles for Filterable Reactive Phosphorus are presented in Figure 4-9 and Figure 4-10.

As shown in the Total Phosphorus results, the effects of the flow diversion and the Richmond WRP upgrade are not as prominent as many of the Nitrogen results. This is again expected to be a result of the lower differential between river concentrations and the concentrations of treated water from both the North Richmond WWTP and the Richmond WRP.

The combined effects of the diversion and planned upgrades to the Richmond, Penrith and Winmalee treatment plants are again predicted to have an overall beneficial effect with respect to compliance with the relevant ANZG DGV.

4.3 Chlorophyll *a*

The results for Chlorophyll *a* are presented in Figure 4-11 and Figure 4-12. Due to the more complex processes involved in algal growth, the immediate and more localised responses in water quality are not as evident as shown in the above nutrient analysis.

Nonetheless, the combined effects of the three planned upgrades, and the associated lower nutrient loads, provide for marked reductions in predicted Chlorophyll *a* concentrations throughout the river reaches analysed.

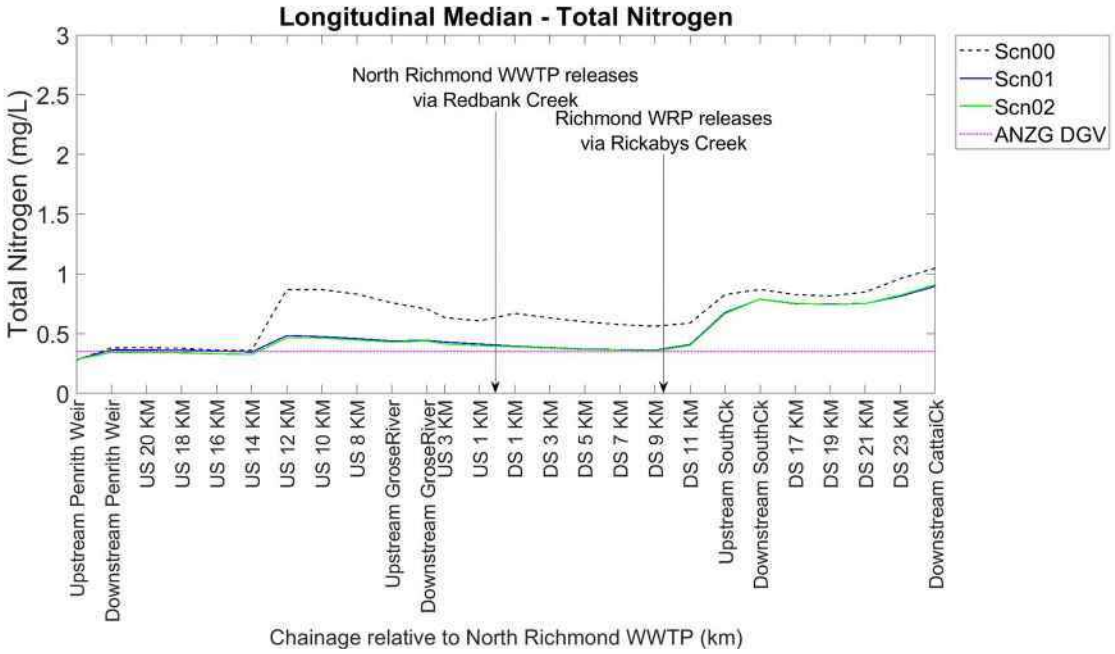


Figure 4-1 Longitudinal profile of predicted annual median Total Nitrogen concentrations (dry year)

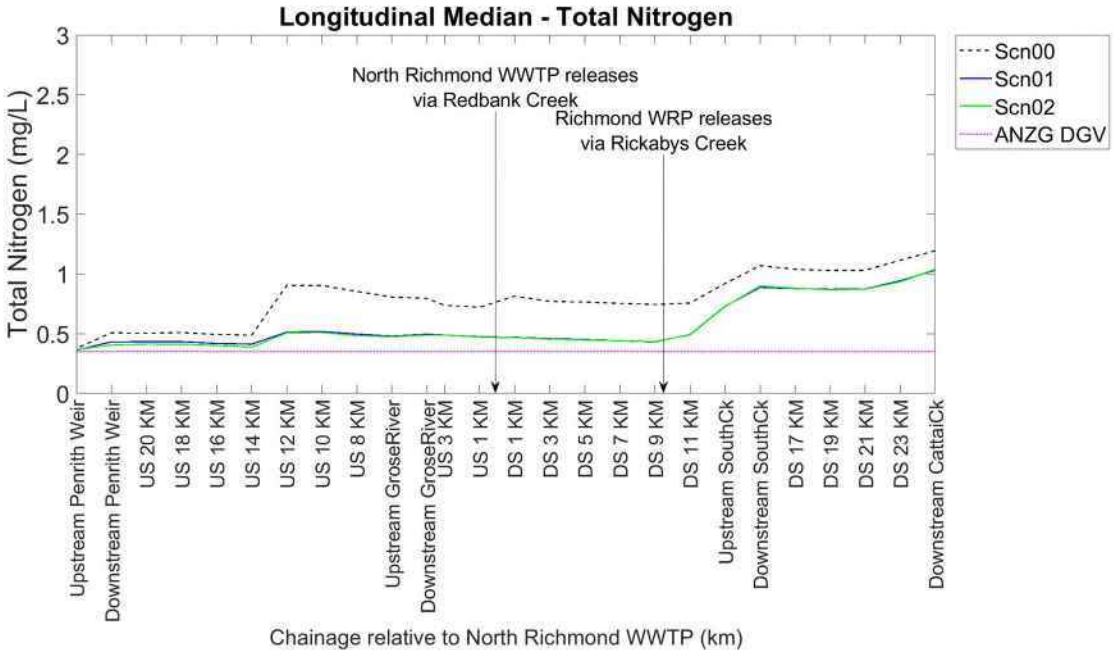


Figure 4-2 Longitudinal profile of predicted annual median Total Nitrogen concentrations (wet year)

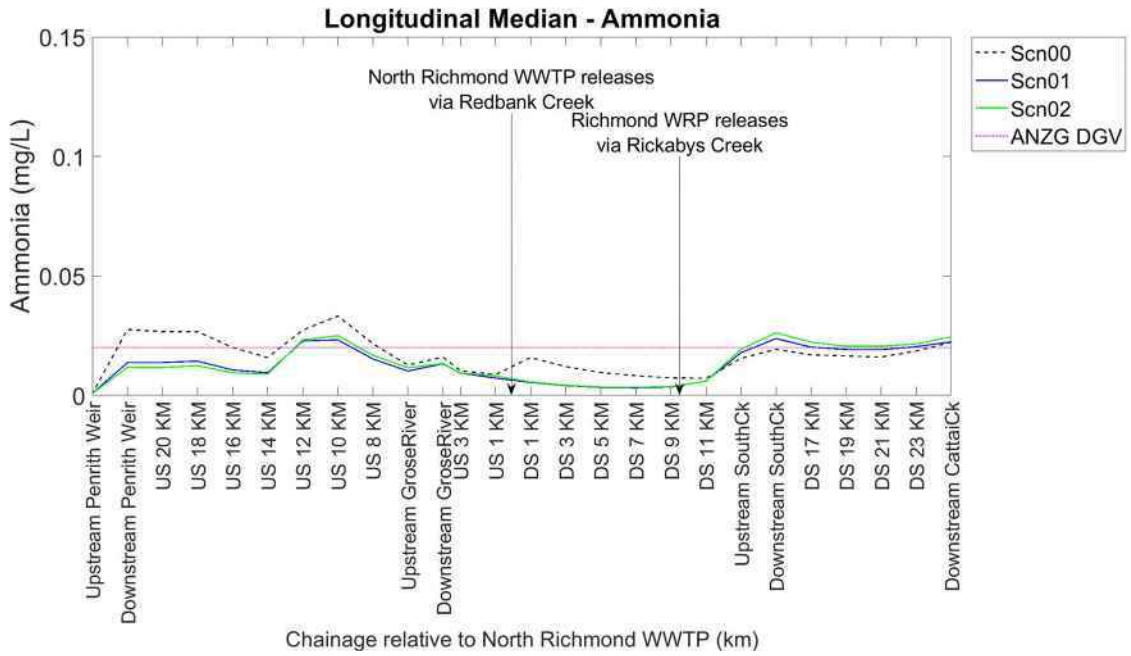


Figure 4-3 Longitudinal profile of predicted annual median Ammonia concentrations (dry year)

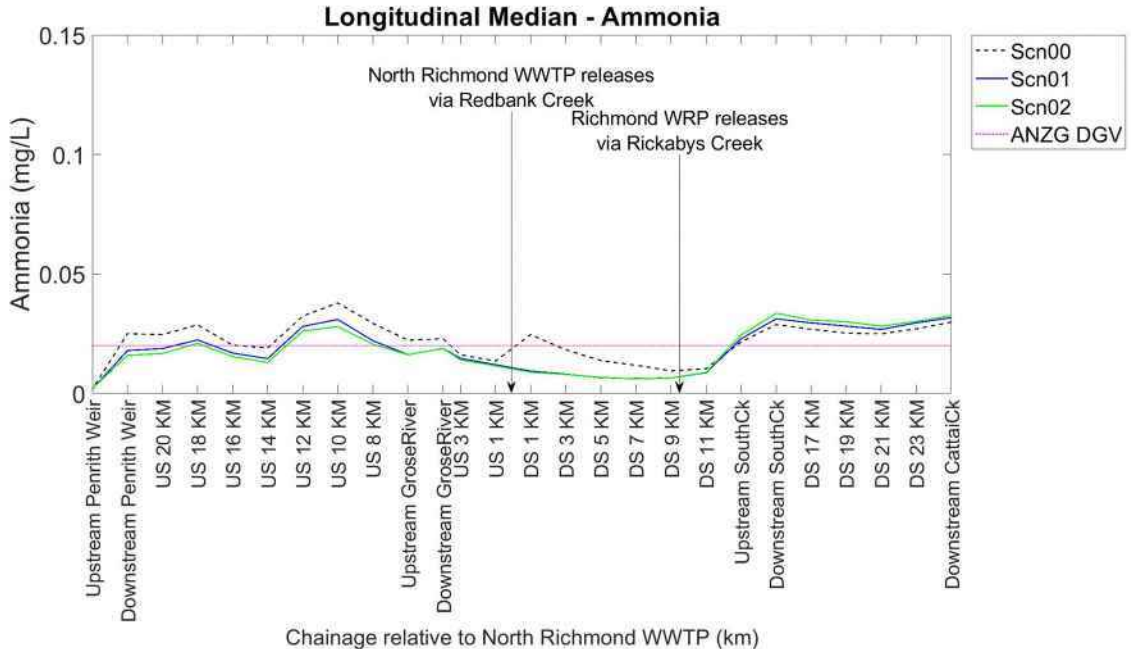


Figure 4-4 Longitudinal profile of predicted annual median Ammonia concentrations (wet year)

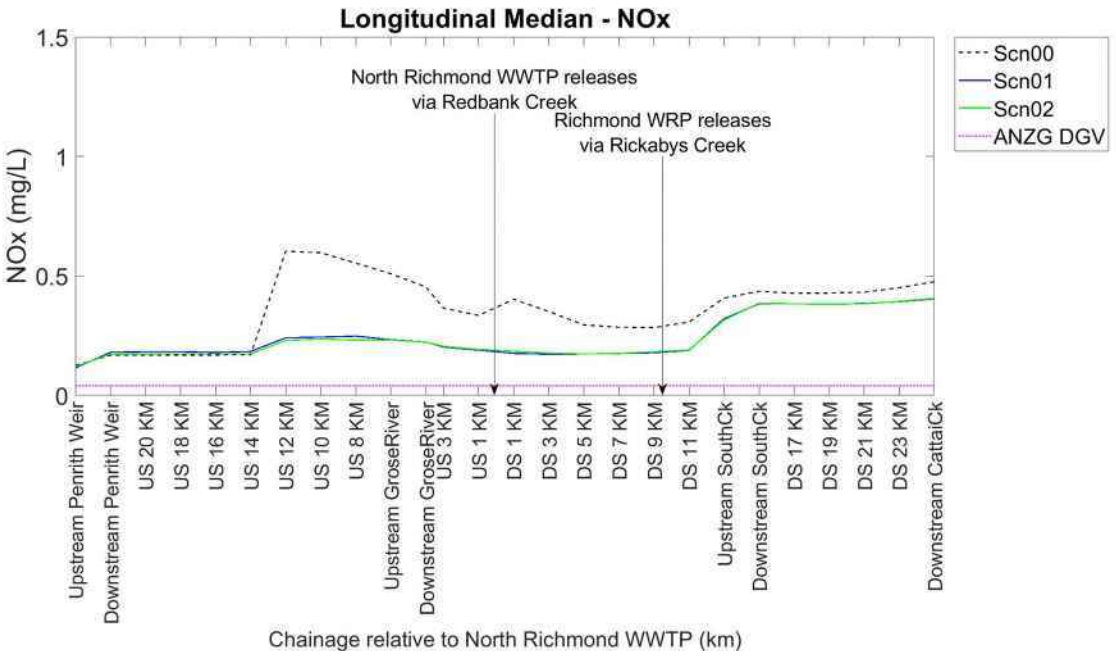


Figure 4-5 Longitudinal profile of predicted annual median Oxidised Nitrogen concentrations (dry year)

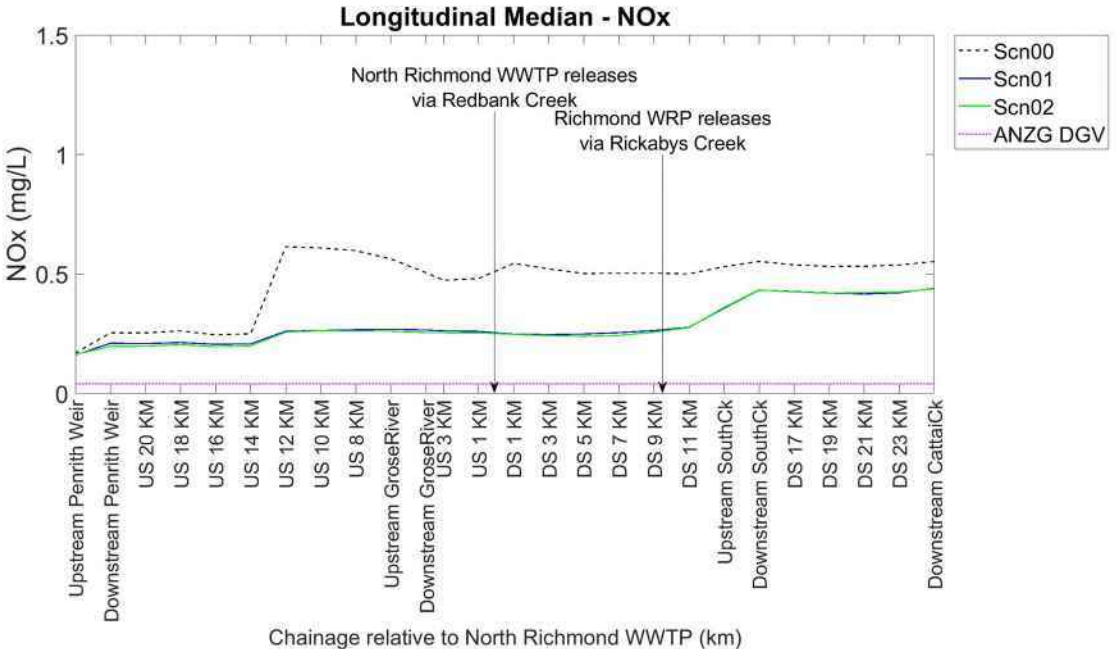


Figure 4-6 Longitudinal profile of predicted annual median Oxidised Nitrogen concentrations (wet year)

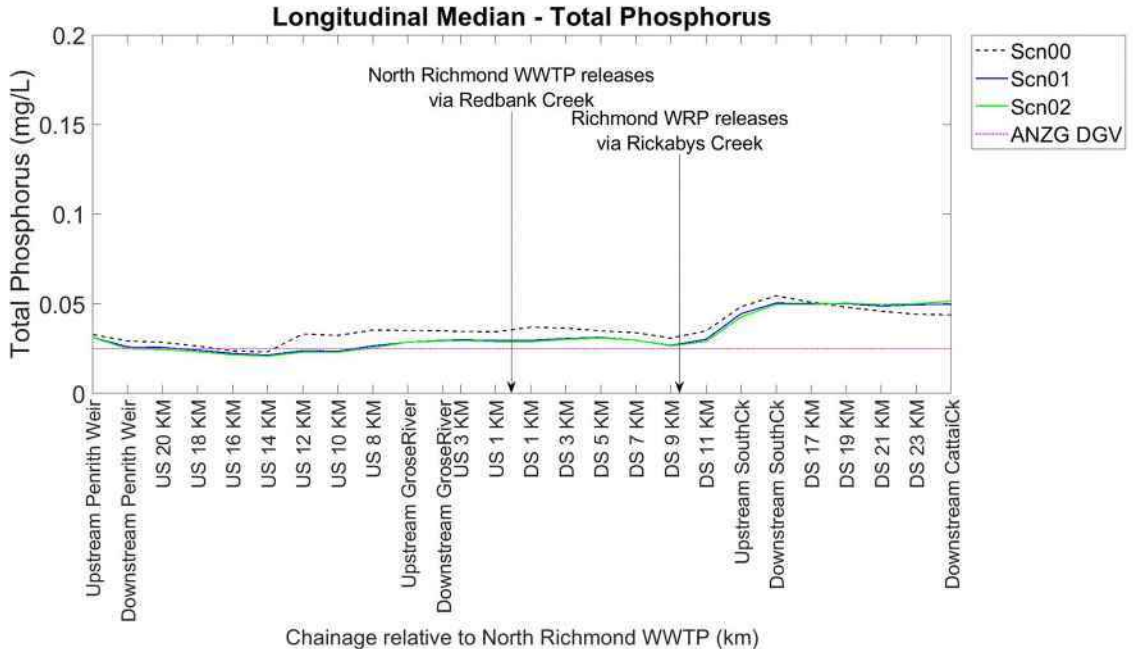


Figure 4-7 Longitudinal profile of predicted annual median Total Phosphorus concentrations (dry year)

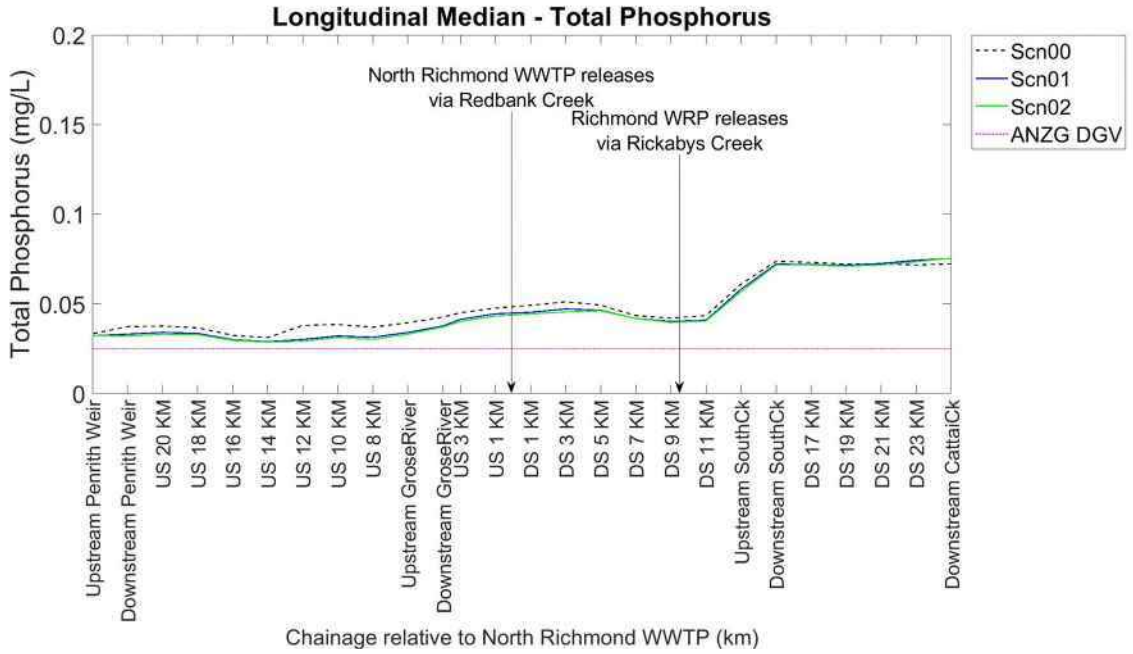


Figure 4-8 Longitudinal profile of predicted annual median Total Phosphorus concentrations (wet year)

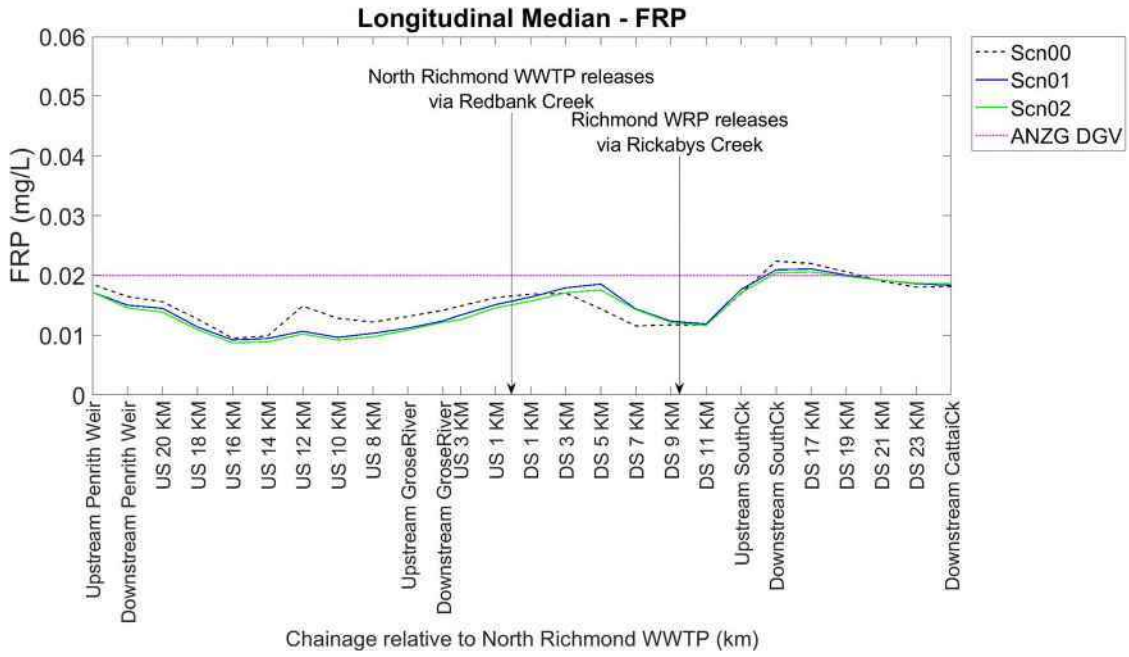


Figure 4-9 Longitudinal profile of predicted annual median Filterable Reactive Phosphorus concentrations (dry year)

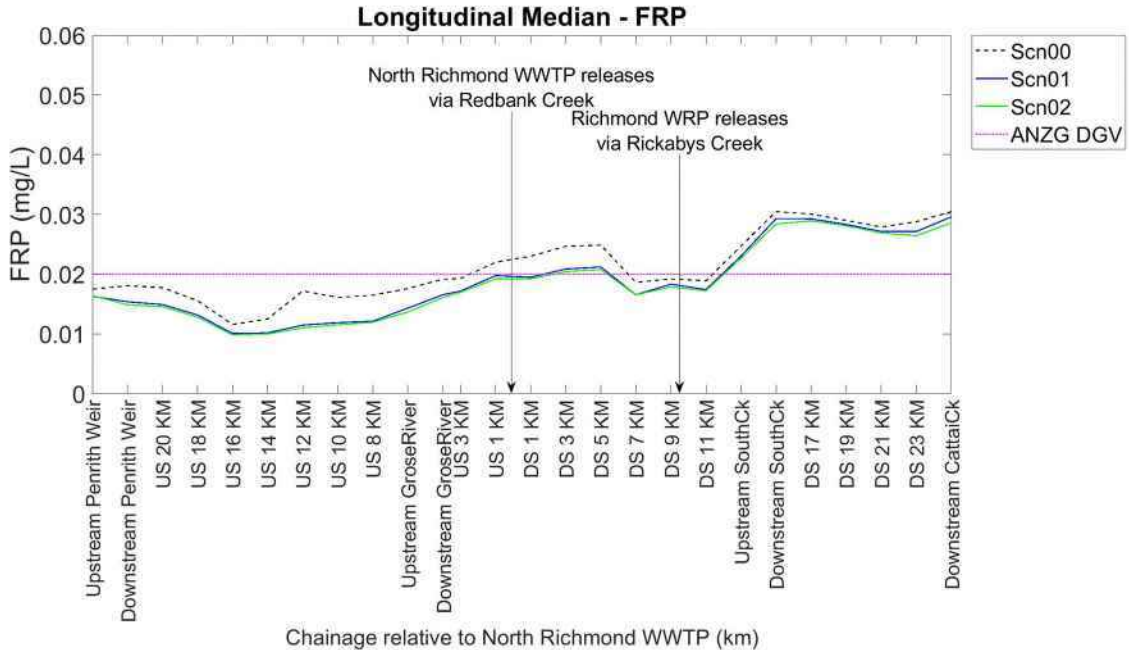


Figure 4-10 Longitudinal profile of predicted annual median Filterable Reactive Phosphorus concentrations (wet year)

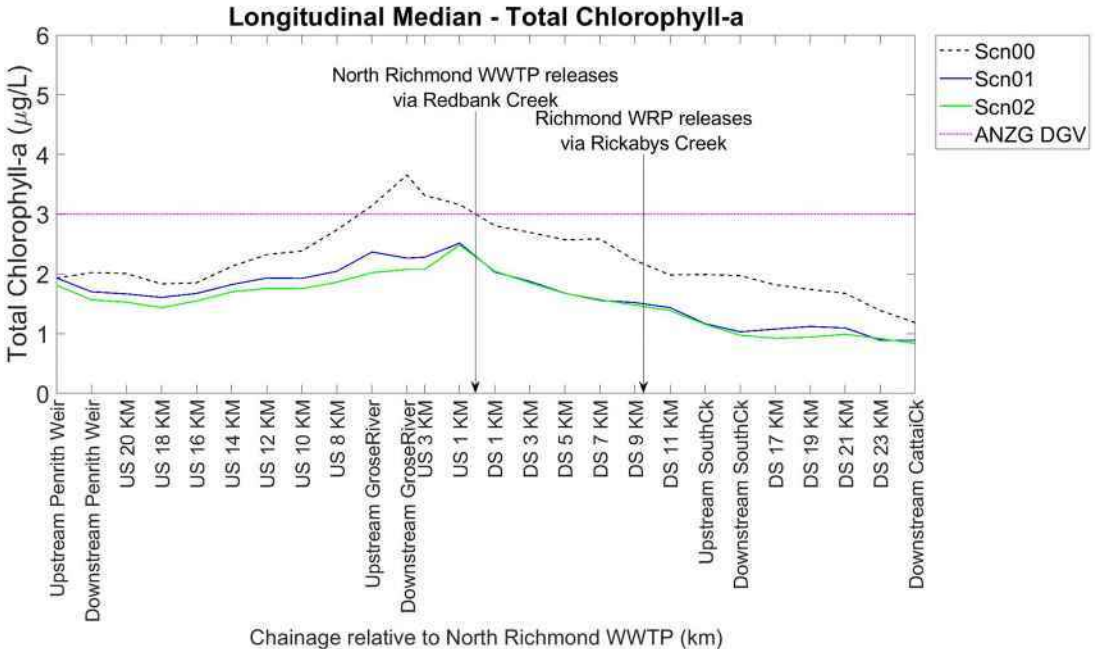


Figure 4-11 Longitudinal profile of predicted annual median Chlorophyll a concentrations (dry year)

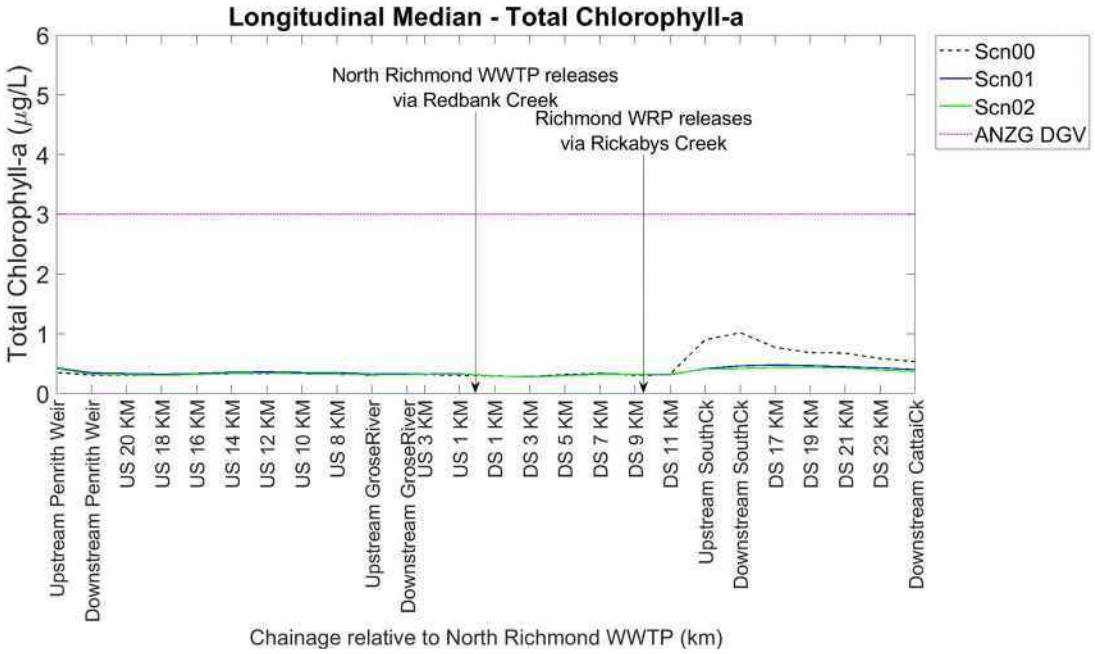


Figure 4-12 Longitudinal profile of predicted annual median Chlorophyll a concentrations (wet year)

5 Conclusions

To support the Review of Environmental Factors, hydrodynamic and water quality modelling has been applied to assist understanding of the potential impacts on water quality in the receiving waterways of the Hawkesbury River.

More specifically, the modelling has allowed for analysis of key water quality parameters across three time horizons:

- 2020 representing current baseline conditions (no upgrade/diversion)
- 2036 representing forecast land use change and population growth (upgrade/diversion included)
- 2056 representing forecast land use change and population growth (upgrade/diversion included).

In addition to these scenarios, the modelling has also assessed the potential impacts over both representative wet and dry rainfall years. The analysis has also focussed on the river reaches from immediately below the Penrith Weir, downstream to the confluence with Cattai Creek.

Predicted nutrient loads

From analysis of the expected nutrient loads, the following conclusions are provided:

- Average Dry Weather Flows within the combined catchments are predicted to increase by ~47% and ~55% over the 2036 and 2056 time horizons, relative to the 2020 flows.
- As a result of the diversion and the upgrade to the Richmond WRP, the estimated nutrient loads to be released to the waterways are predicted to increase by the following lower proportions:
    - Total Nitrogen: increases of 7% (2036), and 14% (2056)
    - Total Phosphorus: increases of 27% (2036), and 35% (2056)

Predicted receiving water quality impacts

From analysis of the model results, the following conclusions are provided:

- The impacts of the planned diversion of flows from North Richmond WWTP, and the associated upgrade to Richmond WRP, are clearly evident in the results for the majority of the nutrient parameters analysed. Localised elevations in the vicinity, and downstream of the confluence with Redbank Creek are predicted under current conditions. These elevations are however not predicted under the future scenarios due to the diversion.
- Due to the characteristics of the treated water, as well as the comparative differences relative to ambient river concentrations, these impacts are most evident for the bioavailable

forms of nitrogen, however they can still be seen clearly in the results for both Total Nitrogen and Total Phosphorus.

- The increase in flows and loading from Rickabys Creek (and the associated releases from the upgraded Richmond WRP) can also be observed in many of the model results. Increases are predicted but to a lesser degree to the impacts from the North Richmond WWTP releases under current conditions. This is considered to be a combined result of the WRP upgrade and the lower comparative loading discussed above, greater tidal influence and flushing, as well as the far more significant nutrient loading from South Creek that is seen to become more influential with distance downstream of Rickabys Creek.
- Also of note are the influences on ambient nutrient concentrations from the other planned upgrades, most notably the upgrade of the Winmalee WWTP (~14 km upstream) and the Penrith WWTP (~22 km upstream). With the combined effects of these upgrades, the potential for greater compliance with many of the ANZG DGVs is predicted.
- With respect to algal growth, the immediate and more localised responses in Chlorophyll *a* levels are not as evident as shown in the nutrient analysis due to the more complex processes involved. Nonetheless, the combined effects of the three planned upgrades, and the associated lower nutrient loads, provide for marked reductions in predicted Chlorophyll *a* concentrations throughout the river reaches analysed.

Appendix D – Biodiversity Study

Richmond Precinct

Flora and fauna assessment

FINALREPORT

Prepared for Sydney Water

15 November 2021

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- Sydney Water: Jill Berwick and Julia Green
- Department of Agriculture, Water and the Environment for access to the Protected Matters Search Tool of the Australian Government
- NSW Environment, Energy and Science Group for access to the BioNet Atlas of NSW Wildlife.
- NSW Department of Primary Industries Fisheries for access to the predicted distribution maps for threatened species and fish communities.

Biosis staff involved in this project were:

- Averill Wilson and Lawrence Boland (assistance in the field)
- Sonika Kumar (mapping)

Contents

Tables

Figures

Glossary

BC Act	*NSW Biodiversity Conservation Act 2016*
Biosecurity Act	*Biosecurity Act 2015*
BOS	Biodiversity Offsets Scheme
CEEC	Critically Endangered Ecological Community
CM Act	*Coastal Management Act 2016*
DBH	Diameter at breast height
DCP	Development Control Plan
DAWE	Department of Agriculture Water and the Environment
DPI	Department of Primary Industries
DPIE	NSW Department of Planning, Industry and Environment
EEC	Endangered Ecological Community
EES	NSW Environment, Energy and Science Group
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FM Act	*Fisheries Management Act 1994*
KTP	Key Threatening Process
LEP	Local Environmental Plan
LGA	Local Government Area
LLS	Local Land Services
NSW	New South Wales
PCT	Plant Community Type
SEPP	NSW State Environmental Planning Policy
SIC	Significant Impact Criteria
SIS	Species Impact Statement
study area	The extent of expected direct and indirect impact for the upgrades.
TEC	Threatened Ecological Community
ToS	Test of Significance
WM Act	*Water Management Act 2000*

Summary

Biosis Pty Ltd was commissioned by Sydney Water to undertake a flora and fauna assessment of Richmond Water Recycling Plant (WRP) and the North Richmond Waste Water Treatment Plant (WWTP), including a connecting corridor containing a transfer main between the two sites (subject site). The Richmond WRP and North Richmond WWTP are both located within the Hawkesbury City Council Local Government Area, approximately 50 kilometres north-west of the Sydney CBD.

The subject site, encompasses the property boundaries defining both the Richmond Water Recycling Plant (WRP) and the North Richmond Waste Water Treatment Plant (WWTP), and also includes a 7 kilometre by 20 - 30 metre corridor connecting the two facilities and nominated sites of impact within the adjacent area (the study area). This assessment approach has been undertaken to allow for assessment of both the subject site as well as any additional areas in the broader study area which are likely to be affected by the proposal, either directly or indirectly. Identified constraints will be used to guide detailed design, with an emphasis on avoiding impacts where feasible.

The study area encompasses 1.28 hectares of native vegetation, while the remaining 10.60 hectares consist of Urban Native/Exotic within highly disturbed areas and landscaped road verges.

Ecology values

Key ecological values include:

- Five Threatened ecological communities:
  - *Cumberland Plain Woodland* (Critically Endangered Ecological Community (CEEC), BC Act).
  - *River-Flat Eucalypt Forest* (Endangered Ecological Community (EEC), BC Act).
  - *Shale/Sandstone Transition Forest* (CEEC, BC Act).
  - *Swamp Oak Floodplain Forest* (EEC, BC Act).
  - *Coastal Freshwater Wetlands* (EEC, BC Act).
- Habitat for the following threatened fauna species:
  - Swift Parrot.
  - Hollow-dependant microbats.
- Five waterways within the study area in low condition including:
  - Hawkesbury River, a Strahler order nine waterway.
  - Redbank Creek, a Strahler order five waterway.
  - One Strahler order three waterway.
  - Three unnamed Strahler order one waterways.
- Four Hollow-bearing trees.

Recommendations

The primary measure for the development to minimise impacts to ecological values on the site is to minimise removal of native vegetation and habitat and avoid disruption to the habitat linkages in study area. To retain these values they need to be considered in the design process.

1 Introduction

1.1 Project background

Biosis Pty Ltd (Biosis) was commissioned by Sydney Water to undertake a flora and fauna assessment of the Richmond Water Recycling Plant (WRP) and the North Richmond Waste Water Treatment Plant (WWTP), including a connecting corridor containing a transfer main between the two sites and other nominated sites of impact in the adjacent area (Figure 1).

Biosis understands the Richmond WRP and North Richmond WWTP Currently service two independent wastewater systems. Sydney Water is proposing to upgrade the service capacities at Richmond WRP to take flows from North Richmond WWTP and to accommodate future growth in the catchment.

The upgrades include:

- Expansion of the Richmond WRP confined within the current boundaries of the plant.
- Construction of a new wastewater pump station to replace the existing pump station (SP0096) along the southern boundary of the North Richmond WWTP.
- Installation of a transfer main connecting the North Richmond Pump Station (SP0096) to the Richmond WRP containing a 7 kilometre by 10-15 metre construction corridor.
- Network capacity upgrades in North Richmond, including:
  - 540 metres of pipe duplication associated with DN225 with maximum construction corridor of 15 metres.
  - 230 metres of pipe amplification DN300 to DN375 with a maximum construction corridor of 15 metres.
  - 172 metres of pipe duplication associated with DN300 with a maximum construction corridor of 15 metres.
- Emergency Relief Structures (ERS) and pipework upgrade, including:
  - 65 metres of pipe amplification associated with DN300 and DN525 with a maximum construction corridor of 15 metres.
- Under boring of pipeline primarily to avoid sensitive waterways including Redbank Creek and Hawkesbury River.

The works required present potential impacts to existing vegetation located within the Richmond WRP and North Richmond WWTP and along the connecting transfer main corridor where the pipeline is open trenched.

The objective of this flora and fauna assessment is to determine impacts to threatened biota located within the study area, and to provide guidance on reducing native vegetation removal and other ecological impacts.

1.2 Scope of assessment

The objectives of this investigation are to:

- Describe the vascular flora (ferns, conifers, and flowering plants), vertebrate fauna (birds, mammals, reptiles, frogs).

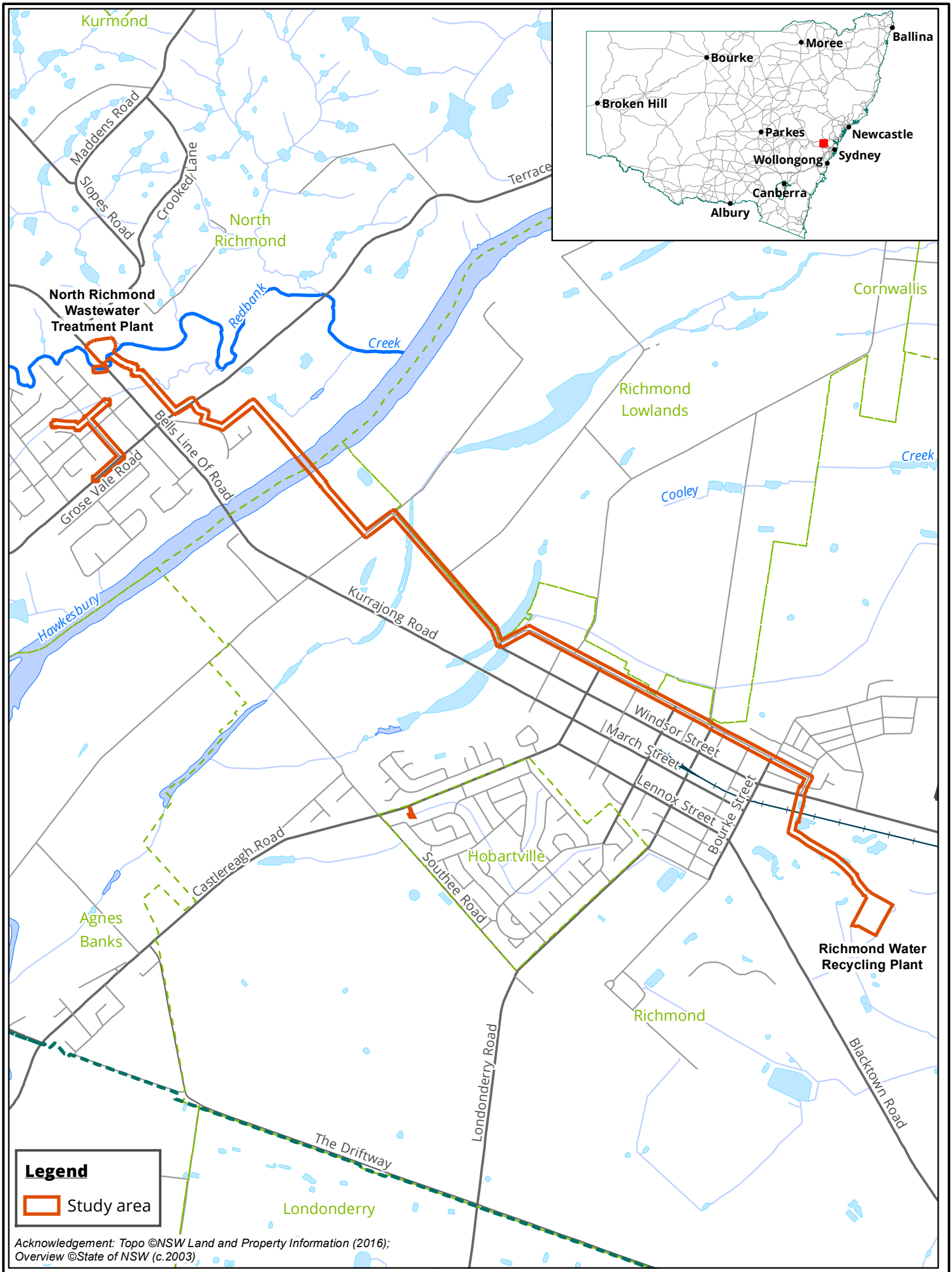
- Map native vegetation and other habitat features.
- Review the implications of relevant biodiversity legislation and policy.
- Identify potential implications of the proposed development and provide recommendations to assist with development design.
- Recommend any further assessments of the site that may be required (such as targeted searches for threatened biota).

1.3 Location of the study area

The Richmond WRP and North Richmond WWTP are both located within the Hawkesbury City Council Local Government Area, approximately 50 kilometres north-west of the Sydney CBD. The Richmond WRP is located approximately 1.6 kilometres south-east of the Richmond town centre, while the North Richmond WWTP is located approximately 800 metres north-west of the North Richmond town centre, with the proposed transfer main connecting the two wastewater facilities running in a predominantly east west direction. The study area also includes nominated sites located in the greater North Richmond locality (Figure 1). The Richmond WRP and North Richmond WWTP are currently zoned SP2 – Infrastructure under the *Hawkesbury Local Environmental Plan 2012* (LEP). The pathway corridor for the connecting transfer main incorporates numerous land use zones as listed under the Hawkesbury LEP 2012.

The study area is within the:

- Sydney Basin Bioregion.
- Hawkesbury-Nepean Catchment.
- Greater Sydney Local Land Services (LLS) Management Area.
- Hawkesbury City Council Local Government Area (LGA).



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

biosis

Figure 1 Location of the study area

Matter: 33990
Date: 12 November 2021,
Checked by: AlHW, Drawn by: SSK, Last edited by: amackegard
Location:P:\33900s\33990\Mapping\33990_F1_Locality.mxd

0 230 460 690 920 1,150
Metres

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Scale 1:30,000 @ A4, GDA 1994 MGA Zone 56

2 Methods

2.1 Database and literature review

Prior to completing the field investigation, information provided by Sydney Water as well as other key information was reviewed, including:

- Commonwealth Department of Agriculture, Water and Environment (DAWE) Protected Matters Search Tool for matters protected by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- NSW Environment, Energy and Science (EES) BioNet Atlas of NSW Wildlife, for items listed under the *Biodiversity Conservation Act 2016* (BC Act).
- The NSW Department of Primary Industries (DPI) Spatial Data Portal for Fisheries Management Act 1994 listed threatened species, populations and communities.
- NSW DPI *Biosecurity Act 2015* for Priority listed weeds for the Greater Sydney Local Land Services (LLS) area.
- EES Vegetation Information System (VIS) mapping, including:
  - *Interpretation Guidelines for the Native Vegetation Maps of the Cumberland Plain, Western Sydney* (NPWS 2002).
  - *Native Vegetation of Southeast NSW: A Revised Classification and Map for the Coast and Eastern Tablelands* (Tozer et al. 2010).

The implications for the project were assessed in relation to key biodiversity legislation and policy including:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- *Environmental Planning and Assessment Act 1979* (EP&A Act).
- *Biodiversity Conservation Act 2016* (BC Act).
- *Local Land Services Act 2013* (LLS Act).
- *Water Management Act 2000* (WM Act).
- *Fisheries Management Act* (FM Act).
- *Biosecurity Act 2015.* (Biosecurity Act).
- *Coastal Management Act 2016.*
- SEPP (Coastal Management) 2018.
- SEPP (Vegetation in Non-Rural Areas) 2017.
- Sydney Regional Environmental Plan No. 20 – Hawkesbury-Nepean River (No 2 – 1997).
- *Hawkesbury Local Environmental Plan 2012.*
- *Hawkesbury Development Control Plan 2002.*
- Sydney Water's Biodiversity Offset Guidelines 2019.

2.2 Field investigation

A field investigation of the study area was undertaken on the 8 April, 13 April, and 19 April 2021 by Averill Wilson and Lawrence Boland. Vegetation within the study area was surveyed using the random meander technique (Cropper 1993) over 17 person hours.

Two areas were unable to be accessed during the field investigations and therefore, the assessment was limited to a desktop assessment (Figure 2).

General classification of native vegetation in NSW used in this report is based on the classification system in Keith (2004) which uses three groupings of vegetation: vegetation formation, vegetation class and vegetation type, with vegetation type the finest grouping. The grouping referred to in this report is Plant Community Type (PCT) as defined by the Biodiversity Assessment Method (BAM) (OEH 2017), and has been the standard used across NSW since 2016.

The vegetation types, within the study area, were stratified into PCTs broadly based on previous vegetation mapping, and the vegetation boundaries marked with a hand-held GPS in the field. Appropriate PCTs were selected on the basis of species composition and structure, known geographical distribution, landscape position, underlying geology, soil type, and any other diagnostic features.

A habitat-based assessment was completed to determine the presence of suitable habitat for threatened species previously recorded (EES 2021) or predicted to occur (Commonwealth of Australia 2021) within 5 kilometres. This list was filtered according to species descriptions, life history, habitat preference and soil preference to determine those species most likely to be present within the study area.

2.2.1 Permits and licences

The flora and fauna assessment was conducted under the terms of Biosis' Scientific Licence issued by the Environment, Energy and Science Group under the *National Parks and Wildlife Act 1974* (SL100758, expiry date 31 March 2022). Fauna survey was conducted under approval 11/355 from the NSW Animal Care and Ethics Committee (expiry date 31 January 2022).

3 Results

The Richmond WRP and North Richmond WWTP contain small patches of native vegetation, with the landscape within the facility boundaries dominated by Sydney Water infrastructure assets. The proposed corridor for the transfer main contains a mixture of land uses including cleared land for agricultural, commercial and residential purposes, as well as areas for both public and private recreational activities.

3.1 Regional soil landscape

Regional soil landscape mapping indicates that the broader study area occurs primarily on Hawkesbury - Nepean Terrace Gravels, Hawkesbury – Nepean Channels & Floodplains and Cumberland Plain (Mitchell 2002). The composition of the soil is highly influential on the vegetation communities observed.

The Richmond WRP and the eastern section of the transfer main corridor is supported by Hawkesbury – Nepean Terrace Gravels and is characterised by three levels of river terrace dating into the Tertiary. General elevation is 20 to 45 metres, local relief 10 metres. Planar, poorly drained terraces with harsh texture-contrast soils and heavy clays in swamps and cut-off meanders (Mitchell 2002).

The western section of the transfer main corridor is influenced by the Hawkesbury – Nepean Channels and Floodplains which is characterised by meandering channel and moderately wide floodplain of the Hawkesbury and Nepean rivers on Quaternary sand and gravel. Sand is dominant upstream of the Warragamba River junction, general elevation 0 to 20 metres, local relief <10 metres. Undifferentiated alluvial sand to poorly structured gradation profiles of sandy loam or clay loam (Mitchell 2002).

The North Richmond WWTP occurs primarily on Cumberland Plain which is characterised by low rolling hills and valleys in a rain shadow area between the Blue Mountains and the coast on horizontal Triassic shales and lithic sandstones forming a down-warped block on the coastal side of the Lapstone monocline. Intruded by a small number of volcanic vents and partly covered by Tertiary river gravels and sands (Hawkesbury-Nepean Terrace Gravels landscape). Quaternary alluvium along the mains streams. General elevation 30 to 120 metres, local relief 50 metres and sometimes affected by salt in tributary valley floors. Pedal uniform red to brown clays on volcanic hills. Red and brown texture-contrast soils on crests grading to yellow harsh texture-contrast soils in valleys (Mitchell 2002).

Vegetation located throughout the broader study area has been predominantly cleared for multiple activities, resulting in isolated plant communities with limited connectivity primarily restricted to riparian corridors. Large open paddocks exhibit evidence of historical clearing for agricultural enterprises, with vegetation fragmentation further attributed to the construction of hard barriers in residential and industrial areas and from various public and private recreational spaces.

3.2 Vegetation communities

Prior to the field investigation, Biosis confirmed that various native vegetation communities including five TECs have been mapped in the broader landscape (Tozer 2003, EES 2021), these include:

- *Cumberland Plain Woodland in the Sydney Basin Bioregion* (CEEC, EPBC Act and BC Act).
- *Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* (Endangered, EPBC Act and BC Act).

- *River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* (CEEC, EPBC Act and Endangered, BC Act).
- *Shale/Sandstone Transition Forest in the Sydney Basin Bioregion* (CEEC, EPBC Act and BC Act).
- *Freshwater Wetlands on Coastal Floodplains* (Endangered, BC Act).
- Urban Native and Exotic.

A key focus of the field investigation was to assess the vegetation of the study area against the final determinations for the above listed TECs to determine presence or absence.

The field investigation confirmed that the vegetation of the study area comprises five PCTs that conform to five separate TECs including:

- PCT 781 *Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion* which forms part of *Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* (EEC, BC Act).
- PCT 849 *Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion* which forms part of *Cumberland Plain Woodland in the Sydney Basin Bioregion* (CEEC, BC Act) however does not meet the listing requirements under the EPBC Act.
- PCT 835 *Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion* which forms part of *River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* (EEC, BC Act) however does not meet listing the requirements under the EPBC Act.
- PCT 1232 *Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion* forming part of Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC, BC Act) however does not meet the listing requirements under the EPBC Act.
- PCT 1395 *Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion* forming part of *Shale/Sandstone Transition Forest in the Sydney Basin Bioregion* (CEEC, BC Act) however does not meet the listing requirements under the EPBC Act.

Urban Native and Exotic vegetation was witnessed throughout the remainder of the study area. The structure, floristic composition and condition of these communities are described in (Table 1). A list of flora and fauna recorded within the study area are provided in Appendix 1 and Appendix 2.

Table 1 Vegetation communities of the study area

Freshwater Wetlands on Coastal Floodplains	
PCT	PCT 781 Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion.
Extent within study area	Approximately 0.38 ha of PCT 781 was recorded north of Richmond Golf Club between the train line and Windsor Street, Richmond NSW.
Description including fauna habitat	Freshwater Wetlands on Coastal Floodplains is characterised by the dominance of herbaceous plants and the absence of woody species. Vegetation composition is dependent on water movement within the landscape. Areas without standing water are dominated by low lying grasses and sedges, while large sedges and floating herbs populate areas subject to regular inundation. The community presented contained areas of standing water containing primarily native species including Broadleaf Cumbungi *Typha orientalis,* Common Reed *Phragmites australis, Juncus usitatus* and *Schoenoplectiella mucronata*. The community has seen significant weed incursion along the boundaries of the standing water including Blackberry, Lantana, Broad-leaved Privet, Small-leaved Privet and African Olive.
Condition	The vegetation community within the study area is in poor condition due to the presence of a tree canopy containing woody perennials comprised of exotic species and the abundance of exotic species within the groundcover layer.
Associated soils, rainfall and landscape position	Freshwater Wetlands on Coastal Floodplains occurs on shallow sandy alluvium inundated by freshwater or slightly brackish water below 10 m elevation.
Threatened ecological community	Commonwealth EPBC Act: Not listed. NSW BC Act: Endangered. The community meets the key diagnostic features as described in the scientific determination for the EEC listed under the BC Act due to species assemblages, presence of standing water and location on alluvial flats (NSW Scientific Committee 2004b).
Threatened species habitat	The Freshwater Wetlands community forms habitat for the Black Bittern.
Picture: Freshwater Wetlands on Coastal Floodplains	

River-Flat Eucalypt Forest	
PCT	PCT 835 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion.
Extent within study area	Approximately 1.18 ha of PCT 835 was recorded along Redbank Creek and adjacent to the north-east car park of the Panthers North Richmond property.
Description including fauna habitat	The community across the broader study area contains a tree canopy of Forest Red Gum and Broad-Leaved Apple. The location adjacent to the north-east car park of the Panthers North Richmond property contains a canopy of Forest Red Gum and non-endemic natives Silky Oak *Grevillea robusta* and Tallowwood *Eucalyptus microcorys*. A lower tree canopy consisting of Swamp Oak, White Cedar and Parramatta Wattle is present along Redbank Creek. The midstorey of the vegetation community across the broader study area is dominated by exotic species, including Castor Oil Plant, Privet and Lantana. The groundcover layer contains a composition of native and exotic species, such as Kidney Weed, *Cyperus brevifolia* and Weeping Grass.
Condition	River-Flat Eucalypt Forest within the study area is in poor condition due to the clearing of vegetation resulting in a weed dominant midstorey and groundcover layer.
Associated soils, rainfall and landscape position	River Flat Eucalyptus Forest occurs on streambanks and alluvial flats soils derived from Wianamatta Shale below an altitude of 160 m, with annual rainfall between 750 – 950 mm.
Threatened ecological community	Commonwealth EPBC Act: Does not meet threshold. Due to the vegetation composition of the understorey containing less than 30% of native species and poor ground cover richness, this community does not satisfy condition threshold for listing under the EPBC Act (DAWE 2020). NSW BC Act: Endangered. The community meets the key diagnostic features as described in the scientific determination for the EEC listed under the BC Act. While lacking diversity, key indicator species are reflective of the scientific determination for characterising River-Flat Eucalypt Forest under the BC Act (NSW Scientific Committee 2011).
Threatened species habitat	River-flat Eucalypt Forest is considered to provide habitat for the following threatened flora/fauna: • *Dillwynia tenuifolia,* Juniper-leaved Grevillea *Grevillea juniperina* subsp. *juniperina,* Nodding Geebung *Persoonia nutans*, *Pultenaea parviflora* . • Black Bittern, Cumberland Plain Land Snail *Meridolum corneovirens,* Dusky Woodswallow *Artamus cyanopterus cyanopterus,* Eastern Coastal Free-tailed Bat *Micronomus norfolcensis,* Flame Robin *Petroica phoenicea,* Glossy-black Cockatoo *Calyptorhynchus lathami,* Greater Broad-nosed Bat *Scoteanax rueppellii*, Koala *Phascolarctos cinereus,* Little Lorikeet *Glossopsitta pusilla*, Swift Parrot *Lathamus discolor,* Southern Myotis *Myotis macropus*, Varied Sittella *Daphoenositta chrysoptera Dillwynia tenuifolia*
Picture: River-flat Eucalypt Forest	

Cumberland Plain Woodland	
PCT	849 Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion
Extent within study area	Approximately 0.59 ha of PCT 849 was recorded in fragmented areas across the broader study area, primarily located along the eastern and north-eastern boundary of the North Richmond WWTP and behind the industrial complex on 84 Bells Line of Road, North Richmond.
Description including fauna habitat	The community present across the broader study area contains a canopy dominated by Forest Red Gum, with intermittent specimens of Grey Box present. The midstorey is mainly populated with exotic shrubs, such as Lantana Lantana camara and Broad-leaved Privet Ligustrum lucidum, interspersed with individual Parramatta Wattle Acacia parramattensis and Black Wattle Acacia decurrens specimens. The groundcover contains a combination of grasses and forbs comprised of exotic and native species.
Condition	Cumberland Plain Woodland within the study area is in poor condition due to historical clearing of vegetation for agricultural endeavours combined with more recent industrial activities. Disturbance to the area, combined with nutrient enriched run off has provided opportunity for exotic species to dominate the vegetative composition of the plant community.
Associated soils, rainfall and landscape position	Cumberland Plain Woodland occurs on clay/loam soils derived from Wianamatta Shale and is restricted to the Cumberland Plain, Western Sydney, at low altitudes primarily below 150 m receiving an average rainfall between 750 and 950 millimetres per annum.
Threatened ecological community	Commonwealth EPBC Act: Does not meet threshold. Due to the species composition of the perennial understorey containing less than 30 % of native perennials, this community does not satisfy the condition threshold for listing under the EPBC Act (Threatened Species Scientific Committee 2009). NSW BC Act: Critically Endangered. The community meets the key diagnostic features as described in the scientific determination for the CEEC listed under the BC Act due to species assemblages recorded, occurrence over soils derived from Wianamatta Shale and located in the Cumberland Plain (NSW Scientific Committee 2009). While lacking diversity, key indicator species are reflective of the scientific determination for characterising Cumberland Plain Woodland under the BC Act.
Threatened species habitat	The Cumberland Plain Woodland of the study area is considered to provide marginal habitat for the following threatened flora/fauna: • *Dillwynia tenuifolia,* Juniper-leaved Grevillea, Nodding Geebung, *Pultenaea parviflora,* • Cumberland Plain Land Snail, Dusky Woodswallow, Eastern Coastal Free-tailed Bat, Flame Robin, Glossy-black Cockatoo, Greater Broad-nosed Bat, Koala, Little Lorikeet, Southern Myotis, Varied Sittella, Swift Parrot
Picture: Cumberland Plain Woodland	

Swamp Oak Floodplain Forest	
PCT	PCT 1232 Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion
Extent within study area	Approximately 0.19 ha of PCT 1232 was recorded adjacent to Pugh's Lagoon, Richmond and Hawkesbury River.
Description including fauna habitat	Swamp Oak Floodplain Forest is characterised by a dense to sparse tree canopy almost exclusively of Swamp Oak, with Lilly Pilly *Acmena smithii* and *Melaleuca* sp. present as localised subdominant species. The midstorey is sparsely populated and is characterised by vines, such as the Common Silkpod *Parsonsia straminea* and Scrambling Lily *Geitonoplesium cymosum*, with the composition of the understorey dependent on groundwater salinity. The community present across the broader study area is populated exclusively by mature Swamp Oak trees with an absence of a midstorey stratum. The understorey is heavily modified and is thinly colonised by exotic Couch Grass *Cynodon dactylon* and Winter Grass *Poa annua*.
Condition	The vegetation community within the study area is in medium condition due to the dominant canopy of Swamp Oaks and the absence of exotic species. However, evidence of damage to the community was present due to recent flooding events.
Associated soils, rainfall and landscape position	Swamp Oak Floodplain Forest occurs on waterlogged and periodically flooded alluvium deposits derived from clay-loam and sandy-loam soils where groundwater is sub-saline to saline at elevations up to 50 m.
Threatened ecological community	Commonwealth EPBC Act: Does not meet threshold. The patch size threshold of this community does not satisfy the condition threshold for listing under the EPBC Act (DEE 2018). NSW BC Act: Endangered. The community meets the key diagnostic features as described in the scientific determination for the EEC listed under the BC Act due to species assemblages recorded, underlying soil composition and broader geographic influences. The presence of key indicator species are reflective of the scientific determination for characterising Swamp Oak Floodplain Forest under the BC Act (NSW Scientific Committee 2004).
Threatened species habitat	The Swamp Oak Floodplain is considered to provide marginal habitat for the following threatened fauna: • Black Bittern • Gang-gang Cockatoo • Glossy-black Cockatoo
Picture: Swamp Oak Floodplain Forest	

Shale/Sandstone Transition Forest	
PCT	PCT 1395 Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion
Extent within study area	Approximately 0.58 ha of PCT 1395 was recorded within the North Richmond golf course along a watercourse.
Description including fauna habitat	Shale/Sandstone Transition Forest species composition is highly dependent on geographic location and contains a varied canopy containing Forest Red Gum *Eucalyptus tereticornis*, Grey Gum *Eucalyptus punctata*, Broad-leaved Ironbark Ironbark *Eucalyptus fibrosa* and Narrow-leaved Ironbark *Eucalyptus crebra*. A variable sub canopy may be present containing species including Black She-oak *Allocasuarina littoralis*, Forest She-oak Allocasuarina torulosa and Sickle Wattle *Acacia falcata*. The underlying soil profile is highly influential on the understorey floristic composition, which varies from a shrub dominant layer to dense grassland. The community present across the broader study area contains a tree canopy of Broad-leaved Ironbark, Forest Red Gum, Narrow-leaved Ironbark with a lower canopy of Black She-oak. The midstorey and groundcover layer are absent due to recreational activities in the area.
Condition	Shale/Sandstone Transition Forest within the study area is in poor condition due to the clearing of the midstorey and groundcover layers.
Associated soils, rainfall and landscape position	Shale/Sandstone Transition Forest occurs on clay soils derived from Wianamatta shale predominantly on the margins of the Cumberland Plain, Sydney, where the underlying sandstone strata are near the surface. Cumberland Shale Sandstone Transition Forest is found up to 350 m ASL in areas where mean annual rainfall ranges from 800 to 1100 mm.
Threatened ecological community	Commonwealth EPBC Act: Does not satisfy threshold. Due to the understorey containing less than 30% of native species, this community does not satisfy the condition threshold for listing under the EPBC Act (DoE 2014). NSW BC Act: Critically Endangered. The community meets the key diagnostic features as described in the scientific determination for the EEC listed under the BC Act. While lacking diversity, key indicator species are reflective of the scientific determination for characterising Shale/Sandstone Transition Forest under the BC Act (NSW Scientific Committee 2019).
Threatened species habitat	The Shale/Sandstone Transition Forest is considered to provide marginal habitat for the following threatened fauna: • Black Bittern • Flame Robin • Gang-gang Cockatoo • Glossy-black Cockatoo • Swift Parrot • Varied Sittella
Picture: Shale/Sandstone Transition Forest	

Urban and Exotic	
PCT	None.
Extent within study area	Approximately 10.60 ha of Urban and Exotic vegetation is present within the broader study area.
Description including fauna habitat	Areas of Urban and Exotic vegetation in the study area is characterised by cleared pastoral land for grazing, weed dominant midstorey within plant communities, ornamental plantings, weed populations along arterial roads and non-endemic natives.
Condition	The community is in poor condition due to the presence of exotic species and non-endemic natives.
Associated soils, rainfall and landscape position	Non applicable.
Threatened ecological community	Non applicable.
Threatened species habitat	This community provides marginal habitat for the following Little Lorikeet and Grey-headed Flying Fox in the form of flowering feed trees.
Picture:	

3.3 Aquatic habitats

Aquatic habitats within the study area are considered to be in a poor state, and include two main watercourses, Redbank Creek and Pugh's Lagoon, as well as several smaller waterways throughout the study area. Habitat for native aquatic species was not observed at any watercourses within the study area with significant channel modification and erosion seen at all sites.

Hawkesbury River supports low quality vegetation on both sides of bank with large patches of exotic grassland species including Kikuyu *Cenchrus clandestinus.*

Redbank Creek supports a low condition patch of River-flat Eucalypt Forest (EEC) within the study area, with large patches of weeds such as Broad-leaved Privet and Small-leaved Privet present. Both Redbank Creek and Hawkesbury River will be underbored to reduce impact on sensitive environments and Key Fish Habitat.

Pugh's Lagoon was highly modified in the study area, with a small roadway traversing the lagoon which was dominated by exotic species on either side of the road. Downstream of the study area the banks of the lagoon were highly modified, with the majority of the riparian corridor consisting of maintained recreation areas.

Large sections of eroded bank were visible across most waterways within the study area, which is indicative of poor bank stability during higher seasonal flow periods. This is considered to be a result of the poor riparian vegetation structure and increased flows associated with the urbanisation of waterways. The dominance of exotic vegetation species in conjunction with the disturbed nature of the waterway are indicative of low quality aquatic habitats. No species listed as noxious under the FM Act were observed within the study area.

3.4 Threatened species

Background searches identified 8 threatened flora species and 18 threatened fauna species recorded (EES 2021) or predicted to occur (Commonwealth of Australia 2021) within 5 kilometres of the study area. Those species considered most likely to have habitat within the study area based on the background research are as follows:

Flora

- Bynoe's Wattle *Acacia bynoeana* (Vulnerable, EPBC Act and Endangered, BC Act).
- *Dillwynia tenuifolia* (Vulnerable, BC Act).
- Juniper-leaved Grevillea *Grevillea juniperina* subsp. *juniperina* (Vulnerable, BC Act).
- *Micromyrtus minutiflora* (Vulnerable, EPBC Act and Endangered, BC Act).
- Nodding Geebung *Persoonia nutans* (Endangered, EPBC Act and BC Act).
- Spiked Rice-flower *Pimelea spicata* (Endangered, EPBC Act and BC Act).
- *Pultenaea parviflora* (Vulnerable, EPBC Act and Endangered, BC Act).
- Magenta Lilly Pilly *Syzygium paniculatum* (Vulnerable, EPBC Act and Endangered, BC Act).

Fauna

- Black Bittern *Ixobrychus flavicollis* (Vulnerable, BC Act).
- Cumberland Plain Land Snail *Meridolum corneovirens* (Endangered, BC Act).
- Dusky Woodswallow *Artamus cyanopterus cyanopterus* (Vulnerable, BC Act).
- Eastern Osprey *Pandion haliaeetus* (Vulnerable, BC Act).
- Flame Robin *Petroica phoenicea* (Vulnerable, BC Act).
- Glossy-black Cockatoo *Calyptorhynchus lathami* (Vulnerable BC Act).
- Greater Broad-nosed Bat *Scoteanax rueppellii* (Vulnerable, BC Act).
- Eastern Coastal Free-tailed Bat *Micronomus norfolkensis* (Vulnerable, BC Act).
- Southern Myotis *Myotis macropus* (Vulnerable, BC Act).
- Large-eared Pied Bat *Chalinolobus dwyeri* (Vulnerable, EPBC and BC Act).
- Eastern False Pipistrelle *Falsistrellus tasmaniensis* (Vulnerable, BC Act).

- Little Bent-winged Bat *Miniopterus australis* (Vulnerable, BC Act).
- Large Bent-winged Bat *Miniopterus orianae oceanensis* (BC Act).
- Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris* (BC Act).
- Koala *Phascolarctos cinereus* (Vulnerable, EPBC and BC Act).
- Little Lorikeet *Glossopsitta pusilla* (Vulnerable, BC Act).
- Swift Parrot *Lathamus discolour* (Endangered BC Act and Critically Endangered, EPBC Act).
- Varied Sittella *Daphoenositta chrysoptera* (Vulnerable, BC Act).
- White-bellied Sea-Eagle *Haliaeetus leucogaster* (Vulnerable, BC Act).
- Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris* (Vulnerable, BC Act).

An assessment of the habitat values of the study area is provided in Table 2 for threatened flora species and Table 3 for threatened fauna species, and discusses areas of value and potential impacts for all species with a medium or greater likelihood of occurrence, and determines the need for a Tests of Significance (ToS) for species listed under the BC Act, or Significant Impact Criteria (SIC) Assessment for species listed under the EPBC Act.

Table 2 Assessment of habitat for threatened flora species

Species	Local distribution and habitat requirements	Likelihood of occurrence	Justification
Acacia bynoeana	Has been recorded approximately 800 m from the study area. *Acacia bynoeana* is usually found in heath and dry sclerophyll forest on sandy soils in open areas.	Low	The characteristics of the soil profiles located across the study area combined with associated vegetation communities do not form a requirement for this species. Furthermore, the subsequent field survey did not detect the species. No further assessment required.
Dillwynia tenuifolia	Has been recorded approximately 1.5 km from the study area. *Dillwynia tenuifolia* is a small shrub and is locally abundant within dry heath and adjacent transitional vegetation.	Low	Primarily occurs within Castlereagh Ironbark Forest and Shale Gravel Transition Forest which are not located within the study area. As such, habitat features which form a requirement for this species are not present within the study area. The subsequent field survey did not detect the species. No further assessment required.
Grevillea juniperina* subsp. *juniperina	Has been recorded approximately 1.5 km from the study area. *Grevillea juniperina* subsp. *juniperina* grows in vegetation communities associated with soils derived from Wianamatta Shale and Tertiary alluvium, including Cumberland Plain Woodland.	Medium	Habitat features which form a requirement for this species are present within the study area, however, subsequent field survey did not detect the species. No further assessment required.

Species	Local distribution and habitat requirements	Likelihood of occurrence	Justification
Micromyrtus minutiflora	Has been recorded approximately 1.2 km from the study area. This species occurs on alluvial soils in open forest.	Low	Primarily occurs within Castlereagh Scribbly Gum Woodland, Ironbark Forest and Shale/Gravel Transition Forest which are not located within the study area. The subsequent field survey did not detect the species. No further assessment required.
Persoonia nutans	Two sightings have been recorded approximately 400 m south from the corridor study area in Richmond. Larger populations are located approximately 2.5 km south of the Richmond study area in undisturbed vegetated areas. Occurs in a range of sclerophyll forest and woodland vegetation communities in western Sydney, with nearby populations restricted to aeolian and alluvial sediments.	Low	Primarily occurs in Agnes Banks Woodland, Castlereagh Scribbly Gum Woodland and in Cooks River / Castlereagh Ironbark Forests which are not located in the study area. Recorded populations are located in nearby areas containing heavily vegetated plant communities to the south of the study area. Furthermore, the subsequent field survey did not detect the species. No further assessment required.
Pimelea spicata	One sighting has been recorded within the North Richmond study area however, subsequent field survey did not detect the species. Plant communities are restricted to the Cumberland Plain and Illawarra areas on well-structured clay soils.	Low	Local populations occur in Cumberland Plain Woodland and Moist Shale Woodland and are associated with *Eucalyptus moluccana*. However, the impact site of the North Richmond study area is located south of the North Richmond WWTP within a residential area. The land is highly transformed and contains cultivated vegetation patches devoid of *Eucalyptus moluccana*. The habitat requirements of this species are therefore not present within the impact site of the North Richmond study area and the field survey did not detect the species. No further assessment required.
Pultenaea parviflora	Two sightings have been recorded approximately 2 km south of the Richmond study area in undisturbed vegetation communities. Occurs on the Cumberland Plain primarily within scrubby, dry heath areas tertiary alluvium or laterised clays.	Low	Primarily occurs on Castlereagh Ironbark Forest and Shale Gravel Transition Forest and transitional areas adjoining Castlereagh Scribbly Gum Woodland which are not present within the study area. The habitat requirements of this species are not present and the field survey did not detect the species. No further assessment required.

Species	Local distribution and habitat requirements	Likelihood of occurrence	Justification
Syzygium paniculatum	One sighting has been recorded approximately 850 m south of the North Richmond study area within a residential area. *Syzygium paniculatum* is a littoral rainforest tree largely restricted to a narrow linear coastal strip off the NSW coast in areas with sandy soils.	Low	The plant communities located within the study area do not form part of the habitat features and requirements for this species. Furthermore, the subsequent field survey did not detect the species. No further assessment required.

Based on the size of the study area, the survey effort is considered comprehensive to assess the presence of the flora species outlined in Table 2. Taking all of these factors into consideration, there is a low likelihood of occurrence for the above listed species.

Table 3 Assessment of habitat for threatened fauna species

Habitat feature	Threatened fauna association	Likelihood of occurrence or impact
Feed trees	Melaleucas, Eucalyptus and other flowering perennial species recorded in the study area may provide nectar resources suitable for a range of arboreal and flying fauna (Grey-headed Flying-fox and nectivorous bird species) whilst in flower. Allocasuarina and Casuarina species provide foraging resources for Glossy-black Cockatoo. *Angophora floribunda, Eucalyptus amplifolia, Eucalyptus moluccana* and *Eucalyptus tereticornis* are listed Koala feed trees (DECC 2008, DPIE 2021a) occurring within the study area.	Based on the recent records of species and resources located within the study area the following species have a moderate to high likelihood of occurrence: • Grey-headed Flying-fox • Little Lorikeet • Swift Parrot • Glossy-black Cockatoo Koala has been recorded 33 times in the locality since 2001, however, the majority of these records are located within the Blue Mountains National Park. A habitat assessment was undertaken as per the EPBC referral guidelines for Koalas. The study area scored a three on the habitat assessment tool, (with a five or more satisfying habitat critical to the survival of Koalas) and therefore the habitat provides low quality habitat for the species. Given the low number of records in the locality, historic nature of the records, disturbance within the study area, high threat of vehicle mortality and fragmentation within the study area it is unlikely that Koala would utilise the study area. Feed trees for Little Lorikeet, Grey-headed Flying-fox and Glossy-black Cockatoo are limited to removal of scattered trees and planted natives. These species are known to preference a wide range of species, all of which are found within adjacent good quality vegetation north, west and south of the study area. Therefore, although small amount of feed tree are proposed to be impacted it is unlikely that they are favoured resources and these species will not be subject to negative impacts. No further assessment required. As the proposed works are likely to impact habitat for Swift Parrot within areas that have been mapped as important areas for the species (DPIE 2021b) further assessments have been undertaken and can be found in Appendix 1 and 2. The assessment found a significant impact is unlikely to results from the project.

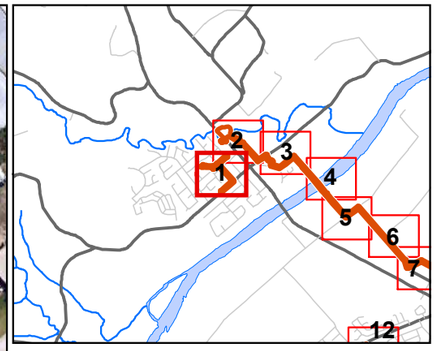
Habitat feature	Threatened fauna association	Likelihood of occurrence or impact
Hollow-bearing trees	Hollow-bearing trees containing small to medium size hollows within the study area (Figure 2) may provide suitable breeding resources for threatened hollow-dependant microbats and birds including: • Southern Myotis • Eastern False Pipistrelle • Little Bent-winged Bat • Eastern Coastal Free-tailed Bat • Yellow-bellied Sheathtail-bat • Greater Broad-nosed Bat • Little Lorikeet.	It is recommended that if possible, hollow-bearing trees be retained as an important habitat feature in the landscape that may be used by threatened microbats and birds, as well as providing feeding and perching habitat for other generic avifauna. Hollows-suitable to support Little Lorikeet are not present within the study area, furthermore it is expected large areas of better suited habitat are located to the north, south and west of the study area. As four Hollow-bearing Trees containing potential habitat for hollowed-dependent microbats are likely to be removed for the proposed work further assessments have been undertaken for these species and located in Appendix 1. The assessment found a significant impact is unlikely to results from the project.
Native vegetation	Native vegetation in the study area which includes both smooth and rough-barked trees may provide foraging habitat for Dusky Woodswallow, Gang-gang Cockatoo, Varied Sitella, Barking Owl, Powerful Owl, Flame Robin and White-throated Needletail.	The study area contains native vegetation which may provide foraging for these species on occasion. Previous impacts including clearing of the native understory, weed encroachment, adjacent development and current land use maintenance (mowing of mostly exotic ground cover) reduce the suitability of the habitat for long-term use by these species. Higher quality habitat occurs in surrounding areas such as the Blue Mountains to the West which includes areas of National Park. The proposed development will limit vegetation removal primarily to scattered trees and urban native environments. These areas, although may be occasionally used by the species, would not provide good quality habitat and is unlikely to be relied on by the species. Therefore, no further assessments required.
Leaf litter	Leaf litter under Eucalypt species can provide habitat for the Cumberland Plain Land Snail.	Forest Red Gum are host tree species which usually provide habitat for Cumberland Plain Land Snail. Habitat assessed within the study area was highly degraded and does not provide suitable habitat due to the removal of exfoliated bark and leaves and the ground cover of exotic grass which is subject to regular maintenance as a manicured lawn. No further assessments required.

Habitat feature	Threatened fauna association	Likelihood of occurrence or impact
Waterways	Major waterways and wetland areas within the study area include: • Pugh's Lagoon • Redbank Creek Waterways and wetland habitat within the study area provides suitable foraging for: • White-bellied Sea-eagle • Eastern Osprey • White-fronted Chat • Southern Myotis • Black Bittern.	White-bellied Sea-eagle and Eastern Osprey may forage over waterways but no nests were observed and the proposed works are therefore unlikely to impact on this species. White-fronted Chat may occur at the edges of Pugh's Lagoon and along muddy banks of the Hawkesbury River on occasion, however the habitat is considered marginal due to the presence of steep banks which provide limited open mudflat foraging areas. Freshwater Wetland areas did not provide suitable habitat for White-fronted Chat. Southern Myotis may forage from waterways within the study area, with the exception of mapped freshwater wetlands which were overgrown and did not provide suitable foraging habitat. The proposal is not expected to impact the extent or alter the extent or flow of the suitable waterways. Black Bittern prefers densely vegetated areas, with freshwater wetlands, and Pugh's Lagoon providing suitable habitat for this species. As impacts are limited to open areas of vegetation within waterways and impacts to better suited habitat will be avoided through under boring, no further assessment is required for these species.
Man-made structures	Culverts, bridges and storm water drains may provide habitat for roosting microbats.	Microbats may occur within these structures within or adjacent to the study area. However, the culverts in the study area are heavily disturbed and only provide marginal habitat for microbats. It is unlikely these habitats are utilised in the study area. No further assessments required.

Based on the size of the study area, the survey effort is considered comprehensive to assess habitat presence for the species outlined in Table 3. Taking all of these factors into consideration, further assessments have been undertaken in Appendix 1 and Appendix 2 which show that a significant impact is unlikely.

3.5 Priority weeds

Seven priority weeds for Greater Sydney LLS, which includes the Hawkesbury City Council LGA, that have been recorded in the study area are listed in Table 6, along with their associated Duty (where relevant to the project). This has been assessed further in Section 4.5.



Legend

- Study area
- Impact area
- No access
- Culvert

Plant Community Type

- PCT 835 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion
- PCT 849 - Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion
- Urban Native/Exotic

Figure 2.1 Ecological values of the study area

0 10 20 30 40 50

Metres

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 33990,
Date: 12 November 2021,
Checked by: AlHW, Drawn by: AM, Last edited by: amackegard
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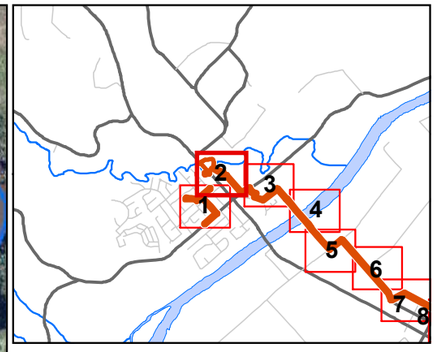

Legend

- Study area
- Impact area
- No access
- Hollow-bearing tree
- Key fish habitat

Plant Community Type

- PCT 835 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion
- PCT 849 - Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion
- Urban Native/Exotic

Figure 2.2 Ecological values of the study area

0 10 20 30 40 50

Metres

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 33990,
Date: 12 November 2021,
Checked by: AIHW, Drawn by: AM, Last edited by: amackegard
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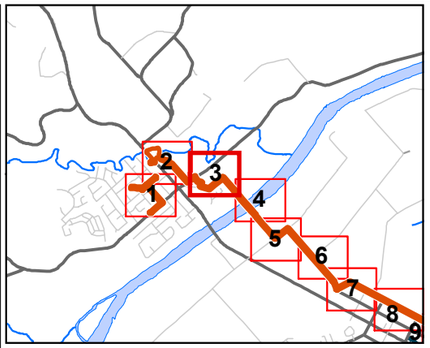

Legend

- Study area
- Impact area
- Key fish habitat

Plant Community Type

- PCT 835 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion
- Urban Native/Exotic

Figure 2.3 Ecological values of the study area

0 10 20 30 40 50

Metres

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 33990,
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Checked by: AIHW, Drawn by: AM, Last edited by: amackegard
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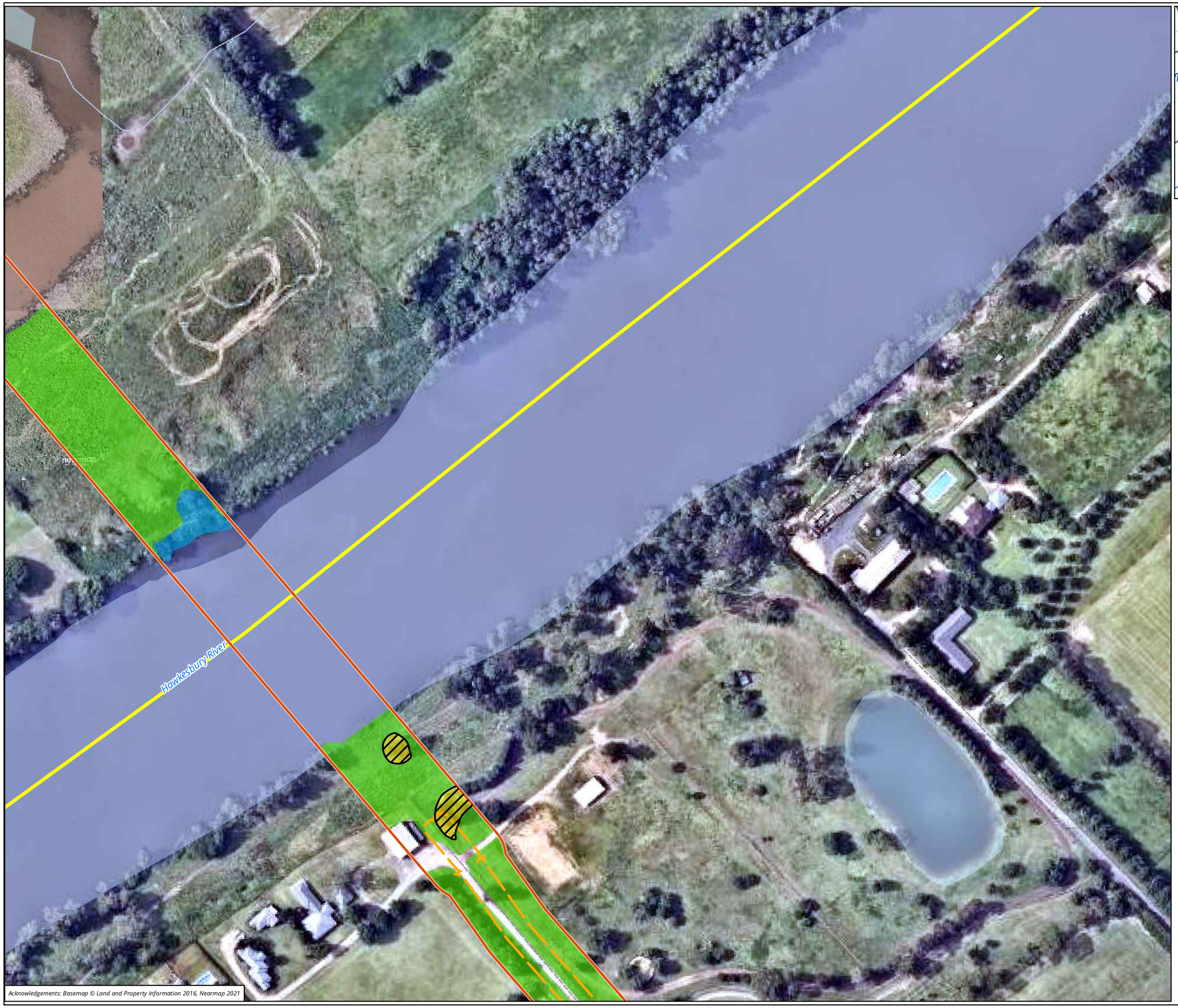

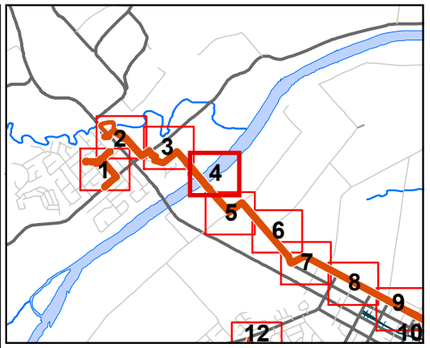

Legend

- Study area
- Impact area
- No access
- Key fish habitat

Plant Community Type

- PCT 1232 - Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion
- PCT 835 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion
- Urban Native/Exotic

Figure 2.4 Ecological values of the study area

0 10 20 30 40 50

Metres

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 33990,
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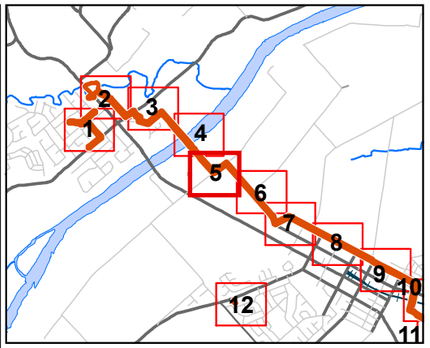

Legend

- Study area
- Impact area
- Coastal wetland (CM SEPP 2018)

Plant Community Type

- Urban Native/Exotic

Figure 2.5 Ecological values of the study area

0 10 20 30 40 50

Metres

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 33990,
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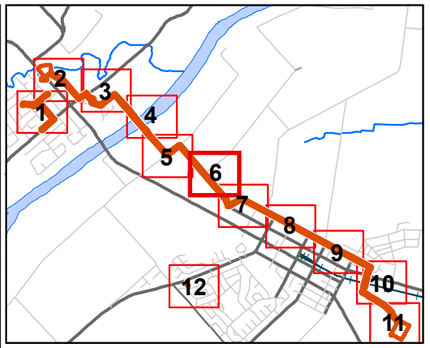

Legend

- Study area
- Impact area
- Coastal wetland (CM SEPP 2018)

Plant Community Type

- Urban Native/Exotic

Figure 2.6 Ecological values of the study area

0 10 20 30 40 50

Metres

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 33990,
Date: 12 November 2021,
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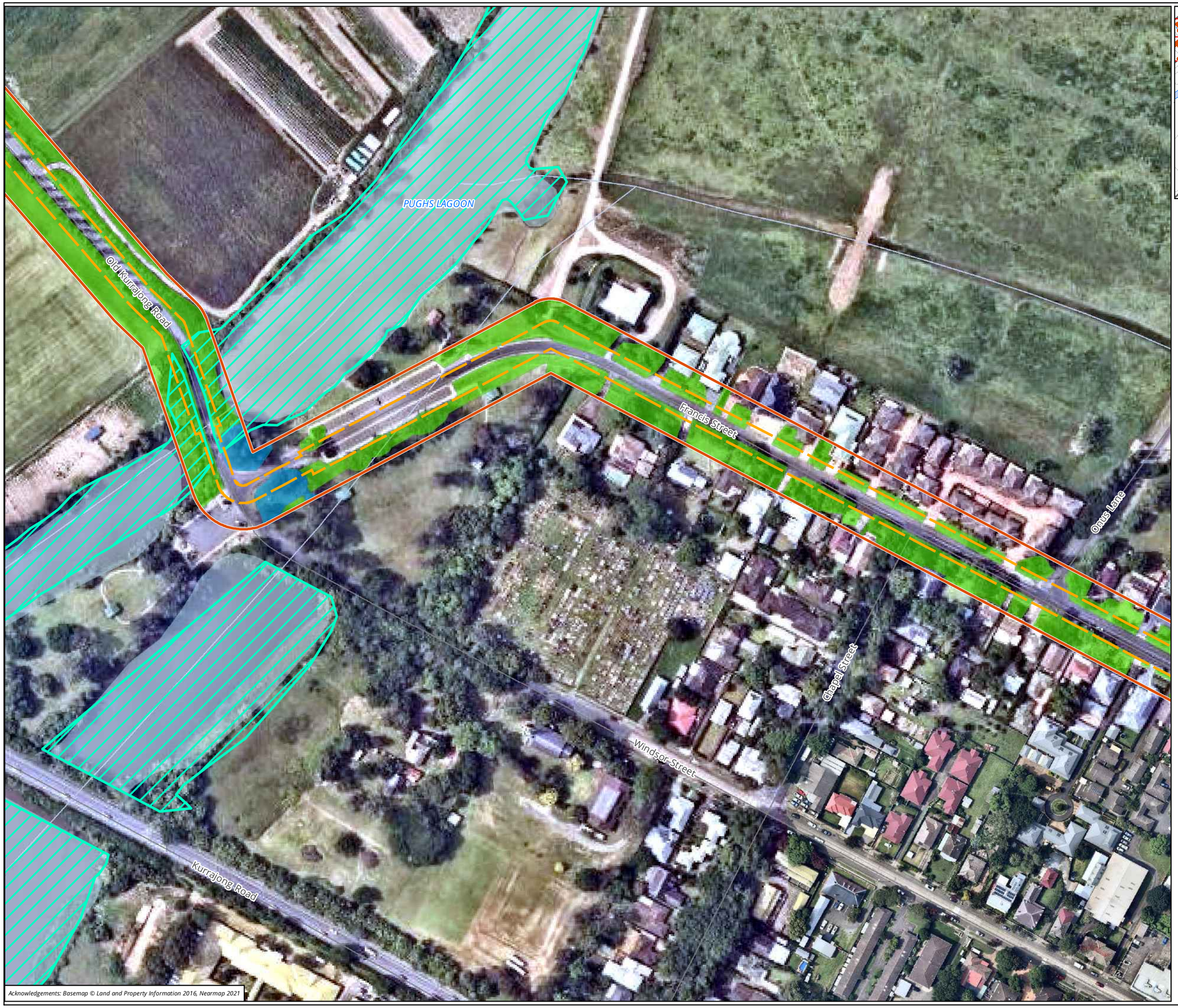

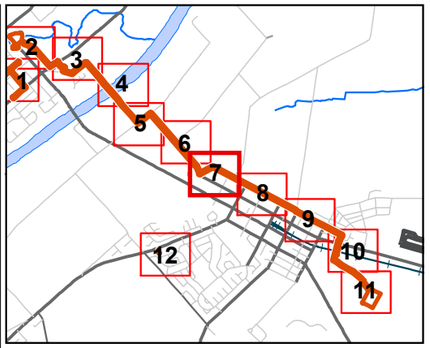

Legend

- Study area
- Impact area
- Coastal wetland (CM SEPP 2018)

Plant Community Type

- PCT 1232 - Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion
- Urban Native/Exotic

Figure 2.7 Ecological values of the study area

0 10 20 30 40 50

Metres

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 33990,
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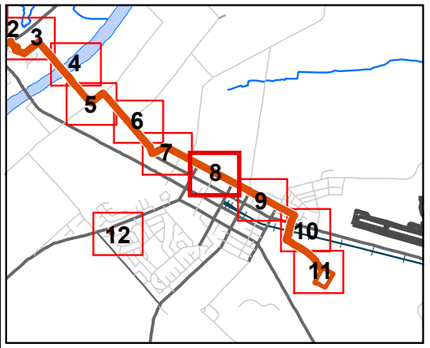

Legend

- Study area
- Impact area

Plant Community Type

- Urban Native/Exotic

Figure 2.8 Ecological values of the study area

0 10 20 30 40 50

Metres

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

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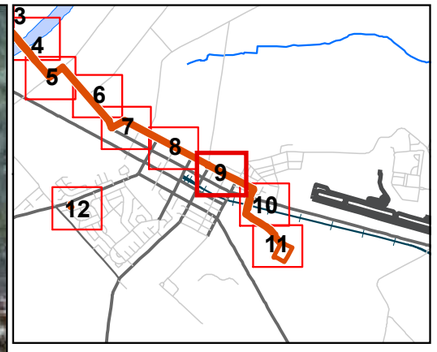

Legend

- Study area
- Impact area

Plant Community Type

- Urban Native/Exotic

Figure 2.9 Ecological values of the study area

0 10 20 30 40 50

Metres

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 33990,
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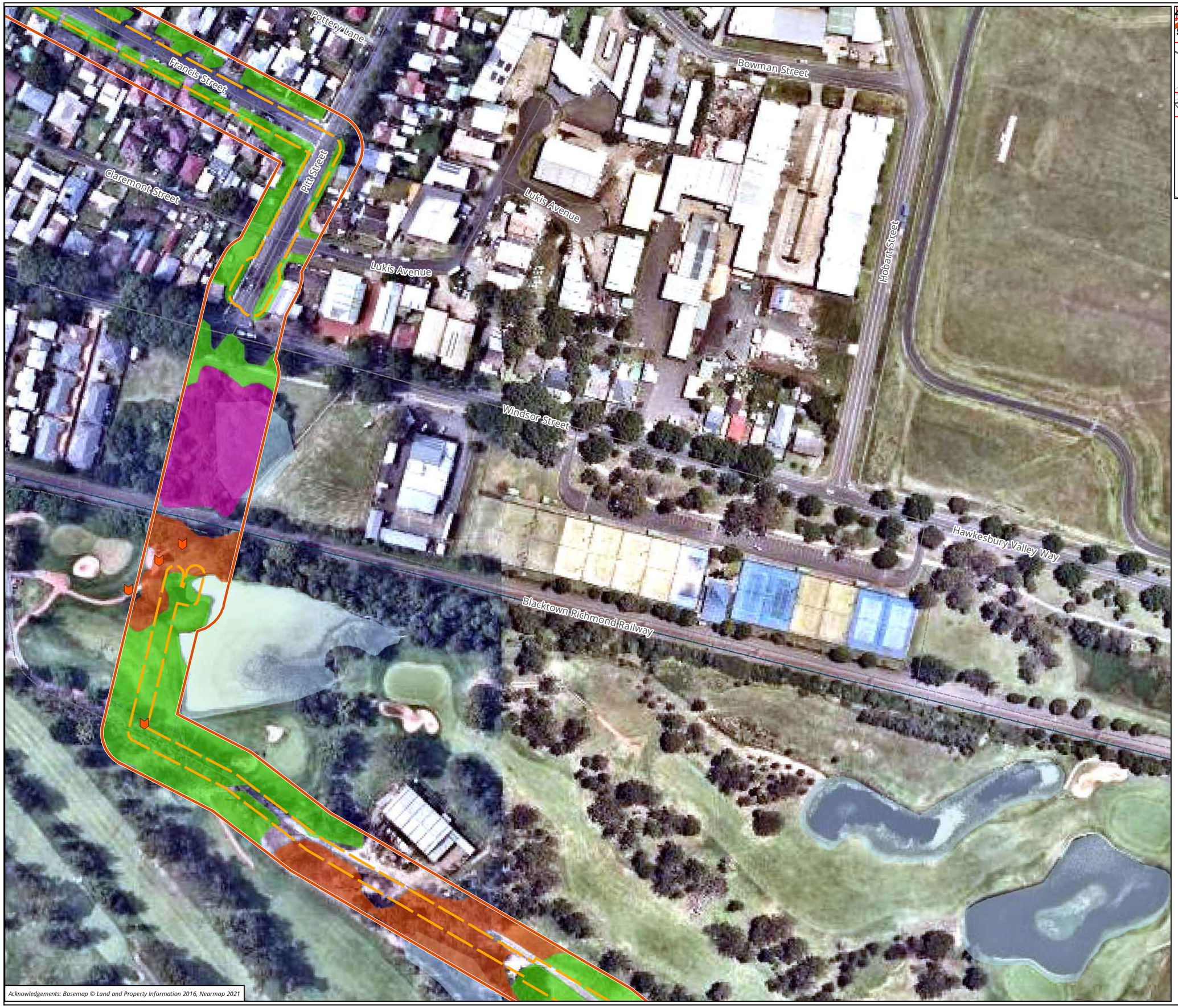

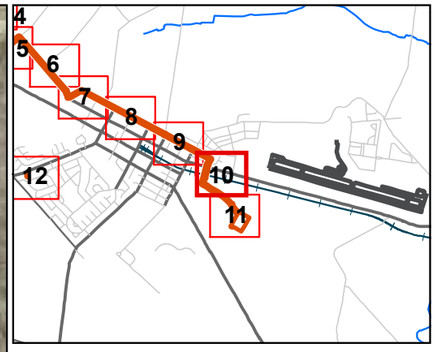

Legend

- Study area
- Impact area
- Hollow-bearing tree

Plant Community Type

- PCT 1395 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion
- PCT 781 - Coastal freshwate rlagoons of the Sydney Basin Bioregion and South East Corner Bioregion
- Urban Native/Exotic

Figure 2.10 Ecological values of the study area

0 10 20 30 40 50

Metres

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 33990,
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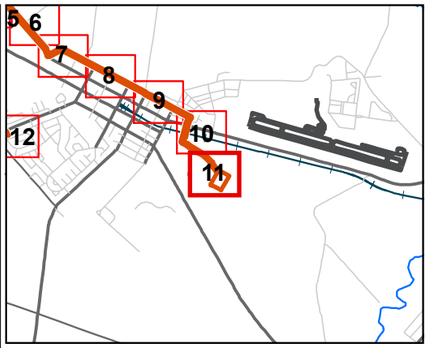

Legend

- Study area
- Impact area

Plant Community Type

- PCT 1395 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion
- PCT 835 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion
- Urban Native/Exotic

Figure 2.11 Ecological values of the study area

0 10 20 30 40 50

Metres

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 33990,
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Location: P:\33900s\33990\Mapping\33990_F2_EcoValues.mxd

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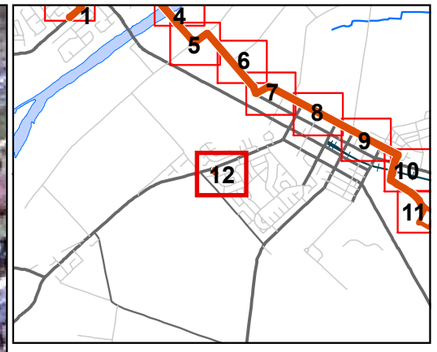

Legend

- Study area
- Impact area

Plant Community Type

- Urban Native/Exotic

Figure 2.12 Ecological values of the study area

0 10 20 30 40 50

Metres

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 33990,
Date: 12 November 2021,
Checked by: AIHW, Drawn by: AM, Last edited by: amackegard
Location: P:\33900s\33990\Mapping\33990_F2_EcoValues.mxd

4 Ecological impacts and recommendations

This section identifies the potential impacts of the proposed works on the ecological values of the study area and includes recommendations to assist Sydney Water to minimise potential indirect ecological impacts during implementation of the works.

The principal means to reduce impacts on ecological values will be to minimise removal of native vegetation and habitat. Under the current proposal, a total of 0.71 hectares of native vegetation is proposed to be impacted.

The ecological values impacted by the proposal are described in Table 4, which includes data requirements to Sydney Water to calculate any required non-statutory offsets

Table 4 Ecological values, impacts and recommendations

Ecological value	Impacts	Recommendations
Threatened ecological communities	Removal of 0.71 ha of native vegetation consisting of four TECs: • 0.31 ha Cumberland Plain Woodland (PCT 849). • 0.27 ha River-flat Eucalypt Forest (PCT 835). • 0.02 ha Swamp Oak Floodplain Forest (PCT 1232). • 0.11 ha Shale/Sandstone Transition Forest (PCT 1395).	• Further risk of impacts to the TECs and individual native trees can be managed by implementing appropriate safeguards in further planning and carrying out the construction works including: – Avoid clearing of individual native trees if feasible. • Offsetting to follow *Sydney Water Biodiversity Offset Guidelines*. – Up to 0.71 ha of TECs may be removed.
Threatened flora/fauna habitat	Impact to 0.71 ha of threatened flora/fauna habitat, consisting of four TECs.	• Further risk of impacts to the TECs and individual native trees can be managed by implementing appropriate safeguards in further planning and carrying out the construction works including: – Avoid clearing of individual native trees if feasible.
Riparian vegetation	Impacts to riparian vegetation include: • 0.27 ha River-flat Eucalypt Forest (PCT 835). • 0.02 ha Swamp Oak Floodplain Forest (PCT 1232)	• Under boring two major riparian corridors and one freshwater wetland within the study area is being used to avoid and minimise potential impact.
Non-threatened native vegetation	No non-threatened native vegetation is expected to be impacted by the proposed works.	• N/A.
Number of locally indigenous native trees and tree hollows to be removed that are not part of a vegetation community	One locally indigenous hollow-bearing tree was recorded within the study area, within the Richmond Golf Course, which is expected to be impacted by the works. Three additional hollow-bearing trees are to be removed, however form part of vegetation community.	• Offsetting to follow *Sydney Water Biodiversity Offset Guidelines*. – Up to one locally indigenous hollow-bearing tree may be removed.
Number of non-locally indigenous native or exotic trees and tree hollows to be removed	Although non-locally indigenous native or exotic trees were identified in the study area, none are expected to be removed for the project.	• N/A.

4.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's key piece of environmental legislation. The EPBC Act applies to developments and associated activities that have the potential to significantly impact on Matters of National Environmental Significance (NES) protected under the Act. Under the EPBC Act, activities that have potential to result in significant impacts on Matters of NES must be referred to the Commonwealth Minister for the Environment and Energy for assessment.

An assessment of the impacts of the proposed development on Matters of NES, against heads of consideration outlined in Commonwealth of Australia (2013) was prepared to determine whether referral of the project to the Commonwealth Minister for the Environment and Energy is required. Matters of NES relevant to the project are summarised in Table 5.

Table 5 Assessment of the project against the EPBC Act

Matter of NES	Project specifics	Assessment against Commonwealth of Australia (2013)
Threatened species (flora and fauna)	One fauna species listed as Critically Endangered, Swift Parrot, under the EPBC Act has been assessed as high likelihood of occurring within the study area.	A SIC (CoA 2013) has been prepared for the species (Appendix 2) and concluded that a significant impact was not likely to result from the project.
Threatened ecological communities	No EPBC Act listed TECs were mapped within the study area.	Not applicable.
Migratory species	No migratory species have been recorded within the study area, however the study area may provide marginal habitat for migratory species.	While the species would be expected to use the study area on occasions, the study area does not provide important habitat for an ecologically significant proportion of the species.
Wetlands of international importance (Ramsar sites)	There are 12 Ramsar sites in NSW, the closest one being over 40 km from the study area.	The study area does not flow directly into a Ramsar site and the development is not likely to result in a significant impact.

On the basis of criteria outlined in Commonwealth of Australia (2013), it is considered unlikely that a significant impact on a Matter of NES would result from the project. However, Sydney Water may choose to refer the proposed action to the Australian Government Minister for the Environment and Energy to determine whether the action requires approval under the EPBC Act.

4.2 Biodiversity Conservation Act 2016

An assessment of the threatened biota present within the study area or with a medium likelihood (or above) of occurrence within the study area is provided in Section 3.4, along with an assessment of whether the project has potential to result in a significant effect. These assessments determined that two CEEC and two EECs have been recorded within the study area will experience negative impacts. ToS assessments prepared for these communities and are provided in Appendix 1.

A ToS has also been prepared for *Swift Parrot* and hollow-dependent microbat species.

The ToS assessments indicate that a significant effect is not likely to result from the proposal. A Species Impact Statement (SIS) or Biodiversity Development Assessment Report (BDAR) is therefore not required.

4.2.1 Biodiversity Offsets Scheme

As the project is unlikely to result in a significant effect on threatened species, populations or communities listed under the BC Act or the FM Act, consideration of the Biodiversity Offsets Scheme (BOS) is not warranted.

4.3 State Environmental Planning Policies

4.3.1 Coastal management SEPP

The study area is located on land in proximity to and within areas mapped as Coastal Wetlands as defined by the State Environmental Planning Policy (SEPP) Coastal Management 2018 (Figure 1).

The proposed works will directly impacted on two separate areas currently mapped as Coastal Wetland. Part 2 Division 1 Clause 11 of SEPP Coastal Management provides controls regarding land in proximity to coastal wetlands mapping, highlighting the need to consider a potential significant impact on the biophysical, hydrological or ecological integrity of the adjacent Coastal Wetland or the quantity or quality of surface or groundwater flows to the adjacent Coastal Wetland.

The two areas that are proposed to be impacted consist of one 50 metre section within Old Kurrajong Road (Figure 1) and one 37 metre section of Old Kurrajong Road that travels over Pugh's Lagoon. Both areas do not contain any native vegetation and, as they are contained within the road corridor, are not consistent with the hydrological and floristic characteristics of Coastal Wetlands.

Biosis understand that Sydney Water are in consultation with DPIE to undertake an amendment to the Coastal Wetland mapping to excise these areas within the road corridor. However, if the mapping is unable to be excised the proposed works will be considered a Designated Development as per Part 2 Division 1 Clause 10 of the SEPP and a Biodiversity Development Assessment Report will be required.

4.3.2 SEPP 19 Bushland in urban areas

The study area falls in land governed by the *State Environmental Planning Policy No 19—Bushland in Urban Areas*

The specific aims of this policy are:

(a) to protect the remnants of plant communities which were once characteristic of land now within an urban area,
(b) to retain bushland in parcels of a size and configuration which will enable the existing plant and animal communities to survive in the long term,
(c) to protect rare and endangered flora and fauna species,
(d) to protect habitats for native flora and fauna,
(e) to protect wildlife corridors and vegetation links with other nearby bushland,
(f) to protect bushland as a natural stabiliser of the soil surface,
(g) to protect bushland for its scenic values, and to retain the unique visual identity of the landscape,
(h) to protect significant geological features,
(i) to protect existing landforms, such as natural drainage lines, watercourses and foreshores,
(j) to protect archaeological relics,
(k) to protect the recreational potential of bushland,
(l) to protect the educational potential of bushland,
(m) to maintain bushland in locations which are readily accessible to the community, and
(n) to promote the management of bushland in a manner which protects and enhances the quality of the bushland

and facilitates public enjoyment of the bushland compatible with its conservation.

Following the results and recommendations provided within this report it is unlikely the proposed works will be adverse to the aims stated in the SEPP.

4.4 Local planning policy

4.4.1 Hawkesbury Local Environment Plan 2012

The study area is subject to Hawkesbury LEP 2012. The study area contains mapping mapped as "Significant vegetation" and "Connectivity between significant vegetation" on the Terrestrial Biodiversity Map under Clause 6.4 primarily along Redbank Creek, Hawkesbury River and Pugh's Lagoon.

The objective of the clause is to protect, maintain or improve the diversity and condition of the native vegetation and habitat, including:

- protecting native flora and fauna
- protecting the ecological processes necessary for their continued existence
- encouraging the conservation and recovery of native fauna and flora and their habitats

Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:

- the development is designed, sited and will be managed to avoid any significant adverse environmental impact, or
- if that impact cannot be reasonably avoided by adopting feasible alternatives—the development is designed, sited and will be managed to minimise that impact, or
- if that impact cannot be minimised—the development will be managed to mitigate that impact.

Recommendations are included below to reduce potential adverse environmental impact within the study area and broader locality. The development is likely to propose unavoidable impacts to vegetation but impacts will be identified during the design process and measures will be implemented during the construction to reduce risk of further impacts.

Furthermore, the objective of works being undertaken by Sydney Water in areas containing native vegetation has been summarised in Sydney Water's *Position Statement: Maintaining and Enhancing Biodiversity Values* (Sydney Water 2018). In accordance with this document, the proposed works will be undertaken in a way such that impacts to native vegetation will be avoided, minimised and mitigated where possible and that all works will be undertaken in a sensitive manner. As such, the proposed works will be carried out in accordance with the objectives of both DCPs.

4.5 Biosecurity Act

Seven Priority Weeds for LLS Greater Sydney, which includes the Liverpool and Penrith LGA's that have been recorded in the study area are listed in Table 6, along with their associated Duty (where relevant to the project).

Table 6 Priority weeds within the study area

Scientific name	Common name	General Biosecurity Duty
Asparagus asparagoides	Bridal Creeper	***No relevant biosecurity duty.***
Asparagus aethiopicus	Ground Asparagus	***No relevant biosecurity duty.***
Olea europaea* subsp. *cuspidata	African Olive	***Regional Recommended Measure*** *Land managers prevent spread from their land where feasible.* *Land managers reduce impacts from the plant on priority assets.*
Lantana camara	Lantana	*All plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.*
Lycium ferocissimum	African Boxthorn	
***Rubus fruticosus* spp. aggregate**	Blackberry	
Senecio madagascariensis	Fireweed	

As such, to prevent the above listed biosecurity impacts from occurring as a result of the presence of the above listed priority weeds within the study area, all practical steps should be taken to control and eradicated the weeds from the study area prior to vegetation removal.

4.6 Water Management Act 2000

As specified in Water Management (General) Regulation 2011 a public authority does not need to obtain a controlled activity approval for any controlled activities that it carries out in, on or under waterfront land.

The WM Act is supported by a series of interpretation guidelines including Controlled activities on waterfront land - Guidelines for laying pipes and cables in watercourses on waterfront land (NSW Office of Water 2012). This guideline relates to the laying of pipes and cables in watercourses or adjoining waterfront land for utilities such as water. The recommendations within this document should be considered during the design and construction phase of the project to assist in mitigating any impacts to waterways or landforms present more broadly within the study area.

4.7 Fisheries Management Act 1994

The FM Act provides for the protection and conservation of aquatic species and their habitat throughout NSW. Impacts to threatened species, populations and communities, and critical habitats listed under the FM Act must be assessed through an Assessment of Significance (Part 7) process.

'Water land' is defined under the FM Act as land submerged by water: whether permanently or intermittently, or, whether forming an artificial or natural body of water, and includes wetlands and any other land

prescribed by the FM Regulations as water land (Fairfull 2013). As such, five waterways within the study area (Figure 2) constitute water land and consultation requirements with NSW DPI apply.

No predicted habitat for threatened aquatic species has been mapped on the DPI spatial data portal within the study area. No records of threatened aquatic species have been recorded within 10 kilometres of the study area on the BioNet Atlas of NSW. The field investigation of each waterway identified a degree of channel modification, riparian degradation and weed ingress along with diffuse (e.g. roads and development) and point source pollution inputs (e.g. stormwater outlets) at all sites. No suitable habitat for threatened aquatic species was identified at any site. Therefore, no threatened aquatic species, populations or communities listed under the FM Act are likely to occur or be impacted by the proposed works within the study area.

Pugh's Lagoon, identified as a wetland in NSW, is not expected to be under bored however is unlikely to be directly impacted by the project as impacts are to occur within the road corridor adjacent to exotic vegetation with no vegetation clearance is expected within the riparian corridor. However, as this has been mapped under the Coastal Management SEPP this is automatically considered a Type 1 Class 1 Highly sensitive Key Fish Habitat waterway and consultation with DPIE is recommended.

Two waterways located in the study area, Redbank Creek and an unnamed 3rd order waterway, are consistent with the definition for key fish habitat within the study area. Hawkesbury River occurs outside the study area as it will be completely under bored and no impacts are expected.

Two waterways located within or adjacent to the study area, Redbank Creek and one unnamed 3rd order waterway are consistent with the definition for key fish habitat under the FM Act. Although Redbank Creek will be under bored, it is likely the unmapped 3rd order waterway will be trenched by the works. An additional four first order waterways are located within the study area. Two creeks that are mapped as KFH, Hawkesbury River and Redbank Creek are being under bored and as such are not expected to be impacted. One third order waterway and three first order waterways are likely to be directly impacted by the works.

Under Section 199 of the FM Act, consultation with the Minister for Primary Industries is required for dredging or reclamation work, including excavation within water land, draining or filling of water land, the removal of woody debris, rocks or freshwater native aquatic vegetation (Fairfull 2013).

A number of standard precautions and mitigations relevant to the protection of fish habitat are provided in section 3.3.2 of Fairfull (2013), these should be considered and deployed as relevant. In particular the following management measures should be taken as relevant to the type of works:

- Silt curtains or a coffer dam should be deployed around instream work sites and stormwater outlet headwall construction zones where required. In addition to standard erosion and sediment control measures, to protect against any impacts to water quality.
- The stockpiling of sediment should be located as far away from the waterway as possible and managed so that it is secure against flooding, to at least the 1 in 10 year flood interval.
- Any runoff from stockpiled sediment must be managed to prevent any sediment entering the waterway.
- Instream works should be limited to calm weather conditions.
- Instream works should be undertaken during low flow periods wherever possible.

The following recommendations should be considered during project construction to protect the aquatic ecological values of the study area:

- Appropriate erosion and sediment controls that take into account the flood prone nature of the land should be employed to protect against any impacts to water quality or indirect impacts to retained vegetation.

- Where natural banks exist (e.g. not constructed from gabions or lined with concrete), these banks should be reformed or remediated to resemble the pre-works condition and form to the fullest extent practicable.
- Any plant or equipment used in-stream should be washed down and cleaned prior to and following use to reduce the translocation risk of aquatic weed species.
- To the fullest extent practicable, minimise disturbance to any native vegetation, including aquatic vegetation within the study area. This may include the demarcation of areas of native vegetation to be retained during works.
- Minimise soil transportation within, into or out of the study area to reduce the spread of weeds.

Sydney Water should undertake consultation with the Minister for Primary Industries and obtain a permit to obstruct the free passage of fish prior to works as relevant to the scope of works. Under Section 199 of the FM Act, consultation with the Minister for Primary Industries is required for reclamation work involving trenching across a waterway however, Sydney water has previous advice stating no requirement for consultation unless the waterway constitutes KFH. As one waterway constituting KFH is proposed to be impacted, consultation with Minister for Primary Industries is recommended. Best practice sediment and erosion should be implemented.

5 Conclusion and recommendations

5.1 Conclusion

This report is an assessment of the potential impact of the proposed works on ecological values within the study area in accordance with the EP&A Act, EPBC Act, BC Act and the FM Act.

The proposed activities that will result in impacts to ecological values include:

- 0.71 ha native vegetation to be removed including:
  - 0.31 ha of Cumberland Plain Woodland (CEEC, BC Act).
  - 0.11 ha of Shale Sandstone Transition Forest (CEEC, BC Act).
  - 0.27 ha of River-flat Eucalypt Forest (EEC, BC Act).
  - 0.02 ha of Swamp Oak Floodplain Forest (EEC, BC Act).
- Removal of 0.71 threatened species habitat including:
  - Four Hollow-bearing trees.

A SIC was prepared for one threatened fauna species, Swift Parrot. On the basis of criteria outlined in (CoA 2013) it is considered unlikely that a significant impact on a Matter of NES would result from the project. However, given the impacts areas calculated Sydney Water may choose to refer the project under the EPBC Act.

A ToS was prepared for one threatened fauna species, Swift Parrot, and four TECs. It was concluded that the project will not have a significant impact on the ecological communities or threatened species, therefore a BDAR is not required.

One waterway, an unnamed 3rd order waterway, constituting KFH is likely to be directly impacted by the works. Therefore consultation with Department of Primary Industries is recommended.

Stockpile and work areas are identified within areas of non-native and cleared vegetation that hold minimal ecological values to the study area.

5.2 Recommendations

Given the potential for the removal of all native vegetation within the impact area, the focus of the recommendations is to minimise disturbance to any surrounding native vegetation, fauna habitat and riparian areas. These are provided in Table 7 and Table 8.

Table 7 Sydney Water standard safeguards

Safeguard category	Safeguard information	Location
Topography, geology and soils		
2.1	Appropriate erosion and sediment control measures should be installed at all sites to avoid sedimentation of receiving water bodies or other indirect impacts to surrounding biodiversity values including: • Divert surface runoff away from disturbed soil and stockpiles. • Install sediment and erosion controls before construction starts. • Reuse topsoil where possible and stockpile separately. • Inspect controls at least weekly and immediately after rainfall. • Rectify damaged controls immediately. • Remove controls once surfaces have been stabilised, including removing trapped sediment in drainage lines.	All locations
2.2	Minimise ground disturbance and stabilise disturbed areas progressively.	All locations
2.6	Stop work during heavy rainfall or in waterlogged conditions when there is a risk of sediment loss off site.	All locations
2.7	Sweep up any sediment/soil transferred off site at least daily, or before rainfall.	All locations
2.7	Eliminate ponding and erosion by restoring natural landforms to the pre-works condition.	All locations
Water and drainage		
3.1	Use appropriate controls to avoid potential sedimentation to waterbodies (e.g. floatation boom).	All locations
3.3	Minimise the impacts to creeks where creek crossings are required. Prior to construction the methodology will be assessed based on: • Geotechnical and constructability issues (e.g. depth of cover, potential for future scouring). • Construction footprint and duration. • Ease of reinstatement. • Environmental issues (flora and fauna, geomorphology, contamination, heritage, water quality and hydrology). • Any issues raised during consultation with Department of Primary Industries.	All locations
3.6	Bund potential contaminants and store on robust waterproof membrane, away from drainage lines.	All locations
3.8	Locate portable site amenities away from watercourses or drainage lines.	All locations
3.16	Conduct refuelling, fuel decanting and vehicle maintenance in compounds where possible. If field refuelling is necessary, designate an area away from waterways and drainage lines with functioning spill kits close by.	All locations
Flora and fauna		
4.2	Residual impacts to native vegetation and trees will be offset in accordance with the Sydney Water Biodiversity Offset Guideline.	All locations

Safeguard category	Safeguard information	Location
4.5	Minimise vegetation clearance and disturbance, including impacts to standing dead trees and riparian zones. Where possible, limit clearing to trimming rather than the removal of whole plants.	All locations
4.6	Physically delineate vegetation to be cleared and/or protected on site and install appropriate signage prior to works commencing.	All locations
4.7	Adjust methodology (e.g. avoid area, hand excavate, implement exclusion fencing) to protect sensitive areas where possible (such as mature trees, known threatened species, populations or ecological communities).	All locations
4.8	Protect trees in accordance with the requirements of Australian Standard 4970-2009 for the Protection of Trees on Development Sites. Do not damage tree roots unless absolutely necessary, and engage a qualified arborist where roots >50mm are impacted within the Tree Protection Zone	All locations
4.11	Retain dead tree trunks, bush rock or logs in-situ unless they are in the impact area and moving is unavoidable. Reposition material elsewhere on the site or approved adjacent sites. If native fauna is likely to be present, a licenced ecologist should inspect the removal and undertake fauna relocation.	All locations
4.12	Inspect vegetation for potential fauna prior to clearing or trimming. If fauna is present, or ecological assessment has determined high likelihood of native fauna presence, including removal of hollow bearing trees, engage a licenced ecologist to inspect and relocate fauna before works.	All locations
4.13	If native fauna is encountered on site, stop work and allow the fauna to move away unharassed. Engage a licenced ecologist if assistance is required to move fauna	All locations
4.14	Avoid impeding/blocking fish passage. Retain snags and natural obstructions in waterways where possible.	All locations
4.17	Stop work immediately and notify the Sydney Water Project Manager if any threatened species (flora or fauna) is discovered during the works. Work will only recommence once the impact on the species has been assessed and appropriate control measures provided.	All locations
4.19	Manage biosecurity in accordance with: • Biosecurity Act 2015 (see NSW Weedwise), including reporting new weed infestations or invasive pests • Contemporary bush regeneration practices, including disposal of sealed bagged weeds to a licenced waste disposal facility.	All locations
4.21	To prevent spread of weeds: • Clean all equipment including PPE prior to entering or leaving the work sites. • Wrap straw bales in geo-fabric to prevent seed spread.	All locations
4.27	Minimise impacts on native vegetation in non-certified areas, native vegetation retention areas and areas outside the growth centre. Options to consider where feasible include: • alternative construction methodologies (under bore vegetation and waterways, compressed construction corridors).	All locations

Safeguard category	Safeguard information	Location
	• avoiding impact to hollow bearing and habitat trees.	
4.28	Vegetation removal must not occur until the following are complete: • The area to be removed has been physically delineated. • The Contractor's Environmental Representative has confirmed consistency with approval documentation. • Pre-clearing surveys, if relevant. • Written authorisation to commence clearing from Sydney Water Project Manager.	All locations

Table 8 Additional Safeguards

Safeguard information	Location
All areas not access are to be surveyed by an ecologist prior to impact to check for habitat values and to confirm assessment.	
All stockpile and compound areas are to be located within existing cleared areas and existing access tracks, and will be rehabilitated at the end of construction.	All locations
All hollow-bearing trees are to be removed in a two stage process: • Stage 1: All surrounding vegetation to be cleared and grubbed. • Stage 2: 24 to 48 hours later (or in accordance with approval documentation) the hollow-bearing trees are to be inspected by an ecologist. If resident fauna is observed, the hollow section is to be lowered to the ground and the animal allowed to move on of its own volition. If injured, the fauna to be taken to a WIRES carer or appropriate veterinarian for care.	All identified HBTs
All impacted culverts are to be inspected prior to impact to check for any potential roosting locations threatened microbats.	Culvert location
All staff on site are to be educated on the ID characteristics of the threatened species and advised to not handle fauna species under any circumstances during toolbox talks.	All locations
No-go fencing installed for retained vegetation to ensure surrounding area remains undisturbed.	All locations

Given the works are being undertaken on behalf of a public authority, Section 199 of the FM Act applies and Sydney Water is required to give the Minister written notice of the proposed work, and consider any matters raised by the Minister within 21 days. It is recommended that the REF, including this report form part of this consultation. If the free passage of fish is required to be obstructed, by the use of silt curtains or coffer dams, during construction a Section 219 permit will be required to be obtained from NSW DPI Fisheries prior to the obstruction occurring.

A number of standard precautions and mitigations relevant to the protection of fish habitat are provided in section 3.3.2 of Fairfull (2013), these should be considered and deployed as relevant. In particular the following management measures should be taken as relevant to the type of works:

While Sydney Water is exempt from the controlled activity approval process, the design considerations and management measures detailed in the relevant WM Act guidelines (NSW Office of Water 2012) should be considered.

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Appendix 1 Test of Significance

River-flat Eucalypt Forest on Coastal Floodplains of Southern New South Wales and Eastern Victoria – Endangered Ecological Community BC Act

River-flat Eucalypt Forest is listed as Endangered under the BC Act. The community is found on the river flats of the coastal floodplains. It has a tall open tree layer of eucalypts, which may exceed 40 metres in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. Major examples once occurred on the floodplains of the Hunter, Hawkesbury, Moruya, Bega and Towamba Rivers, although many smaller floodplains and river flats also contain examples of the community. The remaining area is likely to represent much less than 30% of its original range. Given its habitat, the community has an important role in maintaining river ecosystems and riverbank stability. Associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains

River-flat Eucalypt Forest within the study area

River-flat Eucalypt Forest aligns with PCT 835 in poor condition within the study area. A total of 0.27 hectares of River-flat Eucalypt Forest occurs within the impact area which is subject to assessment under the BC Act.

For this assessment, the local occurrence of River-flat Eucalypt Forest comprises all PCT 835 mapped within the study area and any patches that occur in the vicinity up to 100 – 200 metres across the landscape that could be subject to indirect impacts associated with loss of connectivity. An assessment of the impacts of this vegetation in accordance with the *Threatened species test of significance* is provided below.

Table A.9 Test of Significance for River-flat Eucalypt Forest

Test of Significance for River-flat Eucalypt Forest
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.
Not applicable, not a threatened species.
In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*** ***(ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***
The local occurrence of River-flat Eucalypt Forest is considered to comprise the areas directly impacted by the project, and the areas potentially indirectly impacted through increased fragmentation and isolation. This can be broadly defined as the patch of the community that occurs within the study area and extends into adjacent vegetation in a contiguous manner, including patches that occur in the vicinity up to 100 – 200 metres that are considered to be connected via lack of barriers for movement of genetic material. The proposed works require the removal of 0.27 ha of River-flat Eucalypt Forest from the study area. River-flat Eucalypt Forest is generally present in low condition, and occurs in a fragmented landscape where introduced vegetation cover is significant and intensive land clearing has taken place over the past 150 years. Clearing for the project is unlikely to

Test of Significance for River-flat Eucalypt Forest

further reduce species diversity and simplify community structure more broadly, as the community already occurs in a patchy and edge effected state. The adjacent areas of the community within the broader area will remain intact and are unlikely to suffer substantial changes in species composition. The vegetation to be directly removed does not comprise any ecological components critical to the survival of the EEC in the locality.

In relation to the habitat of a threatened species or ecological community:

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

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

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

The habitat supporting the local occurrence of River-flat Eucalypt Forest comprises long linear strips along a riparian zone (Redbank Creek) where canopy trees have been retained and small degraded patches of the community have been able to persist. These areas of habitat occur with a patchy distribution across the study area.
The project will result in the removal of 0.27 ha of habitat for River-flat Eucalypt Forest, and are already subject to edge effects resulting from the fragmented landscape within which they occur. Areas of contiguous vegetation to that being removed will be avoided, and the nature of this impact will not substantially reduce the habitat available to the EEC in the locality, nor will it result in isolation or fragmentation of habitats. The area of habitat to be impacted by the proposed works is not considered important to the long term survival of River-flat Eucalypt Forest in the locality.

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).

To date no AOBVs have been declared within the project's impact area.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

The proposed works have the potential to result in the following key threatening process which is listed under the Schedule 4 of the BC Act, and to which are considered relevant to River-flat Eucalypt Forest:

- Clearing of native vegetation.

The proposed works requires clearing of land where this community occurs, resulting in the removal 0.27 ha of the EEC. Given some areas of River-flat Eucalypt Forest to be impacted by the proposal will be in the form of partial clearing and under boring, and areas of contiguous vegetation will be avoided, the project is unlikely to increase the impact of any key threatening processes.

Conclusion.

The proposed works are unlikely to significantly impact River-flat Eucalypt Forest for the following reasons:

- The proposed works are localised and the study area has already been exposed to a number of disturbances which are unlikely to be further exacerbated by the proposed works.
- The proposed works is unlikely to significantly alter floristic or structural diversity of the EEC within the study area, particularly given a portion of the impacts are limited to partial clearance and some under boring.
- The localised nature of the proposed works will not significantly trigger or exacerbate any key threatening processes.

Application of the BOS or preparation of a SIS is therefore not required.

Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions –Endangered Ecological Community BC Act

Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions is listed as an EEC under the BC Act. This community comprises of plants that are generally dominated by the Swamp Oak *Casuarina glauca*. The community is found in close proximity to rivers and estuaries and is generally found on soils with a saline influence. The soils of the community may be quite wet and as such the composition of species present will vary markedly from site to site. In the past, areas of Swamp Oak Floodplain Forest were cleared for grazing and have been converted to grass paddocks with no overstorey.

Swamp Oak Floodplain Forest within the study area

Swamp Oak Floodplain Forest aligns with PCT 1232 in moderate condition within the study area. A total of 0.02 hectares of Swamp Oak Floodplain Forest occurs within the impact area which is subject to assessment under the BC Act.

For this assessment, the local occurrence of Swamp Oak Floodplain Forest comprises all PCT 1232 mapped within the study area and any patches that occur in the vicinity up to 100 – 200 metres across the largely cleared agricultural landscape that could be subject to indirect impacts associated with loss of connectivity. An assessment of the impacts of this vegetation in accordance with the *Threatened species test of significance* is provided below.

Table B.10 Test of Signifiance for Swamp Oak Floodplain Forest

Test of Significance for Swamp Oak Floodplain Forest
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.
Not applicable, not a threatened species.
In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*** ***(ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***
The local occurrence of Swamp Oak Floodplain Forest is considered to comprise the areas directly impacted by the project, and the areas potentially indirectly impacted through increased fragmentation and isolation. This can be broadly defined as the patch of the community that occurs within the study area and extends into adjacent vegetation in a contiguous manner, including patches that occur in the vicinity up to 100 – 200 metres that are considered to be connected via lack of barriers for movement of genetic material. The proposed works require the removal of 0.02 ha of Swamp Oak Floodplain Forest from the study area, in the form of complete clearance, partial clearing and under boring. Swamp Oak Floodplain Forest is generally present in moderate condition, and occurs along the water edge where there is evidence of damage as a result of recent flooding events. Clearing for the project is unlikely to further reduce species diversity and simplify community structure more broadly, as the community already occurs in a damaged state. The adjacent areas of the community within the broader area will remain intact and are unlikely to suffer substantial changes in species composition. The vegetation to be directly removed does not comprise any ecological components critical to

Test of Significance for Swamp Oak Floodplain Forest
the survival of the EEC in the locality.
In relation to the habitat of a threatened species or ecological community: ***(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and*** ***(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and*** ***(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.***
The habitat supporting the local occurrence of Swamp Oak Floodplain Forest comprises long linear strips along the edge of a catchment (Pugh's Lagoon) where canopy trees have been retained and patches of the community have been able to persist. The project will result in the removal of 0.02 ha of habitat for Swamp Oak Floodplain Forest. Areas of contiguous vegetation to that being removed will be retained, and the nature of this impact will not substantially reduce the habitat available to the EEC in the locality, nor will it result in isolation or fragmentation of habitats. The area of habitat to be impacted by the proposed works is not considered important to the long term survival of Swamp Oak Floodplain Forest in the locality.
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).
To date no AOBVs have been declared within the project's impact area.
Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.
The proposed works have the potential to result in the following key threatening process which is listed under the Schedule 4 of the BC Act, and to which are considered relevant to Swamp Oak Floodplain Forest: • Clearing of native vegetation. The proposed works require clearing of land where this community occurs, resulting in the removal 0.02 ha of the EEC. Given some areas of Swamp Oak Floodplain Forest to be impacted by the proposal will be in the form of partial clearing and under boring, and that large areas of contiguous vegetation will be retained adjacent to the study area, the project is unlikely to increase the impact of any key threatening processes.
Conclusion.
The proposed works are unlikely to significantly impact Swamp Oak Floodplain Forest for the following reasons: • The proposed works are localised and the study area has already been exposed to a number of disturbances which are unlikely to be further exacerbated by the proposed works. • The proposed works is unlikely to significantly alter floristic or structural diversity of the EEC within the study area, particularly given a portion of the impacts are limited to partial clearance and some under boring. • The localised nature of the proposed works will not significantly trigger or exacerbate any key threatening processes. Application of the BOS or preparation of a SIS is therefore not required.

Cumberland Plain Woodland in the Sydney Basin Bioregion– Critically Endangered Ecological Community BC Act

The Cumberland Plain Woodland is listed as a CEEC under the BC Act. This community occurs on soils derived from Wianamatta Shale, throughout the driest part of the Sydney Basin. It is well adapted to drought and fire and is typically found on heavy clay soils (OEH 2016). This community has undergone significant declines since European settlement with the expansion of Sydney and the outlying regional centres, now only 9 % of the original extent of this community now remains in-tact (OEH 2016) with around 12 % occurring as scattered remnants (DECCW 2011).

Cumberland Plain Woodland within the study area

Cumberland Plain Woodland aligns with PCT 849, and generally occurs in poor condition within the study area. A total of 0.31 hectares of Cumberland Plain Woodland occurs within the impact area which is subject to assessment under the BC Act.

For this assessment, the local occurrence of Cumberland Plain Woodland comprises all PCT 849 mapped within the study area and any patches that occur in the vicinity up to 100 – 200 metres across the largely fragmented landscape that could be subject to indirect impacts associated with loss of connectivity. An assessment of the impacts of this vegetation in accordance with the *Threatened species test of significance* is provided below.

Table B.11 Test of Significance for Cumberland Plain Woodland

Test of Significance for Cumberland Plain Woodland
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.
Not applicable, not a threatened species.
In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*** ***(ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***
The local occurrence of Cumberland Plain Woodland is considered to comprise the areas directly impacted by the project, and the areas potentially indirectly impacted through increased fragmentation and isolation. These areas include all contiguous areas of the CEEC extending from the linear study area and any patches that occur in the vicinity up to 100 – 200 metres that are considered to be connected via lack of barriers to movement of genetic material. The local occurrence of the CEEC is generally present in poor condition, and occurs in a fragmented landscape where introduced vegetation cover is significant and intensive land clearing has taken place over the past 150 years. Land use impacts from clearing and grazing have reduced community integrity and functionality in southern NSW (e.g. loss of small native mammals, reduced flora species richness, reduced genetic exchange across the community due to fragmentation). Clearing for the project is unlikely to further reduce species diversity and simplify community structure more broadly. The CEEC already occurs in a patchy and edge effected state, and the project will not result in a substantial increase to these negative pressures. The adjacent areas of the community within the broader area will remain intact and are unlikely to suffer substantial changes in species composition. The vegetation to be directly removed does not comprise any ecological components critical to the survival of the CEEC in the locality.

Test of Significance for Cumberland Plain Woodland
In relation to the habitat of a threatened species or ecological community: ***(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and*** ***(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and*** ***(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.***
The habitat supporting the local occurrence of the CEEC comprises of small fragmented areas where patches of the community have been able to persist. These areas of habitat occur with a patchy distribution across the study area. The project will result in the removal of 0.31 ha of habitat for the CEEC, however areas contiguous to that being removed will be retained, and areas considered subject to some level of connectivity within 100 – 200 metres will also remain present. These areas are already subject to edge effects resulting from the fragmented and patchy landscape within which they occur, however the project is not considered likely to increase the level to which these negative pressures occur. The area of habitat to be directly and indirectly impacted by the project is not considered important to the long term survival of the community in the locality.
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).
To date no AOBVs have been declared within the project's impact area.
Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.
The proposed works have the potential to result in the following key threatening process which is listed under the Schedule 4 of the BC Act, and to which are considered relevant to Cumberland Plain Woodland: • Clearing of native vegetation. The proposed works requires clearing of land where this community occurs, resulting in the removal 0.31 ha of the CEEC. Given some areas of the CEEC to be impacted by the proposal will be in the form of partial clearing and under boring, and that large areas of contiguous vegetation will be retained adjacent to the study area, the project is unlikely to increase the impact of any key threatening processes.
Conclusion.
The proposed works are unlikely to significantly impact Cumberland Plain Woodland for the following reasons: • The proposed works are localised and the study area has already been exposed to a number of disturbances which are unlikely to be further exacerbated by the proposed works. • The proposed works is unlikely to significantly alter floristic or structural diversity of the CEEC within the study area, particularly given a portion of the impacts are limited to partial clearance and some under boring. • The localised nature of the proposed works will not significantly trigger or exacerbate any key threatening processes. Application of the BOS or preparation of a SIS is therefore not required.

Shale Sandstone Transition Forest in the Sydney Basin Bioregion– Critically Endangered Ecological Community BC Act

Shale Sandstone Transition Forest is listed as Critically Endangered under the EPBC Act and occurs only in NSW, within the Sydney Basin Bioregion. The ecological community occurs between other ecological communities found respectively on shale or sandstone substrates. The ecological community is found to the west of Sydney, on the edges of the Cumberland Plain, as well as on the sandstone-dominated Hornsby, Woronora, and Lower Blue Mountains plateaux that adjoin the plain. Shale Sandstone Transition Forest generally occurs in areas receiving between 800 mm and 1100 mm mean annual rainfall. Typically, it occurs at elevations less than 200 metres above sea level. The vegetation of the CEEC is forest or woodland with an overstorey dominated by various Eucalypt species and an understorey comprised of sclerophyll shrubs, grasses and herbs. The structure and composition of vegetation are primarily determined by the transitional geology between Wianamatta shale and Hawkesbury sandstone and vary considerably depending on the degree and the source of shale influence.

Shale Sandstone Transition Forest within the study area

Shale Sandstone Transition Forest within the study area aligns with PCT 1395, and generally occurs in poor condition within the study area. A total of 0.11 hectares of Shale Sandstone Transition Forest occurs within the impact area which is subject to assessment under the BC Act.

For this assessment, the local occurrence of Shale Sandstone Transition Forest comprises all PCT 1395 mapped within the study area and any patches that occur in the vicinity up to 100 – 200 metres across the largely fragmented landscape that could be subject to indirect impacts associated with loss of connectivity. An assessment of the impacts of this vegetation in accordance with the *Threatened species test of significance* is provided below.

Table B.12 Test of Significance for Shale Sandstone Transition Forest

Test of Significance for Shale Sandstone Transition Forest
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.
Not applicable, not a threatened species.
In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*** ***(ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***
The local occurrence of Shale Sandstone Transition Forest is considered to comprise the areas directly impacted by the project, and the areas potentially indirectly impacted through increased fragmentation and isolation. These areas include all contiguous areas of the CEEC extending from the linear study area and any patches that occur in the vicinity up to 100 – 200 metres that are considered to be connected via lack of barriers to movement of genetic material. Expected impacts are likely to remove approximately 0.11 ha of the community. This level of impact will not lead to the local occurrence of Shale Sandstone Transition Forest being placed at risk of extinction. The local occurrence of the CEEC is generally present in poor condition, and occurs in a fragmented landscape where the lower strata has been cleared for recreational purposes. Land use impacts from clearing have reduced community

Test of Significance for Shale Sandstone Transition Forest
integrity and functionality in southern NSW (e.g. loss of small native mammals, reduced flora species richness, reduced genetic exchange across the community due to fragmentation). Clearing for the project is unlikely to further reduce species diversity and simplify community structure more broadly, and species impacted by the proposed works are common components of the CEEC vegetation. As such, the vegetation to be directly removed does not comprise any ecological components critical to the survival of the CEEC in the locality, and this level of impact will not lead to the local occurrence of Shale Sandstone Transition Forest being placed at risk of extinction.
In relation to the habitat of a threatened species or ecological community: ***(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and*** ***(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and*** ***(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.***
The habitat supporting the local occurrence of the Shale Sandstone Transition Forest comprises linear strips along Redbank Creek, adjacent to residential development in North Richmond where canopy trees have been retained and small fragmented areas of the community have been able to persist. These areas of habitat occur with a patchy distribution across the study area. The project will result in the removal of 0.11 ha of habitat for the CEEC, and are already subject to edge effects resulting from the fragmented landscape within which they occur. Areas of contiguous vegetation to that being removed will be retained, and the nature of this impact will not substantially reduce the habitat available to the CEEC in the locality, nor will it result in isolation or fragmentation of habitats. The area of habitat to be impacted by the proposed works is not considered important to the long term survival of the community in the locality.
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).
To date no AOBVs have been declared within the project's impact area.
Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.
The proposed works have the potential to result in the following key threatening process which is listed under the Schedule 4 of the BC Act, and to which are considered relevant to Shale Sandstone Transition Forest: • Clearing of native vegetation. The proposed works requires clearing of land where this community occurs, resulting in the removal 0.11 ha of the CEEC. Given some areas of the CEEC to be impacted by the proposal will be in the form of partial clearing and under boring, and that large areas of contiguous vegetation will be retained adjacent to the study area, the project is unlikely to increase the impact of any key threatening processes.
Conclusion.
The proposed works are unlikely to significantly impact Shale Sandstone Transition Forest for the following reasons: • The proposed works are localised and the study area has already been exposed to a number of disturbances which are unlikely to be further exacerbated by the proposed works.

Test of Significance for Shale Sandstone Transition Forest

- The proposed works is unlikely to significantly alter floristic or structural diversity of the CEEC within the study area, particularly given a portion of the impacts are limited to partial clearance and some under boring.
- The localised nature of the proposed works will not significantly trigger or exacerbate any key threatening processes.

Application of the BOS or preparation of a SIS is therefore not required.

Hollow-dependent Microchiropteran Bat Species - Southern Myotis, Eastern Coastal Free-tailed Bat, Greater Broad-nosed Bat, Little Bent-winged Bat, Eastern False Pipistrelle and Yellow-bellied Sheathtail-bat – Vulnerable

Southern Myotis is listed as Vulnerable under the BC Act. It is found along the coastal band from the north-west of Australia, across to the top end and south to western Victoria. This species forages over waterways and pools, catching insects and small fish by raking their feet across the water surface. Southern Myotis roost in tree hollows, caves, culverts and under bridges, in groups of 10 – 15 individuals, often close to water. Potential threats to the Southern Myotis include, clearing adjacent to foraging areas, reduction in stream water quality, affecting food resources and the loss or disturbance of roosting sites.

Eastern Coastal Free-tailed Bat is listed as Vulnerable under the BC Act. It occurs along the coastal regions of eastern Australia. In NSW, its range expands west out over the Great Diving Range. The habitat preference of the species is poorly known, however, it has been observed to occur in dry eucalypt forest, coastal woodland, riparian zones and wet sclerophyll forests. The Eastern Coastal Free-tailed Bat forages for moths above forest canopy and along forest edges, and also consumes ground based invertebrates (e.g. ants and beetles). Hollow bearing trees are their preferred roosting sites.

Greater Broad-nosed Bat is listed as Vulnerable under the BC Act. It is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however does not occur at altitudes above 500 metres. The Greater Broad-nosed Bat utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. It prefers hollow-bearing trees as roosting sites, however the species has also been found in buildings.

Little Bent-winged Bat, listed as Vulnerable under the BC Act, is the smallest of the bent-winged bats with uniform dark chocolate-brown fur on its back tending to slightly lighter on the belly. It has a distinctly short muzzle and domed head. The species is a cave-dwelling bat however it is known to roost in caves, abandoned mines, tunnels, stormwater drains, and occasionally buildings. It is insectivorous, feeding primarily on beetles, moths and flies, but is also known to frequently consume spiders. They hunt their prey by flying rapidly with considerable manoeuvrability between the shrub and canopy layers of densely wooded forests (Churchill 2008). The species occurs of the east coast of Australia, ranging from Cape York in Queensland to Wollongong in NSW (DPIE 2019).

Eastern False Pipistrelle, listed as Vulnerable under the BC Act, is a relatively large and robust species of microbat with dark brown to reddish fur on its back and a paler grey belly. The species generally roosts in hollow trunks or eucalyptus trees in colonies of three to 80 individuals. They are an insectivorous species, feeding primarily on larger prey items including beetles and moths and occasionally bugs, ants and flies. They typically hunt within or just the below the tree canopy, favouring gaps and spaces within the forest (Churchill 2008). The species occurs on the south-east coast of Australia, ranging from Southern Queensland down to Victoria and Tasmania, including coastal areas of NSW (DPE 2017).

Yellow-bellied Sheathtail-bat, listed as Vulnerable under the BC Act, is a large species of microbat with rich shiny black fur on the back and contrasting bright white, cream or yellow fur on the belly. It roosts in large

tree hollows in mixed-sex groups of two to six and occasionally up to 30 individuals. They are insectivorous, feeding primarily on beetles but also grasshoppers, crickets, leafhoppers, shield bugs, wasps, and flying ants. They usually forage above the canopy, but will forage lower over open spaces at the forest edge. (Churchill 2008). The species is wide-ranging, present across northern and eastern Australia, including coastal and inland NSW (DPIE 2017c).

There are four hollow-bearing trees within the study area which represent potential roosting habitat for Hollow-dependent Microbats. Approximately 0.71 hectares of native vegetation, including riparian vegetation, will potentially be impacted by the proposed works which represents potential foraging resources for all four of the insectivorous microbat species.

No threatened microbats were recorded during the field investigation (although no targeted surveys were undertaken), however there are known records of the species within 5 kilometres of the study area (OEH 2019a). Due the presence of potential roosting and foraging habitat within the study area, a test for determining whether the proposed works are likely to significantly affect the species in accordance with Section 7.3 of the BC Act has been undertaken below.

Test of Significance for hollow-dependent microbats.
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.
Impacts likely to have an adverse effect on the life cycle of hollow-dependent microbats include direct mortality, loss of high productivity foraging habitat, loss of roosting habitat, introduction of exotic pathogens and hazard reduction and wildfire fires during the breeding season. Impacts are limited to potential habitat occurring along road corridors. A total of 0.71 ha of vegetation will be removed, including four hollow-bearing trees providing potential roosting habitat for the species. Removal of the hollow-bearing trees may reduce the carrying capacity of the study area for the species, but is unlikely to have an adverse effect on the life-cycle of the six threatened microbat species in the locality. Given the availability of similar habitat adjacent to the study area and along surrounding riparian corridors, as well as higher quality habitat within the local area, the proposed small-scale removal of vegetation is considered unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction. Recommendations included within this report are to undertake preclearance survey and translocation of any microbat species found within the study area to native vegetation of similar habitat adjacent to the study area immediately prior to the commencement of works. This will further ensure minimal impact to this species as a result of the proposed works.
In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*** ***(ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***
Not applicable.

Test of Significance for hollow-dependent microbats.

In relation to the habitat of a threatened species or ecological community:

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

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

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

The proposed works will result in the removal of up to 0.71 ha of native vegetation, including the removal of four hollow-bearing tree that represents potential roosting habitat for the microbat species.

The vegetation to be removed is located mostly on private land used for agricultural purposes, which represents the main cause of edge effects and fragmentation within the locality. Given the study area's location directly beside agricultural and industrial land, the removal of this vegetation is unlikely to result in further fragmentation of habitat for the species. Further, the microbat species are highly mobile and are capable of foraging over large distances. The proposed works will not reduce the available area of foraging and will not result in the construction of any barrier likely to impact dispersal of the species. Removal of 0.71 ha of native vegetation will not cause the habitat to become fragmented or isolated from other areas of habitat for this species.

The area of potential habitat proposed for removal represents a small proportion of the available habitat for the species within 5 kilometres of the study area. The study area is located adjacent to a larger area of bushland that will remain undeveloped under the current proposal, which includes native vegetation with an intact understorey that may provide better habitat potential than the area to be impacted by the proposed works. Hollow-bearing trees may provide important roosting for the species, where hollows provide suitable conditions for maternity roosts. Winter roosting habitat may also provide important habitat as increased energy expenditure during winter when the temperature and food availability is lower may impact on individual survival. The hollow-bearing tree to be removed currently occurs along existing infrastructure and is likely to be of lower quality for the species than hollow-bearing trees located further from the edges of these disturbances. Habitat adjoining the study area and surrounding riparian corridors is of similar structure, age and composition as vegetation within the impact area. The hollow-bearing trees within the study area likely represents a very small fraction of the available habitat for this species. Therefore, the importance of the habitat to be removed is not considered significant for the long-term survival of the species within the locality.

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 impact on an area declared as of outstanding biodiversity value (either directly or indirectly).

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

The proposed works have the potential to result in the following key threatening processes which are listed under the Schedule 4 of the BC Act and which are considered relevant to threatened Microbats:

- Clearing of native vegetation
- Loss of hollow-bearing trees

Approximately 0.71 ha of native vegetation, including four hollow-bearing tree, that may provide marginal foraging and roosting habitat for the microbat species will be impacted by the proposed works.

Test of Significance for hollow-dependent microbats.

Conclusion.

In consideration of the above five factors, the proposed activity is not likely to significantly impact the six microbat species within the study area or wider locality, as:

- The proposed works will remove approximately 0.71 ha of native vegetation that provides marginal foraging habitat for the microbat species.
- Works are limited to removal of four hollow-bearing trees, adjacent to existing infrastructure and disturbed areas.
- The localised nature of the proposed works will not significantly trigger or exacerbate any key threatening processes.
- The habitat to be removed is not considered important to the survival of the species.
- Preclearance surveys for the microbat species will be undertaken prior to removal of vegetation to ensure any individuals are translocated and not impacted by the proposed works.

Therefore, no further assessment is required and a SIS or BDAR is not required.

Swift Parrot *Lathamus discolor* – Critically Endangered

Swift Parrot is listed as Endangered under the BC Act and Critically Endangered under the EPBC Act. It breeds in Tasmania during spring and summer, migrating in the autumn and winter months (March to October) to south-eastern Australia from Victoria and eastern parts of South Australia up to south-east Queensland. In NSW it occurs mostly on the coast and south west slopes (DPIE n.d.)

Whilst on the mainland they are typically found in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Their favoured trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *Corymbia gummifera*, Mugga Ironbark *Eucalyptus sideroxylon*, and White Box *Eucalyptus albens*. Commonly used lerp infested trees include Inland Grey Box *Eucalyptus microcarpa*, Grey Box *Eucalyptus moluccana* and Blackbutt *Eucalyptus pilularis*. Individuals are known to return to some foraging sites on a cyclic basis depending on food availability (DPIE n.d.).

Threatening processes impacting Swift Parrot include habitat loss and fragmentation from forest harvesting, residential/industrial development, agricultural clearing, senescence and dieback. Other threats include reduced food availability during drought conditions, competition from introduced bees and large, aggressive honeyeaters for food resources, predation, and exclusion from forest and woodland habitat by over abundant Noisy Miners (DPIE n.d.).

Table 13 Test of Significance for Swift Parrot *Latham discolor*

Test of Significance for Swift Parrot *Latham discolor*
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.
Impacts likely to have an adverse effect on the life cycle of Swift Parrot include loss of winter flowering foraging habitat, roosting habitat loss from forest harvesting and development, competition from introduced species, unsuitable fire regimes, predation, and further habitat fragmentation. The proposed work is expected to impacts to 0.71 hectares of native vegetation including, 0.27 ha of River-Flat Eucalypt forest, 0.31 ha of Cumberland Plain woodland and 0.11 ha of Shale/Sandstone Transition Forest; which may be potential foraging and roosting habitat for Swift Parrot. Additionally, parts of the study area are mapped under the important areas mapping for this species (DPIE 2021) and several preferred winter flowering feed trees are found in the study area including the Red Gum *Eucalyptus tereticornis,* Broad-leaved Ironbark *Eucalyptus fibrosa,* Cabbage Gum *Eucalyptus amplifolia* and *Acacia floribunda*. The habitat within the study area is located predominantly in urban centres and occurs in highly fragmented stands. Remnant native vegetation; particularly in regards to the riparian corridor near Redbank Creek, is not considered to be high productivity due to its highly disturbed nature and small size. It is likely that if the species uses the site for foraging, it also utilises the entire riparian corridor, which is connected to larger areas of remnant vegetation. Similarly with roosting habitat, the species is more likely to use the larger intact forested areas nearby. This species breeds in Tasmania and therefore there would be no nesting habitat within the study area. The small area of potential foraging and roosting habitat proposed to be impacted has potential for indirect impact or direct impacts to individual Swift Parrots. However, due to the small scale of the habitat within the study area, within an area containing larger continuous areas of more suitable habitat, is considered unlikely to affect a viable local population of the species such that it is could be placed at risk of extinction.

Test of Significance for Swift Parrot *Latham discolor*
In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*** ***(ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***
Not applicable.
In relation to the habitat of a threatened species or ecological community: ***(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and*** ***(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and*** ***(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.***
(i)The proposed action will result in potential indirect impacts to up to 0.71 hectares of potential foraging and roosting habitat (River-Flat Eucalypt forest, Cumberland Plain woodland Shale/Sandstone Transition Forest). Weed management and vegetation management will be implemented as part of the proposed works, to ensure that vegetation retained and vegetation within adjacent areas is not modified as a result of the proposal. (ii) The vegetation within the study area is linked to other areas of potential habitat, particularly where the study area intersects riparian corridors such as through the Hawkesbury River and Redbank Creek. The connectivity provided by these riparian corridors in combination with the relatively small amount of vegetation clearing required, would indicate that is unlikely that habitat occurring within the locality will become fragmented or isolated as a result of the proposed works. (iii) The habitat within the study area is highly degraded and provides low quality habitat for the Swift Parrot. There are larger, intact forested areas less than 1.5 kilometres to the east of the site and several riparian corridors provide connecting links between remaining remnant vegetation. Therefore, the habitat to be removed would not be considered of high importance to the survival of the species in the locality.
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 an area of outstanding biodiversity value.
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.
Key threatening processes of relevance to Swift Parrot include loss of winter flowering foraging habitat, roosting habitat loss from forest harvesting and development, competition from introduced species, unsuitable fire regimes, predation, and further habitat fragmentation. The current proposal will result in the removal of 0.71 ha of native vegetation which may be used by the Swift Parrot. As the level of clearing is considered relatively low and will not impact connectivity to foraging habitat it is unlikely that the proposed works will increase the impacts of any key threatening process for this species.
Conclusion.

Test of Significance for Swift Parrot *Latham discolor*

Based on the assessment provided above, it is concluded the Project is unlikely to lead to a significant impact to Swift Parrot. Swift Parrots were not recorded during surveys within the study area and whilst small numbers of individuals may occasionally forage within the vegetation of the study area, the relatively small portion of native vegetation proposed to be removal (0.71 ha) represents only a fraction of the foraging habitat over the extent of the occurrence of the non-breading population. Mitigation measures will be implemented to minimise risk of indirect impacts. Furthermore there are higher quality resources located nearby and the removal of 0.71 ha of native vegetation from the study area is not likely to constitute a significant impact to an important population.

Appendix 2 Significant Impact Criteria assessments

Swift Parrot *Lathamus discolor* – Critically Endangered

Table 14 Swift Parrot *Latham discolor*, EPBC critically endangered species

SIC assessment for critically endangered or endangered species
Lead to a long-term decrease in the size of a population.
Whilst the vegetation within the study includes key feed tree species for Swift Parrot such as the Red Gum *Eucalyptus tereticornis,* Broad-leaved Ironbark *Eucalyptus fibrosa,* Cabbage Gum *Eucalyptus amplifolia* and *Acacia floribunda* and parts of the study area fall within the important areas mapping for Swift Parrot habitat (DPIE 2021) the overall quality of the vegetation within the study area is relatively poor and highly fragmented, predominantly occurring through urban areas and along road verges. Vegetation occurring within the Swift Parrot important areas mapping near the North Richmond WWTP, represent the highest quality vegetation within the study area, however due to the relatively small portion of vegetation be impacted, high levels of connectivity throughout the greater area to equal or better foraging resources, weed infestation within the study area and due to the highly mobile nature of the Swift Parrot is it unlikely that the proposed works would have any impact to the long term decrease in population size of the Swift Parrot.
Reduce the area of occupancy of the species.
The Swift Parrot is a migratory species that occurs over a large range from Tasmania to south-east Queensland. The proposed word are expected to impacts of 0.27 ha of River-Flat Eucalypt forest, 0.31 ha of Cumberland Plain woodland and 0.11 ha of Shale/Sandstone Transition Forest situated within or near Swift Parrot important areas mapping near North Richmond WWTP. As the majority of the study area is within urban centres and along road verges it is likely that if the species uses the study area, it also utilises the entire riparian corridor along the Hawkesbury River and Redbank Creek, which is provide connection to other areas of notable foraging habitat. Given the large range of the species, the minimal impact to potential habitat and the availability of nearby habitat of greater or equal quality, it is unlikely the project will result in a decrease in the area of occupancy for this species
Fragment an existing population into two or more populations.
The project propose to remove only a small corridor of habitat from the study area, which would not represent any significant risk of causing population fragmentation. The potential of indirect impacts are minimised by mitigation measures such as installation of exclusion fencing, tree protection measures and establishing no-go areas. The species is highly mobile and individuals can move freely through areas of unsuitable and marginal habitat to seek out and exploit favourable habitat patches. As a result, the proposal will not fragment the population into two or more populations.
Adversely affect habitat critical to the survival of a species.
Several key feed tree species utilised by the Swift Parrot have been recorded within the study area, include Red Gum, Broad-leaved Ironbark, Cabbage Gum and *Acacia floribunda*. The site is also mapped as key Swift Parrot habitat, under the important areas mapping (DPIE 2021) in the northwest portion of the study area near the North Richmond WWTP. Although the study area contains important areas mapping and known feed trees the overall quality of this habitat is poor due to its highly degraded nature and fragmentation throughout the landscape. As such that it is unlikely to be providing critical habitat for this species. As this project propose to remove only a small portion of poor quality habitat; which represent foraging and roosting habitat only, it is unlikely to adversely affect critical habitat that would likely have an impact on the survival of Swift Parrot.

SIC assessment for critically endangered or endangered species
Disrupt the breeding cycle of a population.
This species breeds in Tasmania and therefore there is no breeding habitat within the study area.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
The proposed works would result in the removal of approximately 0.71 ha of native vegetation, including 0.27 ha of River-Flat Eucalypt forest, 0.31 ha of Cumberland Plain woodland and 0.11 ha of Shale/Sandstone Transition Forest, which may be utilised as foraging habitat for the Swift Parrot. There are several known winter flowing trees found within the study area including Red Gum, Broad-leaved Ironbark, Cabbage Gum and *Acacia floribunda*. As the majority of the site falls within highly disturbed urban areas it is unlikely that this species would be utilising trees along the majority of the alignment. There is some potential for individuals to be utilising vegetation within the golf course near the Richmond WRP and the North Richmond WWTP, however it is unlikely that the small portions of vegetation being removed would contribute to the overall decline of the species.
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 project is unlikely to exacerbate the current level of invasive species threat operating within the study area to the point that they become harmful to the Swift Parrot.
Introduce disease that may cause the species to decline.
The proposed action is unlikely to introduce a disease that causes the Swift Parrot to decline.
Interfere with the recovery of the species.
The National Recovery Plan for Swift Parrot outlines four recovery actions: 1. Identify the extent and quality of habitat 2. Manage and protect Swift Parrot habitat at the landscape scale 3. Monitor and manage the impact of collisions, competition and disease. 4. Monitor population and habitat The study area contains potential foraging and roosting habitat for this species. However, as the habitat is degraded, the amount of native vegetation being removed is relatively small 0.71 ha and riparian corridors provide connectivity throughout the landscape, the works are therefore unlikely to result to direct or indirect impacts to the recovery of Swift Parrot.
Conclusion.
Based on the assessment provided above, it is concluded the project is unlikely to lead to a significant impact to Swift Parrot. Swift Parrots were not recorded during surveys within the study area and whilst small numbers of individuals may occasionally forage within the vegetation of the study area, the relatively small portion of native vegetation proposed to be removal (0.71 ha) represents only a fraction of the foraging habitat over the extent of the occurrence of the non-breading population. Mitigation measures will be implemented to minimise risk of indirect impacts. Furthermore there are higher quality resources located nearby and the removal of 0.71 ha of native vegetation from the study area is not likely to constitute a significant impact to an important population.

Appendix E – Heritage

Aboriginal heritage information must not be made publicly available or be published in any form or by any means by Sydney Water or our contractors / joint ventures, unless where approval has been sought from OEH's AHIMS Registrar and provided in writing to Sydney Water.

For those REFs which are being publicly displayed, all Aboriginal heritage information which identifies individual sites must be removed.

RICHMOND PRECINCT WASTEWATER NETWORK UPGRADES
NORTH RICHMOND, NSW

Aboriginal Cultural Heritage Assessment Report

Prepared for Sydney Water

Hawkesbury Local Government Area

December 2021

Ref. 2029

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Executive Summary

Sydney Water is seeking to undertake a series of upgrades and new construction for wastewater infrastructure at Richmond and North Richmond, in north western Sydney, NSW. The proposal is within the Hawkesbury Local Government Area. Sydney Water proposes to consolidate both the Richmond Water Recycling Plant (WRP) and the North Richmond Waste Water Treatment Plant (WWTP) by transferring all wastewater flows to an upgraded Richmond WRP. The wider project includes a new wastewater pumping station, new transfer main between Richmond WRP and North Richmond WWTP and a series of network upgrades including emergency storages, maintenance holes and emergency relief structures.

Sydney Water engaged Kelleher Nightingale Consulting Pty Ltd to prepare an Aboriginal cultural heritage assessment report (CHAR) for certain areas of the project located on the western side of the Hawkesbury River at North Richmond, and to assist in the preparation of an Aboriginal Heritage Impact Permit (AHIP) application for Aboriginal objects that will be harmed by these proposed works. The CHAR study area includes the new wastewater pumping station (SP0069) at North Richmond, the new pressure/transfer main for SP0096 west of the Hawkesbury River, three maintenance holes along Redbank Creek, and one emergency relief structure on Redbank Creek near the existing WWTP.

This CHAR has been prepared in accordance with the Heritage NSW [formerly Office of Environment and Heritage] *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW*. Consultation with Aboriginal stakeholders has been undertaken in accordance with the Heritage NSW *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* and the requirements of Clause 60 of the *National Parks and Wildlife Regulation 2019*. The CHAR is supported by an Archaeological Assessment Report for the wider project prepared in accordance with the *Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW*.

Aboriginal archaeological assessment including a test excavation program under the *Code of Practice* identified three Aboriginal archaeological sites within the study area. Impact assessment determined that the three sites will be partially impacted by construction of the proposal. The use of existing infrastructure/disturbance corridors where possible has reduced the overall impact footprint of the project and its effect on Aboriginal heritage. While conservation is the best approach when considering Aboriginal heritage, the complete avoidance of all Aboriginal archaeological sites within the study area was not possible due to the requirements of the project and limited area in which it could occur.

The sites exhibit moderate archaeological significance based on their scientific value and potential to inform on Aboriginal landscape use of key landforms on the margin of the Hawkesbury River floodplain. A mitigation program comprising archaeological salvage, undertaken prior to construction, is required where portions of at least moderately significant Aboriginal archaeology would be impacted by the proposed work. Mitigative salvage excavation would be required for the impacted portion of the three identified sites.

A land based AHIP should be obtained under section 90 of the *National Parks and Wildlife Act 1974* for the impact area of the proposal. The AHIP should include Aboriginal objects associated with the impacted portions of the following sites:

Terrace Road Redbank Creek AFT 1	45-5-5543	Partial impact	Moderate significance
Terrace Road Hawkesbury River AFT 1	45-5-5541	Partial impact	Moderate significance
Norfolk Place Hawkesbury River AFT 1	45-5-5542	Partial impact	Moderate significance

The AHIP should include provision for archaeological salvage excavation within the impacted site areas. Salvage excavation should be completed prior to any works which may harm Aboriginal objects at these site locations. The location of the non-impacted site areas should be avoided by the proposed works. Protection measures should include identification in the Construction Environmental Management Plan as environmentally sensitive “no-go zones” on maps and workers inducted as to appropriate protection measures. Temporary protective fencing that is difficult to move/reposition during the construction works may be required along the AHIP boundary.

Contents

Figures

Tables

1 Introduction

1.1 Project background, proponent and consultants

Sydney Water is seeking to undertake a series of upgrades and new construction for wastewater infrastructure at Richmond and North Richmond, in north western Sydney, NSW. The proposal is within the Hawkesbury Local Government Area (LGA). Sydney Water proposes to consolidate both the Richmond Water Recycling Plant (WRP) and the North Richmond Wastewater Treatment Plant (WWTP) by transferring all wastewater flows to an upgraded Richmond WRP. Currently, the North Richmond WWTP is experiencing capacity issues, and regulatory non-compliances associated with wet weather overflows. As a result, the North Richmond WWTP and the Richmond WRP require upgrades to facilitate growth in the catchment and meet current and known future regulatory requirements.

The wider project includes a new wastewater pumping station, new transfer main between Richmond WRP and North Richmond WWTP and a series of network upgrades including emergency storages, maintenance holes and emergency relief structures. The project will help to service population growth in the Richmond Precinct and would ensure ongoing compliance with the Environmental Protection Licence (EPL) into the future.

Sydney Water engaged Kelleher Nightingale Consulting Pty Ltd (KNC) to prepare an Aboriginal cultural heritage assessment report (CHAR) for certain areas of the project located on the western side of the Hawkesbury River at North Richmond, and to assist in the preparation of an Aboriginal Heritage Impact Permit (AHIP) application for Aboriginal objects that will be harmed by these proposed works.

This CHAR has been prepared in accordance with the Heritage NSW [formerly Office of Environment and Heritage (OEH)] *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011). Consultation with Aboriginal people has been undertaken in accordance with the Heritage NSW *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (OEH 2010a) and the requirements of Clause 60 of the *National Parks and Wildlife Regulation 2019*. The CHAR is supported by an Archaeological Assessment Report (KNC 2021) for the wider project prepared in accordance with the *Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW* (OEH 2010b).

1.2 Location and scope of work

Richmond WRP and North Richmond WWTP currently service two independent wastewater systems separated by the Hawkesbury River. The distance by road between the two treatment plants is about 6.5 kilometres. The wider project comprises upgrades to the wastewater network within both the Richmond and North Richmond wastewater catchments including upgrades to pumping stations, wastewater mains, maintenance holes and emergency relief structures.

The ‘study area’ for this CHAR comprises certain proposed upgrade and construction locations for the project located west of the Hawkesbury River at North Richmond. The scope of work for the wider project is provided in Table 1 below.

The CHAR study area includes the new wastewater pumping station (SP0069) at North Richmond, the new pressure/transfer main for SP0096 west of the Hawkesbury River, three maintenance holes along Redbank Creek, and one emergency relief structure (ERS) on Redbank Creek near the existing WWTP.

Figure 1 shows an overview of the CHAR study area, with Figure 2 showing the relevant components being assessed for the CHAR. The remainder of the wider project area (east of the Hawkesbury River) was assessed as part of the Archaeological Assessment Report (KNC 2021) and no impact to Aboriginal heritage was identified in this area.

Construction is anticipated to start in early-2022 and be completed by mid- 2023.The work sites will be restored to their pre-existing condition following construction in consultation with landowners.

Table 1. Richmond Precinct wastewater network upgrades - scope of works for wider project

Works required	Asset/Location	Description of works
Site establishment		• Set up of site sheds, signage, amenities, material laydown areas and construction areas • Establish environmental controls
New wastewater pumping station to replace the existing pumping station. The new pumping station will have a larger capacity of 250 L/s compared to the existing 90L/s capacity.	SP0069	• Removal of trees as required • Relocation of minor services • Construction of temporary access roads • Removal of the first flush system • Relocation/demolition of the existing sludge pump system • Construction of a temporary chlorine dosing unit • Excavation to approximately 20m deep • Construct new pumping station including associated electrical equipment • Replace existing single 90L/s wet weather pump with two new 90L/s wet weather pumps • Trenchless construction to connect the new pumping station with the existing pumping station prior to decommissioning of the existing one.

New pressure/transfer main for SP0096	Between SP0096 and Richmond WRP	• Construction of 6.7km DN560 PE/DN400 P pressure main to transfer flows from SP0096 to Richmond WRP.
		• Inlet pipework via open trenching
		• Trenchless construction (10-15m deep) at key locations including:
		  ○ Hawkesbury River - 339 m using HDD
		  ○ Redbank Creek - 159 using HDD or microtunnelling
		  ○ Pughs Lagoon
		  ○ Railway line - 161m using micro tunnelling
		• For each of these locations, a secondary pipeline has been provided parallel to the primary pipeline to provide redundancy in the system.

Duplication and amplification of existing network sewer mains	North Richmond	• Duplication of approximately 520m of an existing DN225 gravity sewer • Amplification and duplication of 230m of existing gravity sewer from DN300 to DN375 through opening trenching • Duplication of 170m of an existing DN300 gravity sewer through opening trenching
New emergency storage at existing pump station	SP0527 SP0913	• Construction of two new emergency storages • Construction of a new platform for the electrical kiosk • Trenchless construction to connect the new emergency storage to the existing wet well.
New diesel pump at existing pump station	SP0383	• Installation of a new diesel pump • Construction of an acoustic housing for the pump due to its proximity to nearby residences.
Emergency relief structure rectification	1072994 1073014 1073050 1072922 1394518 1072946	• Underground pipework & concrete structure modification for the discharge ERSs • Replacing of valves in all ERSs
Maintenance hole rectification	1072690 1075162 1075154 1394872	• Replacing the maintenance hole covers

1.3 Statutory controls and development context

The proposal is for wastewater infrastructure and will be assessed under Part 5 of the *Environmental Planning and Assessment Act 1979.* Sydney Water is preparing a Review of Environmental Factors (REF) for the project.

Aboriginal objects will be harmed by the proposed activities and an application for an AHIP is being made under section 90A of the *National Parks and Wildlife Act 1974*. This CHAR has been prepared to support the AHIP application. It has been prepared in accordance with the *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011).

Figure 1. Overview of the study area

1.4 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NPW Act) is the primary statutory control dealing with Aboriginal heritage in New South Wales. Items of Aboriginal heritage (Aboriginal objects) or Aboriginal places (declared under section 84) are protected and regulated under the NPW Act.

Under the Act, an "Aboriginal object" is defined as "any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction and includes Aboriginal remains". As such, Aboriginal objects are confined to physical evidence and are commonly referred to as Aboriginal sites.

Aboriginal objects are protected under section 86 of the Act. It is an offence to harm or desecrate an Aboriginal object, either knowingly [section 86 (1)] or unknowingly [section 86 (2)].

There are offences and penalties relating to harm to, or desecration of, an Aboriginal object or declared Aboriginal place. Harm includes to destroy, deface, damage or move. Penalties are tiered according to offences, which include:

- a person must not harm or desecrate an Aboriginal object that the person knows is an Aboriginal object
- a person must not harm an Aboriginal object (strict liability offence)
- a person must not harm or desecrate an Aboriginal place (strict liability offence)
- failure to notify Heritage NSW of the location of an Aboriginal object (existing offence and penalty)
- contravention of any condition of an AHIP.

Under section 87 (1) it is a defence against prosecution if "(a) the harm or desecration concerned was authorised by an Aboriginal heritage impact permit and (b) the conditions to which that Aboriginal heritage impact permit was subject were not contravened".

Section 87 (2) of the Act provides a defence if "the defendant exercised due diligence to determine whether the act or omission constituting the alleged offence would harm an Aboriginal object and reasonably determined that no Aboriginal object would be harmed".

Section 89A of the Act relates to the notification of sites of Aboriginal objects, under which it is an offence if the location of an Aboriginal object is not notified to the Director-General in the prescribed manner within a reasonable time.

Under section 90 (1) of the Act "the Director-General may issue an Aboriginal heritage impact permit". The regulation of Aboriginal heritage impact permits is provided in Part 6 Division 2 of the Act, including regulations relating to consultation (section 90N).

An AHIP is required for an activity which will harm an Aboriginal object.

1.5 Objectives of the CHAR

The proposed infrastructure works will impact on Aboriginal objects (sites). Approval obtained under the *National Parks and Wildlife Act 1974* is required for these Aboriginal objects prior to any impact or harm. The proponent is applying for an AHIP under section 90A of the Act. Clause 61 of the *National Parks and Wildlife Regulation 2019* requires that an application for an AHIP is accompanied by a CHAR. The CHAR is to provide information on:

- The significance of the Aboriginal places that are the subject of the application
- The actual or likely harm to those Aboriginal objects or Aboriginal places from the proposed activity that is the subject of the application
- Any practical measures that may be taken to protect and conserve those Aboriginal objects or Aboriginal places
- Any practical measures that may be taken to avoid or mitigate any actual or likely harm to those Aboriginal objects or Aboriginal places.

The Heritage NSW *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011) provides further guidance on the preparation of a CHAR. This report has been prepared in accordance with the requirements of the Regulation and the Heritage NSW guide.

This CHAR has been prepared to accompany an application for an AHIP for Aboriginal objects impacted by the project, including those associated with the impacted portions of Aboriginal archaeological sites Terrace Road Redbank Creek AFT 1, Terrace Road Hawkesbury River AFT 1 and Norfolk Place Hawkesbury River AFT 1.

Figure 2. Detail of the study area and proposal components

2 Landscape Context

2.1 Geology

The study area is located in a transitional zone between two physiographic regions, where the western margin of the Cumberland Plain meets the eastern foothills of the Blue Mountains Plateau. The underlying geology of these physiographic regions strongly influences landform, soil types and hydrologic characteristics of the surrounding area. When mapped at 1:100,000 scale, the study area intersects various geological formations (Figure 3). The majority of the study area is located atop Ashfield Shale of the Wiannamatta Group. Ashfield Shale formed during the Middle Triassic Period and consists of dark-grey to black sideritic claystone and siltstone which grades upward into a fine sandstone-siltstone laminate (Clark and Jones 1991). Ashfield Shale remains as erosional remnants underlying the elevated ridgelines on the foothills of the predominantly sandstone plateau. One of the maintenance holes and a portion of the new pressure main occur on this underlying geology. The township of North Richmond occupies this higher ground on the western side of the river. The Hawkesbury Sandstone is the chief geological formation which forms the dissected plateau and foot slopes of the Blue Mountains to the west, consisting of mostly medium-coarse grained lithic quartz sandstone with minor laminated mudstone and siltstone lenses. Hawkesbury Sandstone outcrops along the various creek lines dissecting the foothills, including along Redbank Creek and other tributaries to the Nepean/Hawkesbury River. It underlies the North Richmond WWTP and new SP0096 area, ERS and two of the maintenance holes.

Bordering the Nepean/Hawkesbury River is a wide band of Quaternary (Cainozoic) deposit known as the Lowlands Formation, which forms a broad, low terrace between Castlereagh and Pitt Town with narrower deposits on the western side of the river east of North Richmond. The Lowlands Formation consists of basal gravels, grading upwards to sand, silt and clay. Fine lithic quartz sands occur in a thin band paralleling the present river course between Agnes Banks and Cordners Corner, near Windsor. The gravel component includes granite, porphyry, volcanics, basalt, quartz, quartzite, chert and sandstone. Gravel beds are present along the Hawkesbury/Nepean. The Lowlands Formation broadly corresponds with the extent of major flooding events (1-100 year) along this section of the Hawkesbury, and forms the modern floodplain. To the east of the study area, a small area is mapped as the Clarendon Formation, a sheet deposit of clay, clayey sand and silt overlying the eroded remnants of the Tertiary level terrace. This same formation underlies the elevated townships of Agnes Banks, Richmond and Clarendon on the higher level Tertiary terrace east of the river.

2.2 Soil landscapes

Soil landscapes within the study area are influenced by the underlying geology and topography, with the variety of soil landscapes present (Figure 3) highlighting the complex depositional environment associated with the river (Bannerman, Hazleton and Tille 1990). Residual soils of the Blacktown Soil Landscape occur on the more elevated Ashfield Shale underlying North Richmond on the western side of the river. These are primarily derived in situ from underlying lithologies and consist of shallow to moderately deep hard-setting red, brown and yellow podzolic soils. Soil fertility and soil drainage are low. Erosional susceptibility of this soil landscape is relatively low, but is increased where surface vegetation is not maintained (Bannerman, Hazleton and Tille 1990). Blacktown soils have the capacity to conserve Aboriginal objects in situ, but their deflationary tendency means vertical stratigraphy is often lost.

Bordering the river and roughly analogous with the Lowlands Formation and modern floodplain are alluvial soils of the Freemans Reach Soil Landscape. These soils occur on level landforms with minor relief to meander scrolls, levees and backwater swamps and are part of current, active floodplains. Parent materials are derived from the surrounding Narrabeen Group and Wianamatta Group geologies. The Freemans Reach soil landscape consists of sandy loam, apedal sand and apedal sandy clay loam overlying sandy clay and has a high level of stream bank erosion in addition to permanently high water tables and seasonal waterlogging. Being an active flood plain, this soil landscape is dynamic, with streambank erosion and deposition occurring constantly. The floodplain is also subject to scour, sheet and rill erosion during flood events, with a varying depth of sedimentary material left behind once the waters recede. Archaeological potential is strongly dependent on topography and flood effects.

2.3 Hydrology and topography

Hydrology and topography around the study area is dominated by the Hawkesbury River, a major river of coastal NSW (Figure 4). The Hawkesbury River forms a boundary between the foothills of the Blue Mountains and the low lying, gently undulating plain and hills of the Cumberland Plain. Numerous lower order watercourses dissect the rolling low hills at the base of the Blue Mountains and the Tertiary terrace system to the east. West of the river, the principal tributary within the study area is Redbank Creek, an east flowing third order tributary of the Hawkesbury River. The study area also contains several first and second order tributaries of Redbank Creek which flow to the north or east. Farm dams and waterbodies have been constructed to capture the runoff of these minor drainage tributaries and have likely altered the original hydrology of the study area across the foothills. Redbank Creek has its confluence with the river proper approximately 1.4km downstream of the existing Richmond Bridge, at a low-lying swampy area.

The confluence of the Grose and Nepean Rivers is the point at which the Nepean becomes the Hawkesbury, approximately 3.5 kilometres upstream of where the study area crosses the Hawkesbury. The nature of the river corridors has been subject to change over time, varying between well-defined single channels and banks, to broad braided channel systems many kilometres wide. Flood events are common and range from minor to extreme. The effects of recent heavy rainfall and extensive flooding across north western Sydney in March 2021 were apparent during the field survey for the project (see KNC 2021), with large portions of the study area inundated. This was estimated as the worst flooding in over 30 years, peaking at 12.9 metres at Windsor.

The 1:100 year flood level at North Richmond is 17.5 metres Australian Height Datum (m AHD). A flood study undertaken for the Hawkesbury LGA indicates that flooding up to the 1:100 year flood level would affect almost the entirety of the study area west of the river, while a flood at Probable Maximum Flood (PMF) extent (26.5m AHD at North Richmond) would also inundate the township of Richmond and eastern part of North Richmond (approximate extent shown in Figure 5).

Bordering the western and northern edges of the Cumberland Plain, the Nepean/Hawkesbury forms a relatively wide channel with a broad floodplain. Further downstream at Sackville, the river enters a narrow gorge system which confines it to a narrower channel. The result of this topography is that during flood events, water is unable to exit the floodplain at the same fast rate as which it is coming in. Backflow of flood waters up tributary systems such as South Creek, Eastern Creek, Rickabys Creek and the Grose River then occurs, causing further inundation of surrounding areas. In most rivers in NSW, the differences between the 100 year flood level and the PMF are relatively small (i.e. nearly always less than 2 metres). However the water levels in the Hawkesbury River during an extreme flood can rise up to three building storeys above the 100 year flood level. During these major events, significant areas of land are inundated (Figure 5). The unique topography of the Hawkesbury/Nepean river valley contributes to more severe flooding characteristics than are common along other major river systems of south eastern Australia. Flooding is therefore a key factor when assessing long-term Aboriginal landscape use and the preservation of resulting archaeological deposits.

2.4 Vegetation and land use

Native vegetation within the study area has been extensively modified by European land use practices. European settlement of the area began in the in the late 18th century with several land grants made along the Hawkesbury River. The land grants were primarily utilised for growing maize, wheat and barley in addition to raising cattle, sheep, goats, pigs and horses. The occurrence of several floods in the late 18th and early 19th centuries prompted the establishment of settlements on the elevated landforms adjacent to the Hawkesbury River floodplain including Windsor, Richmond, Castlereagh, Wilberforce and Pitt Town. The fertile soil of the river's floodplain acted as the 'bread basket' for the early colony, leading to early and widespread vegetation clearance, particularly across the Richmond Lowlands. Prior to this, a diverse range of flora and fauna would have been present across various vegetation communities.

West of the river, the rolling foothills contained Shale/Sandstone Transitional Forest (both low and high sandstone influences) and Shale Plains Woodland, with Riparian Forest along the Hawkesbury. To the east, Alluvial Woodland and Freshwater Wetlands would have occupied the Richmond Lowlands, while the more elevated Tertiary terrace was dominated by Shale Plains Woodland, Alluvial Woodland and Shale Gravel Transition Forest around the terrace edges. The variety of vegetation communities would have encouraged a diverse population of fauna and provided a wide range of resources for Aboriginal people.

Land use practices have had a variable impact on the landscape within the study area. Existing road and rail corridors have modified the landscape by creating cuttings and artificial embankments in addition to modifying the course of several waterways. Existing wastewater infrastructure has cause localised severe disturbance. A number of dams and drainage line modifications have been constructed throughout the area, altering the area's hydrology and smaller-scale drainage patterns. Vegetation clearance has contributed to the erosion of exposed soils along fence lines and infrastructure corridors, and accelerated erosion and stream bank incision along waterways. Ongoing rural and residential development has also contributed to disturbance. Overall, land use disturbance around the study area is generally characterised by vegetation clearance, agriculture, construction of roads, tracks, buildings and infrastructure, fill dumping and the environmental effects of erosion and flooding.

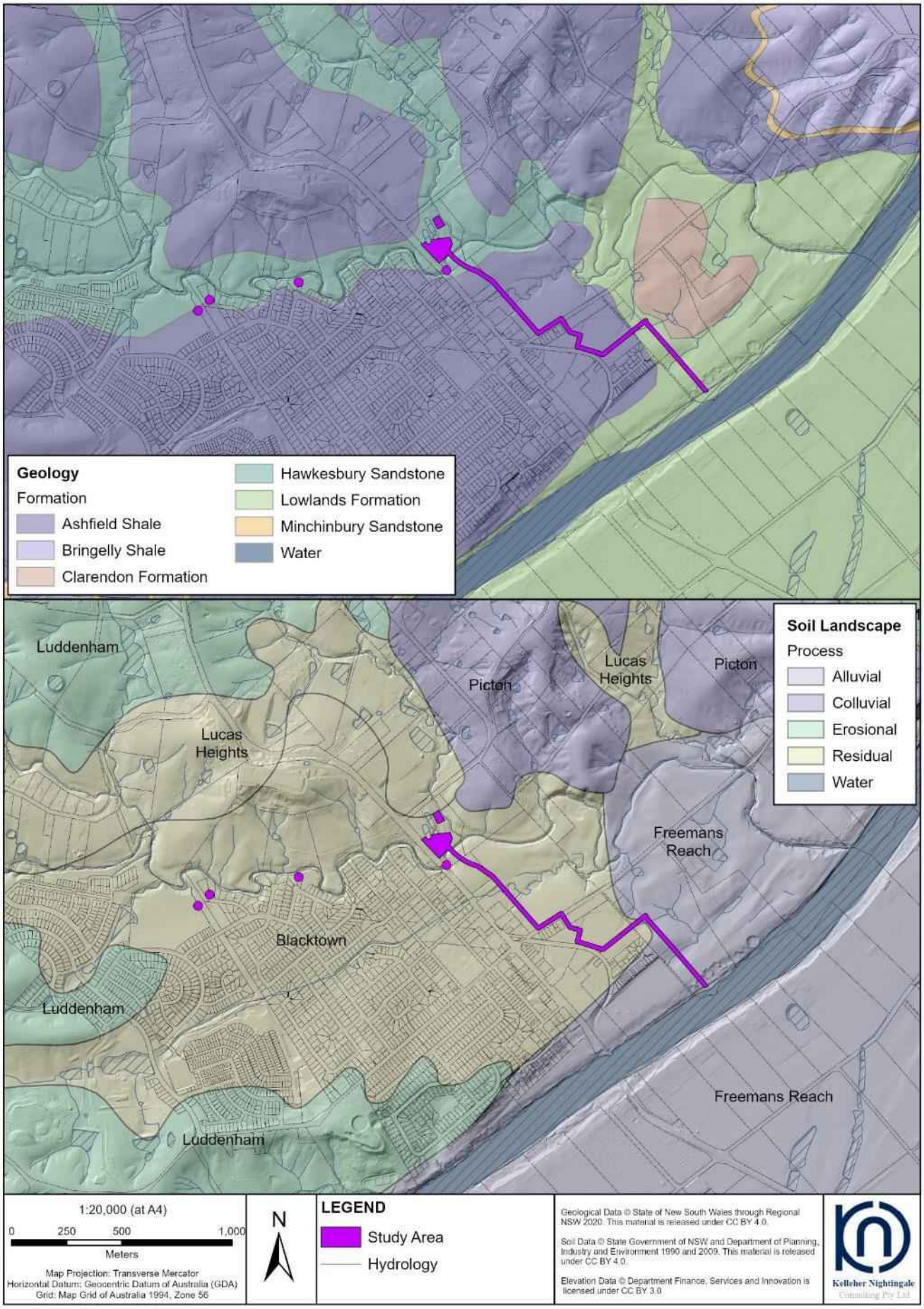

Figure 3. Geology and soil landscapes of the study area

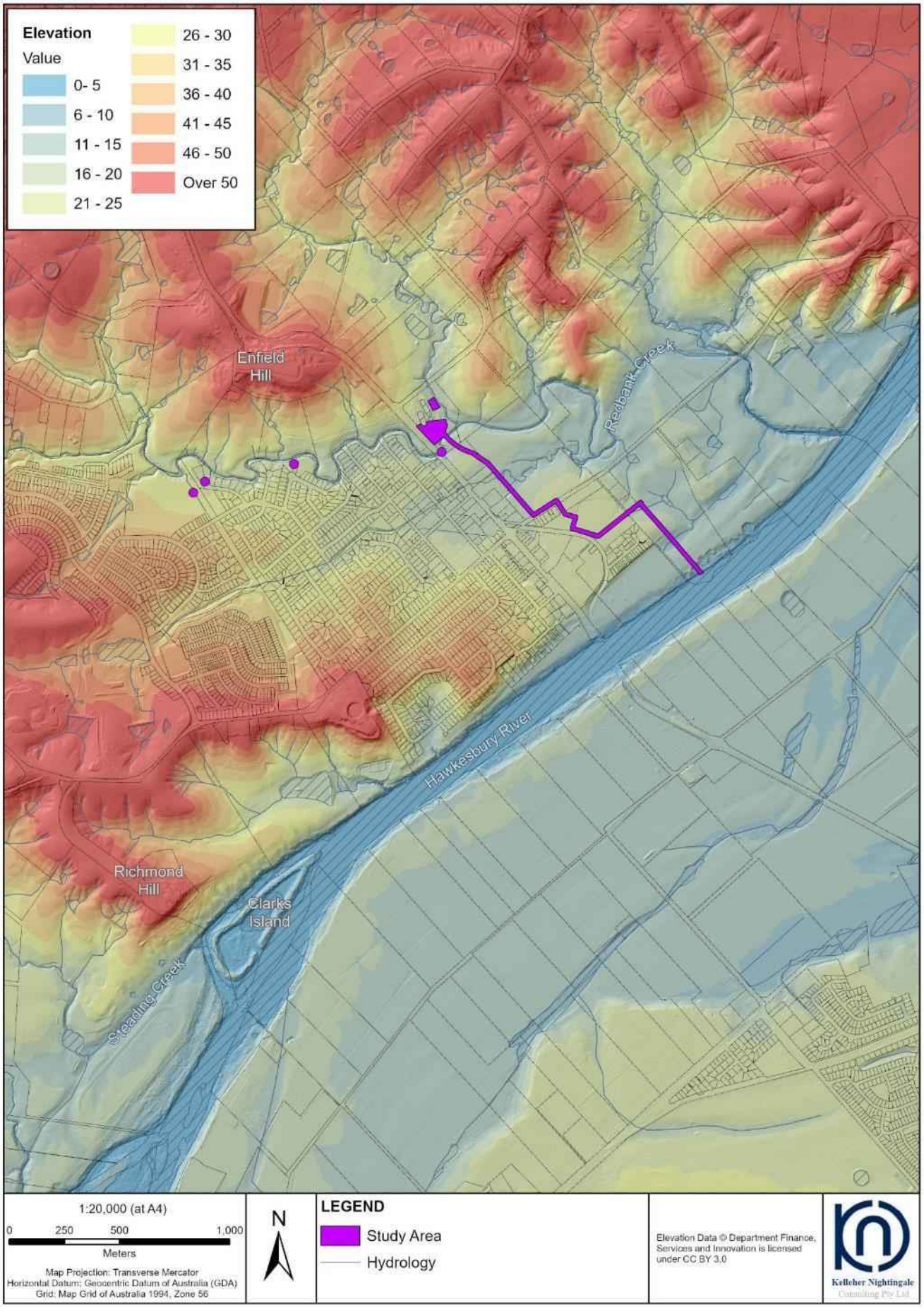

Figure 4. Topography and hydrology of the study area

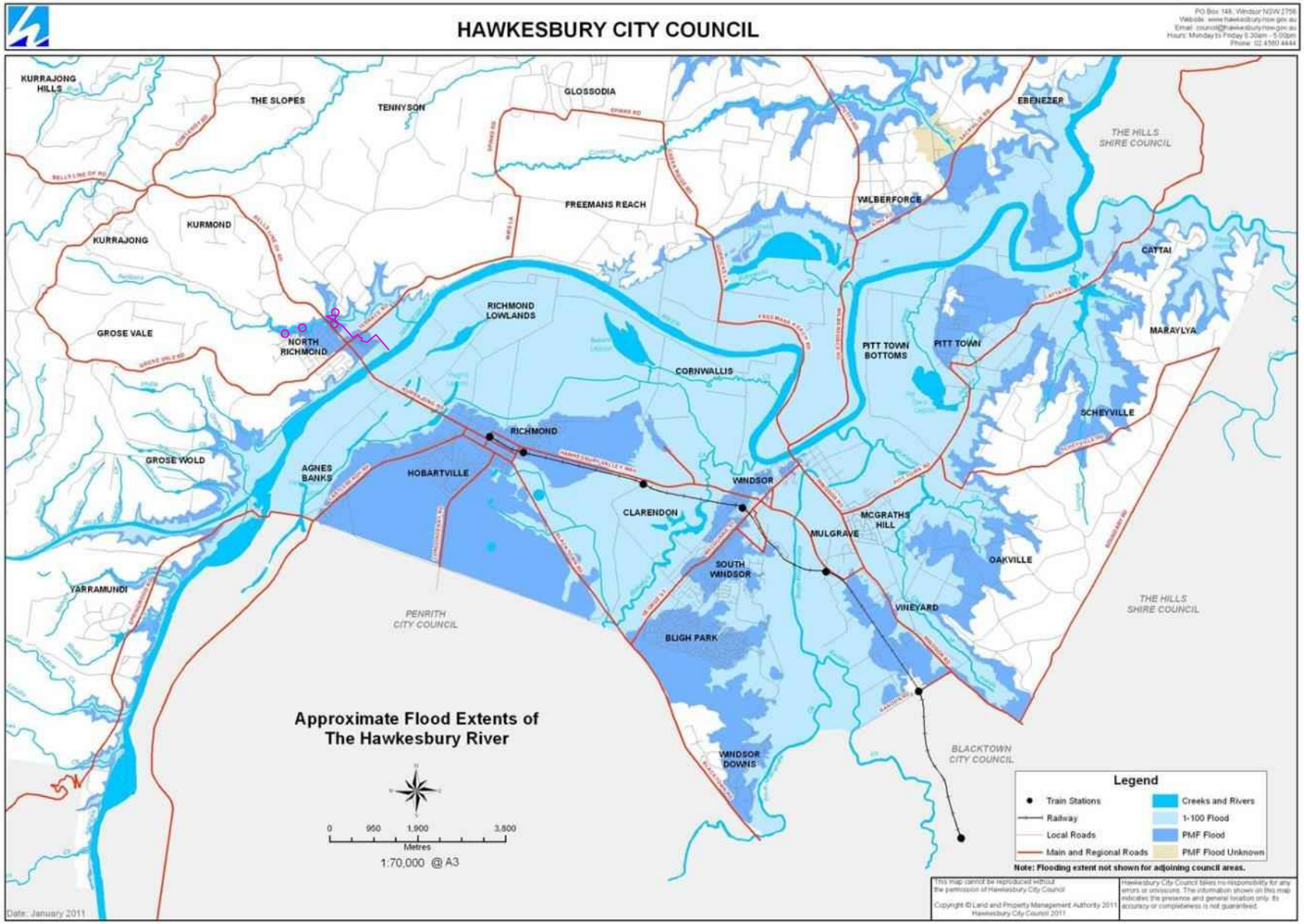

Figure 5. Hawkesbury LGA flood mapping (approximate location of study area shown in purple)
After Bewsher 2012. Available online at https://www.hawkesbury.nsw.gov.au/services/other-key-services/emergency-information/flood-information/flood-extent-maps

3 Ethnohistoric context

Historic accounts of the Indigenous inhabitants of the Sydney area provide an insight into Aboriginal life at the time of initial European exploration and settlement. The study area lies within a landscape which was important to, and intensively used by, past Aboriginal peoples (Attenbrow 2002). Aboriginal people living in the Sydney region at the time of first European contact were distinguished by various language groups. Languages recorded across the region included the Darug, Darkingung, Gandangarra and Tharawal. Included in these were various dialects spoken across territorial ranges. People appear to have been organised into economic units of small residential groups or 'bands' who had an association with certain areas of land and spoke the same dialect of language. The study area lies in a landscape traditionally considered the province of the Darug people.

Darug was first described as a language (or dialectic group) by surveyor, anthropologist and linguist R H Mathews in the early 20th century. He described the extensive range of this language group as follows: "the Dharruk [Darug] speaking people adjoined the Thurrawal on the north, extending [up] to the Hawkesbury River, and inland to what are now Windsor, Penrith, Campbelltown and intervening towns" (Mathews and Everitt 1900). Since then, most historic and linguistic research has suggested that the Darug were principally an 'inland' group, associated with the Cumberland Plain and distinct from Aboriginal groups who frequented the coast. The Darug language group included a number of sub-groups often referred to as 'clans' or 'tribes', based upon family groupings and associations with particular areas of country.

A clan of the Darug group called the Buruberongal were recorded by Governor Phillip as inhabiting lands to the northwest of Parramatta. It is likely that the study area falls within the traditional area of the Buruberongal people, who were associated with Yarramundi and nearby Richmond Hill. Ethnohistorical sources suggest that despite differences in words used, customs and material culture, the Buruberongal people and other Darug 'clans' would have interacted with neighbouring language groups for ceremonies, intermarriage, dispute resolution, trade and access to certain resources in the region.

The expedition led by Governor Phillip in 1789 to explore the Hawkesbury-Nepean provides the earliest European historical accounts of the region. Various journals kept by members of the party describe the landscape and their first interactions with Aboriginal people of the region. The party reached the junction of the Grose and Nepean Rivers in July 1789, where Captain Hunter recorded they "found the river to divide into two narrow branches, from one of which the stream came down with considerable velocity, and with a fall over a range of stones which seemed to lye across its entrance", with "...too little water for the boats which we had with us to advance any farther, and the stream was very strong". Aboriginal people were clearly inhabiting the area at that time, with Hunter recording various signs of life and occupation at the river confluence:

> *On the banks here also we found yams and other roots, and had evident marks of the natives frequenting these parts in search of them for food. They have no doubt some method of preparing these roots, before they can eat them; for we found one kind which some of the company had seen the natives dig up; and with which being pleased, as it had much the appearance of horse-radish, and had a sweetish taste, and having swallowed a small quantity, it occasioned violent spasms, cramps in the bowels, and sickness at the stomach: it might probably be the casada root.* (Hunter 1793 [1968])).

Hunter later concluded that the Aboriginal people he had seen eating the yams must process them in some way to make them safe for consumption, noting that they "no doubt have some way of preparing these roots, before they can eat them". Other recorders including Captain Watkin Tench (1793:230) also observed Aboriginal use of this resource, noting that for inland people "they depend but little on fish, as the river yields only mullets, and that their principal support is derived from small animals which they kill, and some roots (a species of wild yam chiefly) which they dig out of the earth". These wild yams were found in considerable quantities along the banks of the Hawkesbury-Nepean River and would have formed an important food resource for Aboriginal people living in the area.

Similarly, Kohen (1986:77) records that inland Aboriginal people living between Parramatta and the Blue Mountains were not as dependant on fish and shellfish as groups closer to the coast, but relied on small animals and plant foods in addition to seasonally available freshwater mullet and eels. The Hawkesbury-Nepean River and the lands adjacent were a major resource for Aboriginal people living on the western Cumberland plain. The swamps, wetlands and anabranch channels related to the rivers were a rich source of various birds, shellfish, eels, water rats and fish.

Berries, Banksia flowers and wild honey were also recorded as foods of the local inhabitants (Collins 1798). Small animals provided the protein component of the Aboriginal diet on the wider Cumberland Plain, with hunting comprising a major economic role of the men. Along the river, traps and snares were set for bandicoots and wallabies, while decoys for snaring birds were also a commonly employed technique, "these are formed of underwood and reeds, long and narrow, shaped like a mound raised over a grave, with a small aperture at one end for the admission of the prey" (Tench 1793). During the expedition of Governor Hunter, Aboriginal traps were identified at Richmond Hill, south west of the study area, with Captain Collins recording the following:

> *At the foot of Richmond Hill, I once found several places constructed expressly for the purpose of ensnaring animals or birds. These were wide enough at the entrance to admit a person without much difficulty; but tapering away gradually from the entrance to the end, and terminating in a small wickered grate. It was between forty and fifty feet in length; on each side the earth was thrown up; and the whole was constructed of weeds, rushes, and brambles: but so well secured, that an animal once within it could not possibly liberate itself. We supposed that the prey, be it beast or bird, was hunted and driven into this toil; and concluded, from finding one of them destroyed by fire, that they force it to the grated end, where it is soon killed by their spears. In one I saw a common rat, and in another the feathers of a quail.* (Collins 1798: Appendix IV)

Possums and gliders were also particularly common in the open woodland across the Cumberland Plain and probably formed the main sources of animal food. These were hunted in a number of ways, including smoking out the animal by lighting a fire in the base of a hollow tree, burning large tracts of land and gathering the stranded animals, as well as cutting toe-holds in trees (Kohen 1993:10; Tench 1793:82). The western Sydney basin was also known for a hunting method called 'Walbunga' where kangaroos were flushed out of areas and toward awaiting hunters by way of small grass fires.

Aboriginal firing of the landscape is also considered at least partially responsible for the open, 'park-like' appearance of the lands along the Nepean/Hawkesbury and Cumberland Plain as described by early European accounts. Hunter described how "the trees stand very wide of one another, and have no underwood; in short the woods ... resemble a deer park, as much as if they had been intended for such a purpose". Hunter believed that the fires were set in order to clear underbrush from frequently travelled routes and to make more accessible the roots and tubers found below ground. An additional benefit, as recorded by Philip, were the possums, sugar gliders and other animals which succumbed to the fires and provided a ready source of food (Attenbrow 2002:42). Firing of the landscape may also have ensured the fruiting of certain plant species and allowed for new vegetation growth, which encouraged kangaroos to graze (Attenbrow 2002:42).

The open landscape and fertile soils of the Hawkesbury-Nepean floodplain were encouraging to early recorders as they appeared to present suitable farmland to feed the growing colony. In 1791, Phillip undertook a second expedition through the area in order to determine if the Nepean and Hawkesbury were in fact the same watercourse. This time, two Aboriginal men from Sydney, Colbee and Ballederry, accompanied the party to act as translators. In the vicinity of the current study area, the party encountered three Aboriginal men of a group known as the Buruberongal, who Colbee referred to as 'climbers of trees'. Interactions with the Buruberongal were friendly and the three spent the evening with the European party: Gomberee, his son Yellowmundee (better known as Yarramundi) and young grandson Djimba.

Gomberee gifted two stone hatchets and two spears to Phillip, and received two European axes and some bread in return. Gomberee also demonstrated tree-climbing to the Europeans, speedily climbing up a tree by using toe-hold notches cut into the bark as he went. Tench described Yarramundi as a "Car-ad-yee, or Doctor of renown", indicating that he held special status as a medicine man, as evidenced by a ceremonial operation performed on Colbee that evening (Tench 1793). According to Tench, Ballederry described the Buruberongal as a tribe full of Car-ad-yee of "especial note and skill". The three men left early the next morning and parted on friendly terms.

Unfortunately, subsequent European relations with the Aboriginal inhabitants of the region were not as pleasant. As the Hawkesbury was opened up for land grants and farms were established, European use of land and resources began to seriously impede Aboriginal people's traditional use of the landscape and conflicts inevitably followed. Fearing that the fledgling settlements along the Hawkesbury would have to be abandoned due to raiding and skirmishes with the local Aboriginal inhabitants, Lieutenant-Governor Paterson ordered extreme reprisals against the Darug, ordering the Corps to "kill any Darug they found and hang their bodies from gibbets as a warning to the rest" (Connor 2002:38). Richmond Hill, within the "Belmont" property to the south west of the study area, was the site of a reported battle between local Darug people and the NSW Corps in May and June of 1795 and is considered to be the first recorded battle between Aboriginal people and the white settlers. As a result, a detachment of the military remained in the district for more than 50 years.

The property where the 'Battle of Richmond Hill' took place is approximately 1.5 kilometres south west of the study area, along Grose Vale Road. The original grant included Lots 11 and 12, DP 1134453. A portion of this property, comprising Lot 11 DP 1134453, is currently being considered for accession onto the NSW State Heritage Register for its historic values as an estate, including the mansion and associated gardens. The draft register listing and associated nomination documents also acknowledge that "the larger Belmont Park property on which it is sited may have state significance for its associations with the local Aboriginal people… The property includes an Aboriginal Memorial Garden in the form of a turtle. This is a place of peace, reflection and reconciliation which commemorates Richmond Hill as the site of a fierce battle in 1795 between the Dharug Aboriginal inhabitants and the British colonists. This memorial is considered to be significant". No Aboriginal archaeological values associated with this heritage register listing have been identified to date, but the inclusion of Aboriginal cultural significance of the property in the draft listing indicates the area retains strong cultural value to the Aboriginal community. The Belmont property is located outside of the study area.

By 1803, many local Aboriginal people were reporting difficulties in accessing their traditional lands, as described during a meeting with Governor King: "on questioning the cause of their disagreement with the new settlers, they very ingeniously answered that they did not like to be driven from the few places that were left on the banks of the river, where alone they could procure food; that they had gone down the river as the white man took possession of the banks; if they went across white men's grounds the settlers fired upon them and were angry.

Escalating conflict with the white settlers continued through the early years of the 19th Century. Many officials, including Governor Macquarie, often recognised that these conflicts were initiated by the settlers. The *Sydney Gazette* records a meeting between "two of the Richmond Hill chiefs Yaragowhy and Yaramandy [Yarramundi]" and local officials who gave the men gifts of food and clothes to take back to their people. The skirmishes were a result of tension between the British settlers on farm allotments and the local Aboriginal people of the area, increased by periods of drought during the early years of the colony. By this stage, many traditional hunting and gathering areas had been subsumed by the expansion of farmland and violence escalated between settlers and the local Aboriginal people during a drought through the years 1814-1816 (Brook and Kohen 1991). The drought put the stable supply of food to the growing colony at risk and Macquarie became more inclined to protect the interest of the farmers.

Each case of violence reported from farms dotted around the Sydney region at Bringelly, Appin, along the Nepean and the Hawkesbury Rivers was similar, in that the local Aboriginal people had gone to their traditional food gathering areas, and when they found their usual resources gone, they used the resources that had replaced them, namely crops such as corn, and animals including sheep and cattle. The settlers, seeing this as theft, often shot the Aborigines. In retaliation, a number of settlers were also killed.

A punitive expedition in 1816 was organised in response to this ongoing conflict (Brook and Kohen 1991:23). Three groups of soldiers were sent from Sydney to Cowpastures, the Airds and Appin district and to Parramatta, Windsor, the Grose and the banks of the Nepean respectively (Brook and Kohen 1991: 23). Several Aboriginal guides took part in the punitive expeditions, including Yarramundi's son Colebee and a man named Nurragingy. Brook and Kohen (1991:34) note that of the three punitive expedition parties sent out, the two with Aboriginal guides did not make any significant contact with Aboriginal groups, whereas the one party without Aboriginal guides did, leading to the suggestion that the Aboriginal guides were 'cunningly and successfully shielding their "wild" compatriots'.

Nevertheless, Colebee and Nurragingy were invited to select a parcel of land as a reward for their assistance. The actual location of the grant within the District of Bathurst was selected by Colebee and Nurragingy, south east of the current study area along Richmond Road. The grant was registered in 1819 with only Colebee's name (Brook and Kohen 1991:38) although Colebee did not stay long on the grant, instead becoming a constable at Windsor in 1822, before marrying an Aboriginal girl called Kitty from the Black Town. Colebee's grant was later taken up by his sister Maria, another of Yarramundi's children.

Maria was born at Richmond Bottoms around 1805 and was one of the first students to enter the Blacktown Native Institution in 1814. Maria excelled in her studies and in 1819 it was reported by the *Sydney Gazette* that an Aboriginal girl (almost certainly Maria) had won first prize in the NSW school examinations, ahead of twenty other students from the Native Institution and almost 100 European children. Teachers reported that Maria was "well in advance of other students" (Parry 2005). In 1824 Maria married convict carpenter Thomas Lock in the first officially sanctioned marriage between a convict and an Aboriginal woman. The newlyweds settled on a small farm near the Native Institution but later moved to Liverpool.

In 1831, Maria petitioned Governor Darling for her deceased brother Colebee's lands at Blacktown. Difficulties with adjoining landowners led to a drawn-out struggle for land rights but Maria persisted and in 1843 she received Colebee's 30 acre grant. The Locks returned to Blacktown in 1844 and acquired a further 30 acres. Maria had ten children, born between 1827 and 1844, nine of whom lived to adulthood. Maria's legacy lives on to the present day, with dozens of contemporary Aboriginal families tracing their descent through her to Yarramundi and Gomberee. Aboriginal cultural and familial connection with the study area therefore remains strong, with an unbroken link through time and space stretching back to the 1740s and beyond.

Aboriginal culture and cultural heritage is dynamic and continues to evolve in contemporary times. Despite the major social and economic upheaval that European arrival caused for the Aboriginal people living on the Cumberland Plain, contemporary Aboriginal community groups have retained strong ties to western and northwestern Sydney. The region remains important to Aboriginal people, who have maintained their traditional ties to the area. Aboriginal culture endures to this day across the Cumberland Plain and has influenced many aspects of Australian culture including in the names of animals, localities, creeks and rivers (Walsh 1993). Members of the contemporary Aboriginal community continue to experience connection with the area through cultural and family associations.

4 Archaeological Context

Several archaeological investigations have been conducted within and in the vicinity of the current study area. Previous archaeological investigations have primarily been undertaken as part of planning for residential and commercial developments and associated infrastructure projects within the region. The accompanying Aboriginal archaeological assessment to this CHAR (KNC 2021) provides a review of these assessments, their findings, and relevance to the current study area. The assessment comprised a review of previous archaeological investigations, Aboriginal Heritage Information Management System (AHIMS) and other database searches, analysis of environmental context, archaeological field survey and a test excavation program conducted with Aboriginal stakeholders. The assessment encompassed the wider proposal area, including the current CHAR study area.

Background information review identifies that previous archaeological field surveys and excavations across the region have provided data on artefact distribution, site typology and lithic raw material use that assist in understanding the archaeology of the study area. Aboriginal occupation of the Sydney region is likely to have spanned at least 20,000 years, although dates of potentially more than 40,000 years have been indicated from artefacts found in gravels of the Cranebrook Terrace on the Nepean River. Late Pleistocene occupation sites have been identified around the fringes of the Sydney Basin and from rock shelter sites in adjoining areas: dates of 13,000 years before present (BP) at Shaws Creek in the Blue Mountain foothills; 11,000 BP for Mangrove Creek and Loggers Shelter and c. 20,000 BP at Burrill Lake on the South Coast (Attenbrow 2002).

Archaeological site types in the region correlate with the topography and geology. Open camp sites or artefact scatters and isolated finds dominate the archaeological record of the western Cumberland Plain and are found throughout the region. Previous studies have demonstrated the relationship between artefact densities and proximity to water sources and landform. Relatively elevated landforms along the margins of creeks (especially those offering permanent water) and rivers would have been favourable for occupation by Aboriginal people. This is reflected in the archaeological record by higher artefact densities recorded at these sites, potentially reflecting repeated or more intensive use of these locations. Sandstone geology, especially flat outcrops in association with water sources were utilised for abrading ground stone tools whilst in steeper terrain, rock shelters were used for habitation and art. Previous investigations along Redbank Creek have identified a high value archaeological resource associated with this landscape feature.

Regional archaeology has been variably impacted by historical and current land use practices as well as by natural processes. Preservation of archaeological sites in open contexts is difficult because of the adverse effects of erosion, floods and disturbance from various human activities. Conversely, ground surface visibility is often increased by these processes, leading to increased identification of artefacts in these areas. Previous studies have underscored the relationship between particular landforms and ground disturbance as key factors in the location of archaeological sites. High value archaeological sites occur where significant soil deposits remain largely intact and archaeological context is preserved, notwithstanding artefact frequencies. Portions of the current study area have been disturbed by past land use practices and natural processes. It can be expected that higher-value archaeological deposit will be restricted to areas where these disturbances are limited.

The Rickabys Creek and Nepean River gravels would have provided an abundant and varied source of raw materials for tool making, as evidenced by the wide assortment of materials present in identified archaeological sites within the local area. The riverine environment would also have provided food resources and permanent fresh water sources. The formation of swamps and lagoons by the ever changing channel system created different environments, broadening the range of plant and animal species available in the area. While resource rich, the area immediately surrounding the river may not have been favourable for large scale or more permanent settlements due to flooding. An understanding of flood effects is particularly relevant for assessing Aboriginal archaeology within the Hawkesbury/Nepean floodplain.

The landscape assessment identified that soils within the study area may retain intact archaeology where disturbance to the ground surface has been low. Ground disturbance, vegetation removal and development all accelerate the erosion that the identified soils are prone to. Where these disturbances have occurred, the soils become more vulnerable to destabilisation and erosion during flood events. Aboriginal objects may be present in the deeper soils of lower slopes and drainage lines but these are not always representative of in situ deposit. The alluvial Freemans Reach soils bordering the waterways may retain archaeological deposits where disturbance levels are low, however the dynamic and changing nature of the active floodplain means that finer stratigraphic details may have been lost. Conversely, depositional events during flooding may preserve original stratigraphy intact, particularly on more elevated terrace landforms experiencing lower flood energies. Survivability of archaeological sites and artefacts within the landscape is consequently determined by environmental factors. In the study area and surrounds, the particular characteristics of the Hawkesbury/Nepean system directly influence the stability and integrity of deposits within the floodplain. Erosional processes and flood scouring may remove sites and objects and redeposit them further downstream, or bring in objects from further up the catchment. Conversely, depositional processes that occur during flood events may bury existing sites under an accumulation of new deposit laid down by receding floodwaters, preserving them intact beneath the sediment. The frequency and extent of flooding events of the Hawkesbury/Nepean mean that these processes will have had a profound effect on the archaeology of the study area.

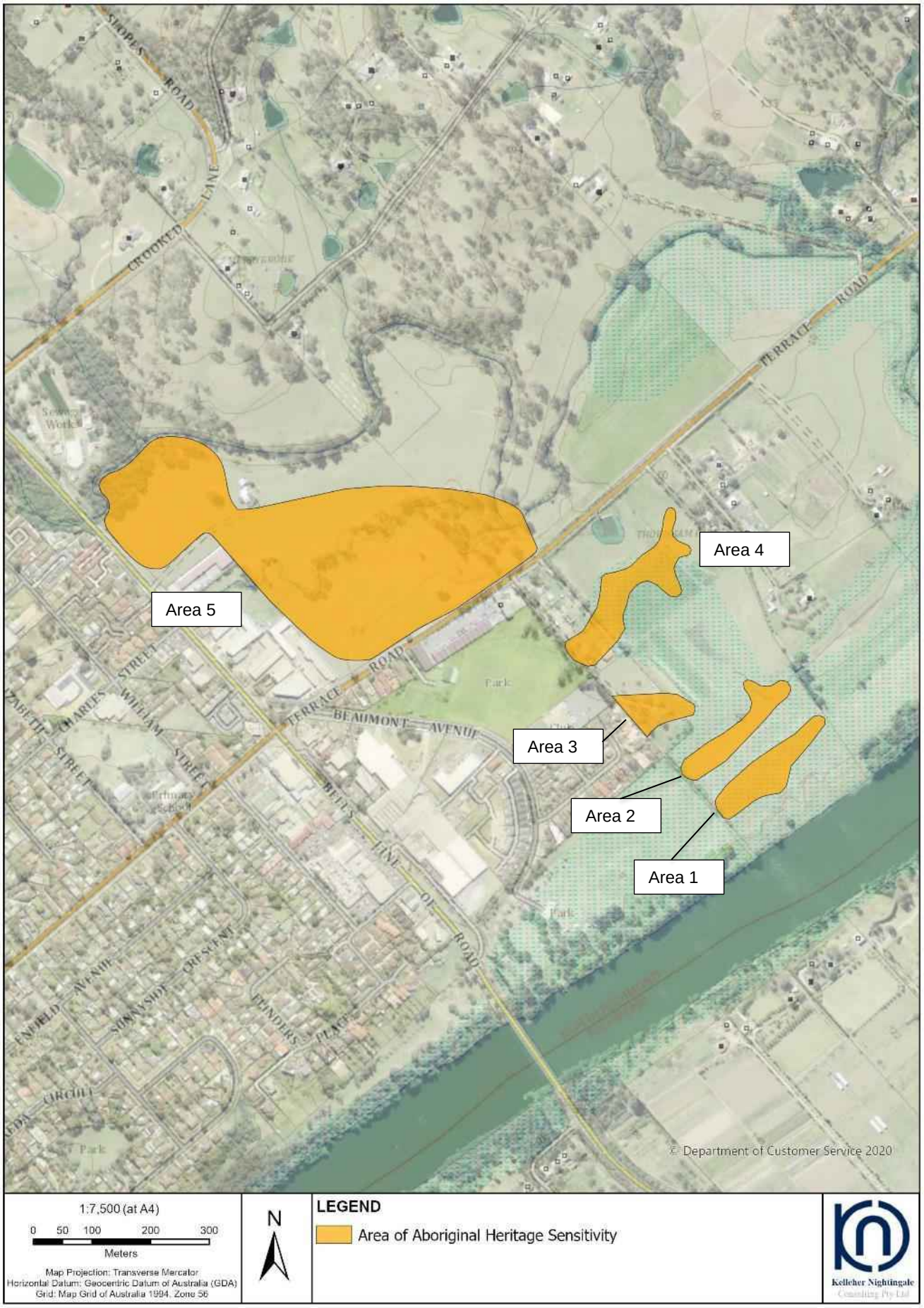

Figure 6. Identified areas of sensitivity following field survey

Archaeological sensitivity is therefore closely associated with raised, level landforms bordering or within the Hawkesbury floodplain, or located along permanent water sources such as Redbank Creek. Archaeological potential is increased where disturbance levels are low and frequent flood effects are absent or aggrading.

The archaeological assessment determined that there were no previously recorded AHIMS sites within the CHAR study area. The closest sites comprised an isolated find (AHIMS 45-5-5077; NR-IA1-18) of a silcrete flake located in a disturbed parking area at the end of O'Dea Place, and a severely disturbed surface scatter (AHIMS 45-5-2478; Beaumont Ave (BA-OS-1)) near the Hawkesbury River south of Beaumont Avenue. Neither site would be affected by the project.

An archaeological survey of the study area was subsequently carried out in March 2021. The survey focused on assessing the archaeologically sensitive landforms identified by background information review and identifying any Aboriginal archaeological sites or areas of potential. Assessment of archaeological potential was based on topographic location and visible disturbance. The survey closely inspected any areas of exposed ground, such as eroded surfaces, for artefacts, or evidence of intact soils while any mature trees were inspected for evidence of Aboriginal bark removal.

Ground surface visibility and exposure varied significantly across the study area. Higher ground surface visibility was present along the road corridors and in areas where natural processes such as erosion, or land use practices had removed vegetation or restricted its growth. Stripped and graded areas associated with more recent construction offered the best visibility but these areas were also severely disturbed. The existing wastewater infrastructure locations including the maintenance holes, ERS on Redbank Creek, and North Richmond WWTP were confirmed to be highly modified locations with no archaeological potential due to severe ground disturbance.

The survey identified five areas of Aboriginal archaeological sensitivity along the proposed SP0096 pressure main route (Figure 6). These were defined on the basis of landform and lower levels of disturbance, representing well-defined, elevated areas above the Hawkesbury floodplain or associated with Redbank Creek and its tributary. No Aboriginal objects were identified on the surface due to low archaeological visibility, however these areas were considered to display good potential for intact subsurface deposit. The remainder of the assessment area displayed low potential for subsurface archaeology due to unfavourable location or existing ground disturbance from natural processes or land use practices including construction and development. Further assessment, including test excavation, was recommended for the identified areas of sensitivity.

4.1 Archaeological test excavation program

Following the findings of the survey, it was determined that further investigation of the identified sensitive areas along the proposed pressure main alignment would be required to supplement the information regarding past Aboriginal land use within the study area. An archaeological test program was undertaken along the proposed alignment in August 2021 (KNC 2021), in accordance with the *Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW (*OEH 2010b). The test excavation program was undertaken within four of the five locations of archaeological sensitivity identified during the survey. Area 2 was not tested as it was evident at the time of the test program it had been affected by recent severe flooding of the Hawkesbury River. Test areas were chosen to collect information about the nature and extent of subsurface archaeological deposit, based on a sample derived from subsurface investigations and to build on information already obtained through previous assessment.

Results established the presence of three subsurface archaeological deposits at Areas 2, 3 and 4 (Figures 7 and 8). Area 1 was found not to contain any cultural material. A results summary is provided in Table 2. A total of 39 test squares measuring 50cm x 50cm (each 0.25m^2) were excavated during the program. Excavation took place across a variety of landform contexts between and across test areas, including terrace, crest/ ridges and hilltop/ ridgeline landforms. The majority of test squares were excavated at Area 5, on lower terraces and hilltop/ridgelines of the Blacktown soil landscape between Terrace Road and Redbank Creek (n=23). The remaining test units at Areas 1, 3 and 4 were placed on the alluvial Freemans Reach soil landscape between Terrace Road and the Hawkesbury River, on terrace and crest/ ridge landforms (n=16). Soil profiles were relatively uniform within these test areas, and informed by their overarching geomorphic contexts.

The lower terrace tested as part of Area 1 comprised the deepest soil profiles across the test program. Soil profiles measured between 60cm and 80cm in depth with very fine alluvial silt, which was texturally distinct from the other soil profiles of the Freemans Reach alluvial landscape. Soil profiles in Area 1 comprised deep dark brown silt/ sandy loams between 24cm and 60cm, overlain by loosely compacted yellow sand. The well sorted fine texture of alluvial silts demonstrate a series of siltation events consistent with intermittent overbank deposition through high energy deposition. In contrast, Area 3, a crest/ ridge landform, displayed intact squares of moderately deep medium-fine alluvial silt. These natural soils were between 40cm and 60cm in depth, and comprised a pale grey brown silty soil of medium to hard compaction, overlying a loose yellowish brown silty sand, and yellowish brown silty basal clays. Gravels were common, and texturally the sediment appeared less well sorted than landforms lower in elevation. This deposit was consistent with a lower energy deposition of sediment which contains some poorly to moderately sorted gravels consistent with low energy flood deposition.

Table 2. Summary of test excavation results

Area	Soil Landscape	Test units	Landform	Number of test squares (sample size)	Artefact count	Mean artefact density	Peak artefact density	Site name
1	Freemans Reach (Alluvial)	TS31-TS33	Terrace	3 (0.75m^2)	0	-	-	N/A
2		Not tested						
3		TS24-TS28, TS34-TS38	Crest/ridge	10 (2.5m^2)	202	80.8/m^2	TS26 (268/m^2)	Norfolk Place Hawkesbury River AFT 1
4		TS 29-TS30, TS39	Terrace	3 (0.75m^2)	13	17.3/m^2	TS39 (32/m^2)	Terrace Road Hawkesbury River AFT 1
5	Blacktown (Residual)	TS7-TS14	Lower terraces	8 (2m^2)	32	16/m^2	TS7 (60/m^2)	Terrace Road Redbank Creek AFT 1
		TS1-TS6	Hilltop/ridgeline	6 (1.5m^2)	22	14.7/m^2	TS3 (40/m^2)	
		TS15-TS23	Hilltop/ridgeline	9 (2.25m^2)	148	65.8/m^2	TS17 (148/m^2)	
		Area 5 Subtotal		*23 (5.75m^2)*	*202*	*35.1/m^2*		

Test Area 4 encountered shallower soils of brown silty loam overlying yellow basal clay at approximately 25 cm in depth. This appears consistent with an eroded landform of moderate elevation bordering the flood zone. Ferromanganese flecking and nodules and ironstone inclusions were present throughout soil profiles, indicating some intermittent waterlogging of sediment. The strong alluvial silt signature from Areas 1 and 3 was mostly absent. At Area 5, squares located on the elevated crest immediately north of Terrace Road (TS1-TS6) displayed intact and moderately deep soils consisting of pale grey brown silty sandy loam, with variation in humic topsoil representation, over silty sandy yellowish brown sand. The yellowish brown basal sandy clay layer was encountered at depths between 40 cm and 70 cm. The remaining test squares in Area 5 were relatively uniform residual profiles typical of the Blacktown soil landscape. These comprised dark brown to brown silty clays, some with duplex leached soils of pale greyish brown, but a majority truncated into a homogenous dark brown silty clay overlying a light brown to orange clay substrate.

Subsurface archaeological deposit was identified at three of the four tested areas. Area 3 recovered a total of 202 artefacts from ten test squares excavated across the crest/ ridge. As subsurface archaeological deposit and Aboriginal objects were identified, this test area was designated as site 'Norfolk Place Hawkesbury River AFT 1', with moderate-high artefact density. Artefacts recovered consisted primarily of chert (61.4%) and silcrete (31.2%), with quartz and fine grained siliceous raw materials also identified. Artefact types included flakes and distal fragments (around 30% of the assemblage), with four cores, and various flake fragments also present. Thirteen artefacts were identified as representing formal retouch or modified artefacts, and a further 40 artefacts demonstrated edge damage that could be macroscopically interpreted as usewear. Artefacts were primarily recovered from the upper 50 cm of the soil profile, with eight artefacts recovered from depths of 50-60 cm.

Test excavation at Area 4 recovered a total of 13 artefacts from three excavated squares across the upper terrace landform. Nine of the artefacts were chert and the remaining four were silcrete. The assemblage comprised various flake fragments and angular fragments ranging from 5mm to 44mm in dimension. One retouched piece and three fragments of edge damage/usewear artefacts were also identified. The artefacts were within the top 30 cm of the profile. As the area was found to contain subsurface archaeological deposit and Aboriginal objects it was designated as site 'Terrace Road Hawkesbury River AFT 1', a moderate density artefact deposit.

Test excavation at Area 5 recovered a total of 202 artefacts from 19 of the 23 excavated squares. The terrace above Redbank Creek yielded slightly higher artefact densities than the lower terraces around the tributary or the crest along Terrace Road. Artefacts consisted of chert (60.4%), silcrete (33.7%) and quartz (5.9%). Reduction types were primarily angular fragments (50% of the assemblage). Flakes formed 18% of the assemblage, with various flake fragments and cores forming less than 10% each respectively. Three backed artefacts and four artefacts with edge damage/usewear were also identified. The presence of a moderate-high density subsurface artefact deposit meant this area was designated as site 'Terrace Road Redbank Creek AFT 1'.

Overall, the sites appear to represent a range of Aboriginal land uses across a variety of landscape contexts associated with Redbank Creek and the Hawkesbury River. Archaeological significance of all three sites was assessed as moderate. Impact assessment identified that all three sites would be at least partially impacted by the proposal. If impact to the sites could not be avoided, it was recommended that additional assessment and an AHIP would be required prior to impacting the identified sites. The assessment would include a process of Aboriginal community consultation and the preparation of a CHAR, in accordance with the relevant Heritage NSW guidelines.

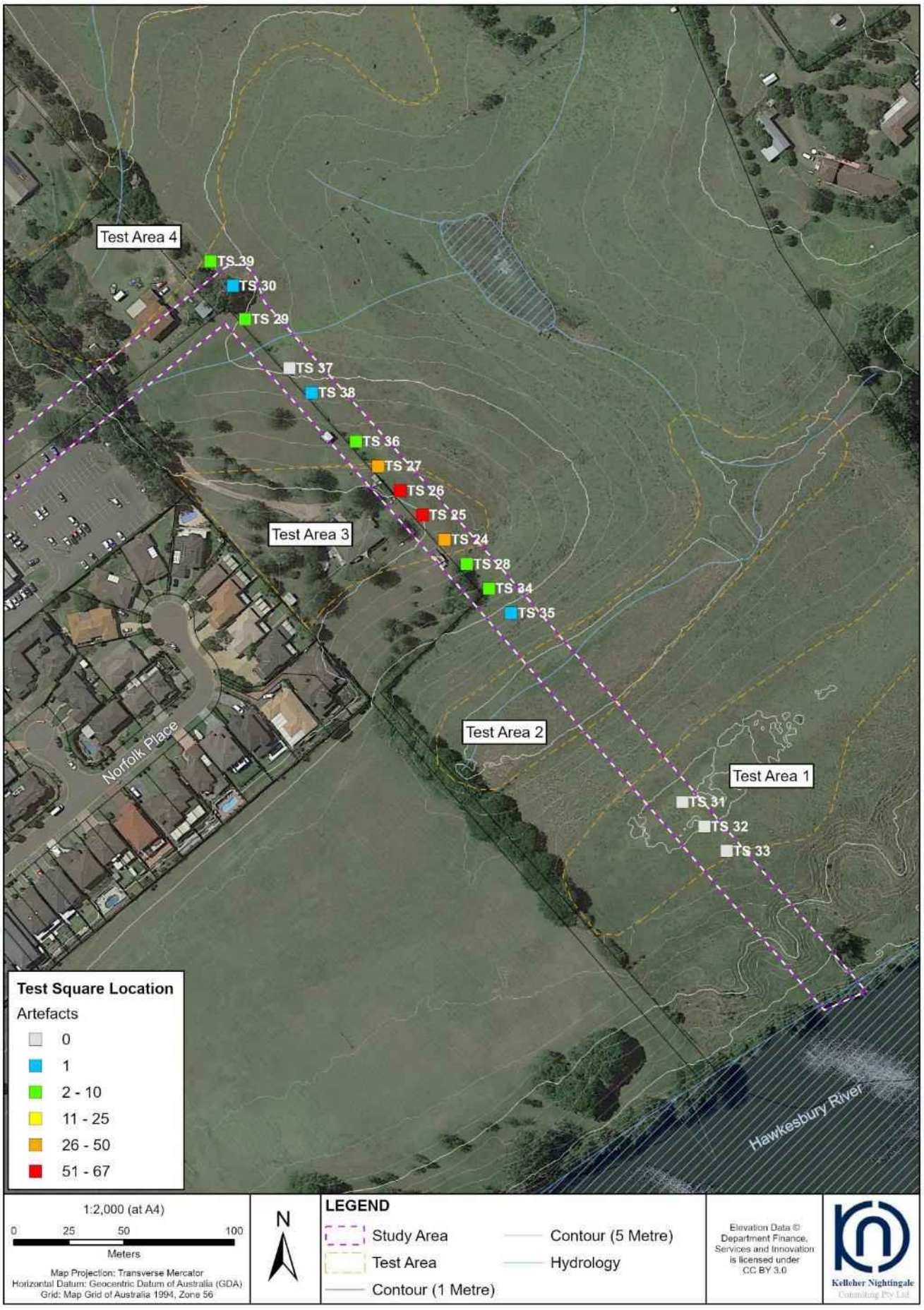

Figure 7. Test excavation results – Areas 1 -4 south of Terrace Road

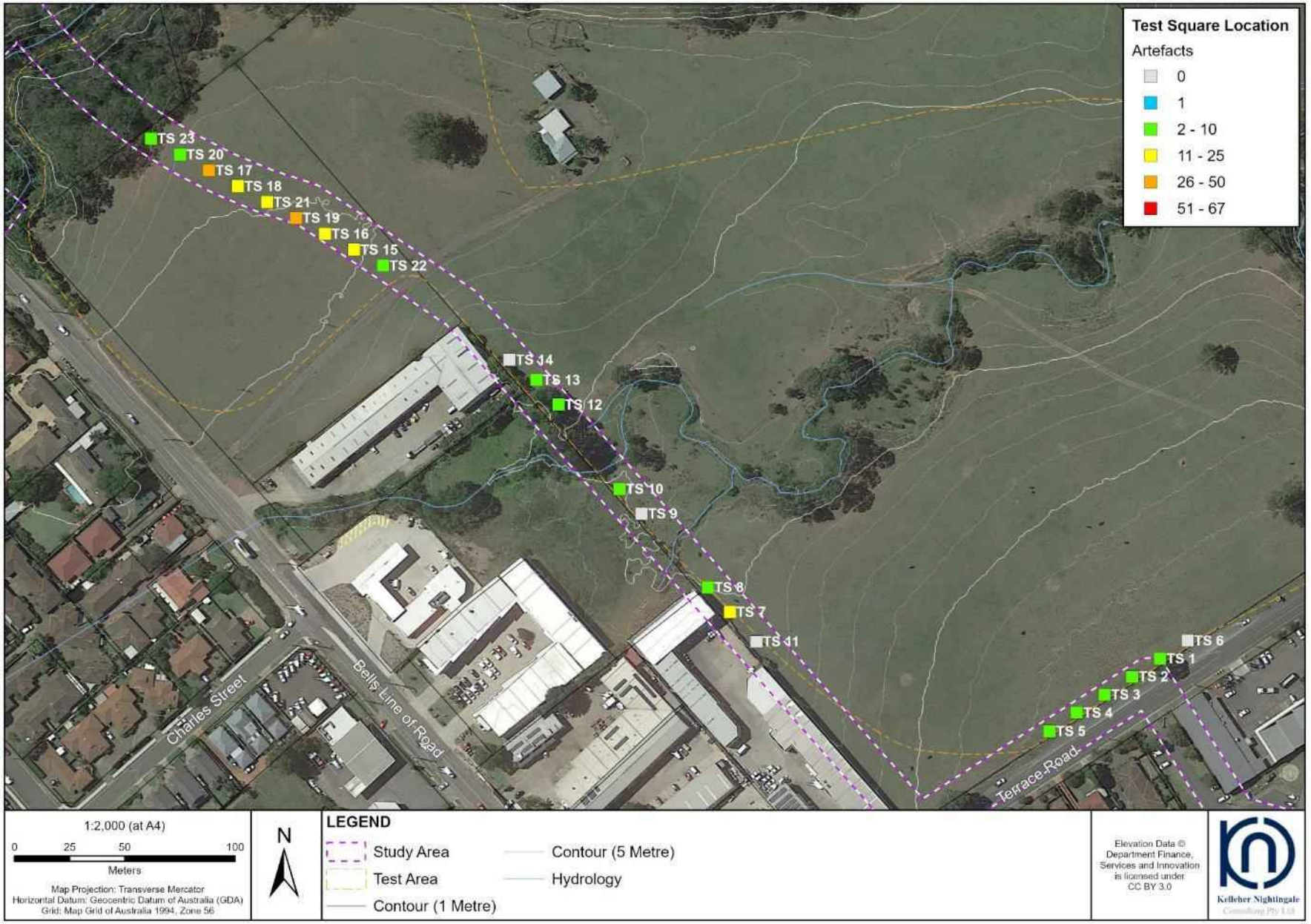

Figure 8. Test excavation results – Area 5 north of Terrace Road

5 Aboriginal Community Consultation

5.1 Consultation for the CHAR and AHIP application

The aim of consultation is to integrate cultural and archaeological knowledge and ensure registered stakeholders have information to make decisions on Aboriginal cultural heritage. For the preparation of this CHAR, consultation with Aboriginal people has been undertaken in accordance with the Heritage NSW *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (OEH 2010a) and the requirements of Clause 60 of the *National Parks and Wildlife Regulation 2019*. A consultation log for the project is attached as Appendix C.

The formal consultation process has included:

- notification of Aboriginal persons, including register of native title determinations search and government agency notification letters;
- advertising for registered stakeholders in local media (Appendix A);
- notification of closing date for registration (14/06/2021);
- record of registration of interest (Heritage NSW and DLALC notified 15/06/2021);
- provision of project information and proposed cultural heritage assessment methodology (28 day review period ending on 13/07/2021);
- invitation to advise on Aboriginal cultural value of the study area;
- provision of draft CHAR for review (a 28 day review period ending on 26/11/2021); and
- ongoing consultation with the local Aboriginal community.

5.2 Registration of interest

Aboriginal people who hold knowledge relevant to determining the cultural heritage significance of Aboriginal objects and Aboriginal places in the study area were invited to register an interest in a process of community consultation. Investigations for the current project have included consultation with the 16 Aboriginal community individuals and groups as listed in Table 3.

Table 3. Registered Aboriginal stakeholders*

Registered Aboriginal Stakeholder	Representative and/or Contact Person
Deerubbin Local Aboriginal Land Council	Steven Randall
Darug Custodian Aboriginal Corporation	Justine Coplin
Paul Gale	Paul Gale
Didge Ngunawal Clan	Lilly Carroll
Waawaar Awaa Aboriginal Corporation	Rodney Gunther
Wurrumay Pty Ltd	Vicky Slater
Kamilaroi Yankuntjatjara Working Group	Phil Khan
Registered Aboriginal Stakeholder	Details withheld
Warragil Cultural Services	Aaron Slater
A1 Indigenous Services	Carolyn Hickey
Gulaga	Wendy Smith
Muragadi Heritage Indigenous Corporation	Jesse Johnson
Registered Aboriginal Stakeholder	Details withheld
Barraby Cultural Services	Lee Field
Yurrandaali Cultural Services	Bo Field
Yulay Cultural Services	Arika Jalomaki

*two Aboriginal stakeholders have registered for the project but have chosen to withhold their details in accordance with item 4.1.5 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*.

5.3 Consultation regarding the land and proposed activity

Following on from Stage 1 of the consultation process undertaken by KNC (stakeholder identification and registration), project-specific consultation was undertaken. Information regarding the proposed Richmond Precinct Wastewater Network Upgrades project was provided to registered Aboriginal stakeholder groups in a letter dated 31/05/2021. Information included an outline of the proposal, location of the study area and an invitation to consult during the assessment.

Stakeholders were also provided with the proposed assessment methodology for the Cultural Heritage Assessment Report, and invited to review and provide feedback (review period of 28 days, closing on 13/07/2021). An invitation was extended for Aboriginal cultural knowledge holders and stakeholders to provide comments on the proposed cultural heritage assessment methodology, including any protocols regarding the gathering of information and any matters such as issues/areas of cultural significance that might affect, inform or refine the assessment methodology.

5.4 Stakeholder responses to the proposed assessment methodology for the Cultural Heritage Assessment Report

Formal responses to the proposed assessment methodology were received from nine stakeholder groups, including A1 Indigenous Services (A1), Darug Custodian Aboriginal Corporation (DCAC), Kamilaroi-Yankuntjatjara Working Group (KYWG), Muragadi Heritage Indigenous Corporation (MHIC), Waawaar Awaa Aboriginal Corporation (WAAC), Warragil Cultural Services (Warragil), Wurrumay Pty Ltd (Wurrumay), Yulay Cultural Services (Yulay) and one Registered Stakeholder who chose to withhold their details.

A1 expressed that they had reviewed the project information and supported the proposed assessment methodology. A1 indicated a preference to be involved in any future consultation and fieldwork (email dated 20/06/2021).

DCAC stated that they had received and reviewed the project information and assessment methodology, and supported the recommended methodology for the assessment (email/letter dated 21/06/2021).

KYWG stated that they agreed with the proposed assessment methodology and supported the proposed approach (email dated 29/06/2021).

MHIC stated that they had reviewed the project information and proposed assessment methodology, and agreed with the assessment recommendations (email dated 15/06/2021).

WAAC stated that they supported the proposed assessment methodology, particularly the need for test excavation in areas of archaeological sensitivity that could not be avoided by the proposal (email/letter dated 16/06/2021).

Warragil expressed agreement with the proposed assessment approach, particularly the test excavation component of the assessment (email dated 30/06/2021).

Wurrumay stated that they had read and agreed with the proposed assessment methodology (email dated 22/06/2021).

Yulay stated that they had reviewed the project information and agreed with the proposed assessment methodology for the project (email dated 24/06/2021).

One of the stakeholders who chose to withheld their details in accordance with item 4.1.5 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (OEH 2010a) stated that the proposed assessment methodology was consistent with their views for identifying and assessing Aboriginal heritage (email dated 09/07/2021). This stakeholder also noted the importance of involving Aboriginal stakeholders in impact assessments as part of a duty of care to Aboriginal heritage.

5.5 Review of draft CHAR

The draft CHAR was provided to stakeholders for a 28 day review and comment period (review package sent 29/10/2021, closure of comment period on 26/11/2021). Cultural information provided by stakeholders was then integrated into the final CHAR. Comments and information received from stakeholders during this period are attached in full in Appendix B and summarised below.

5.6 Stakeholder responses to draft CHAR

Formal responses to the draft CHAR were received from five stakeholder groups, including DCAC, Didge Ngunawal Clan (DNC), KYWG, Waawaar Awaa Aboriginal Corporation (WAAC) and one Registered Stakeholder who chose to withhold their details.

DCAC stated that they supported the draft CHAR and the recommendations in the report (letter/email dated 22/11/2021).

DNC expressed agreement with the draft CHAR and stated they were 'happy with everything' (email dated 01/11/2021).

KYWG stated that they agreed with the recommendations and supported the draft CHAR (letter/email dated 18/11/2021). KYWG also suggested possible cultural heritage interpretation for the project.

WAAC (email dated 04/11/2021) supported the proposed salvage program, the application for an AHIP, the avoidance and protection of non-impacted site areas, and the inclusion of an unexpected finds procedure in the CEMP.

One of the stakeholders who chose to withheld their details in accordance with item 4.1.5 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (OEH 2010a) provided the following comments on the proposed mitigation and management measures (email dated 16/11/2021): inclusion of cultural heritage awareness training during site inductions for all staff, and ongoing (daily) inspections of the protective fencing, to be included in SWMS and toolbox talks. The stakeholder also expressed a preference for reburial of salvaged artefacts on Country.

5.7 Aboriginal cultural values

It has been identified during the consultation process that the study area has cultural heritage value to the local Aboriginal community. Some of the Aboriginal cultural heritage values expressed by stakeholders include:

- strong association with the land
- responsibility to look after the land, including the heritage sites, plants and animals, creeks and the land itself
- scarred trees
- artefact sites and landscape features
- creek lines and prominent watercourses, particularly Redbank Creek and the major landscape feature of the Hawkesbury/Nepean River and their tributaries
- indigenous plants and animals
- general concern for burials, as their locations are not always known and they can be found anywhere.

Additional cultural values for the study area have been provided by stakeholders throughout the consultation process.

DCAC placed strong importance on the care of Darug sites, places, wildlife and the promotion of their culture and history. DCAC noted that the general area of the project was significant due to archaeological evidence of continued occupation, with significant site complexes in the vicinity. The connection of sites in the landscape was identified as a key feature of Aboriginal cultural importance: "Darug sites are all connected, our Country has a complex of sites that hold our heritage and past history… evidence of the Darug lifestyle and occupation are all across our Country" (email/letter dated 21/06/2021). DCAC also noted during the CHAR review process the cultural importance of the wider landscape and particular landforms within it, both for the information they hold and the connection they provide for Darug people to their culture and history (letter/email dated 22/11/2021).

KYWG expressed that the study area was highly important to Aboriginal people, with a settlement history over tens of thousands of years and expressing the responsibility to "care for the land as she cares for us" (email dated 29/06/2021). KYWG stated that "We hold a deep connection to the land, water, sky, and fire. We have passed on our knowledge from generation to generation through word of mouth, this continues to happen today. We look to the sky for guidance and follow the water ways and apply our knowledge to the land our mother as she provides to us many resources that we always give back to her in many ways. We have a belief system of kinship and followed lore, we also have a spiritual connection to the land and all that surrounds it" (email dated 18/11/2021).

Wurrumay expressed that their membership had ancestral connection to the project area (email dated 02/06/2021).

One of the stakeholders who chose to withheld their details highlighted the importance of understanding environmental context when assessing Aboriginal heritage, noting that "cultural connections to landscape spread far and wide over many types of terrain" (email dated 09/07/2021).

6 Summary and Analysis of Background Information

Analysis of the background information presented in the preceding chapters allows an assessment of cultural heritage values within the study area to be made. Combining data from historical/ethnographic sources, Aboriginal community consultation, landscape evaluation and archaeological context provides an insight into how the landscape around the study area was used and what sort of events took place in the past. This section draws together a variety of information to bring further understanding to the cultural landscape of the study area.

Culturally, this part of north-western Sydney has demonstrated importance and value to the contemporary Aboriginal community. In particular, the cultural value of the significant hydrological system associated with the Hawkesbury River has been identified. The Hawkesbury River and Redbank Creek are specially highlighted as significant landscape features located within the study area, especially given their association with significant archaeological sites. Stakeholders expressed that they had a responsibility to look after the land, including the heritage sites, plants and animals, creeks and the land itself. Several stakeholders also indicated that they held additional cultural, spiritual, personal and familial connections to the study area. Aboriginal community consultation undertaken for the current project has demonstrated that members of the contemporary Aboriginal community continue to experience connection with the area through cultural and familial associations.

The study area and surrounding region are known to have been important to and extensively used by past Aboriginal people. Archaeological evidence of past Aboriginal occupation and use of the landscape shows the types and preservation of archaeological sites in the region and how these are highly influenced by geology, soil landscapes and ground surface disturbance. Previous archaeological investigations have demonstrated that the preservation of intact subsurface archaeological deposits is strongly affected by environmental factors such as proximity to flood zones, landform and slope stability in addition to land use disturbances. Investigations within neighbouring and environmentally comparable areas have indicated that more archaeologically valuable information exists where suitable landforms have suffered minimal disturbance. Archaeological site types in the wider locality comprise open artefact scatters, isolated finds, PADs, grinding grooves and rockshelter sites. The diversity of site types is related to the study area's location along a transitional zone between the shale-based Cumberland Plain and the more rugged sandstone country of the Blue Mountains.

Archaeological excavations undertaken within the Cumberland Plain have demonstrated that artefact density and site frequency in the region is heavily influenced by the reliability and permanence of fresh water sources, with higher frequency and artefact density in the vicinity of higher order watercourses. The study area is located adjacent to the largest watercourse of the Cumberland Plain and includes Redbank Creek, an important tributary of the Hawkesbury River. Previous excavations of sites in proximity to these systems indicates that significant deposit is retained in suitable areas and demonstrates a long Aboriginal settlement history of the region.

Archaeological assessment for the current project, including field survey and test excavation, has identified that the current CHAR study area contains three Aboriginal archaeological sites. These sites are spatially associated with a series of terraces and elevated landforms around Redbank Creek and its tributary, and two more elevated crests/terraces which jut out into the main Hawkesbury River floodplain. Test excavation determined that these areas display relatively intact soils containing a moderate to high quantity of Aboriginal objects. The specific combination of landform, elevation and location on the margin of the floodzones would have made them attractive locales for Aboriginal occupation. These same factors, along with relatively low levels of direct landscape disturbance, means they have preserved intact Aboriginal archaeological deposit. The remainder of the study area and proposed work areas have been assessed as displaying low archaeological potential due to unfavourable landform and /or extensive land use disturbance related to road construction, installation of existing utilities and buried infrastructure. The identified sites therefore represent the remaining archaeological resource within the study area.

6.1 Known Aboriginal sites within the study area

Review of background information, Aboriginal community consultation, and archaeological assessment has resulted in the identification of three Aboriginal archaeological sites within the CHAR study area. Sites are listed in Table 4 and shown in Figure 9.

Table 4. Identified Aboriginal archaeological sites within the study area

Site Name	AHIMS #	Description
Information removed out of respect for Aboriginal culture and community - contact Sydney Water for more details if required.		Moderate-high density subsurface artefact deposit on elevated terraces and flats surrounding a tributary south of Redbank Creek
		Moderate density subsurface artefact deposit on terrace spur extending into primary river floodplain south of Terrace Road
		Moderate-high density subsurface artefact deposit on defined crest above primary river floodplain east of Norfolk Place

Figure 9. Identified Aboriginal archaeological sites within the study area

7 Cultural Heritage Values and Statement of Significance

7.1 Significance Assessment Criteria

One of the primary steps in the process of cultural heritage management is the assessment of significance. Not all sites are equally significant and not all are worthy of equal consideration and management (Sullivan and Bowdler 1984, Pearson and Sullivan 1995:7). The determination of significance can be a difficult process as the social and scientific context within which these decisions are made is subject to change (Sullivan and Bowdler 1984). This does not lessen the value of the heritage approach, but enriches both the process and the long-term outcomes for future generations, as the nature of what is conserved and why, also changes over time.

Significance assessments can generally be described under three broad headings (Pearson and Sullivan 1995:7):

- value to groups such as Aboriginal communities
- value to scientists and other information gatherers
- value to the general public in the context of regional, state and national heritage.

The assessment of significance is a key step in the process of impact assessment for a proposed activity as the significance or value of an object, site or place will be reflected in resultant recommendations for conservation, management or mitigation.

The *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (OEH 2010b) requires significance assessment according to criteria established in the *Australia ICOMOS Burra Charter* (Australia ICOMOS 2013). The *Burra Charter* and its accompanying guidelines are considered best practice standard for cultural heritage management, specifically conservation, in Australia. Guidelines to the *Burra Charter* set out five criteria for the assessment of cultural significance:

- Aesthetic value - relates to the sense of the beauty of a place, object, site or item;
- Historic value - relates to the association of a place, object, site or item with historical events, people, activities or periods;
- Scientific value - scientific (or research) value relates to the importance of the data available for a place, object, site or item, based on its rarity, quality or representativeness, as well as on the degree to which the place (object, site or item) may contribute further substantial information; and
- Social value - relates to the qualities for which a place, object, site or item has become a focus of spiritual, political, national or other cultural sentiment to a group of people. In accordance with the Heritage NSW *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW*, the social or cultural value of a place (object, site or item) may be related to spiritual, traditional, historical or contemporary associations. "Social or cultural value can only be identified though consultation with Aboriginal people" (OEH 2011:8).
- Spiritual value - refers to the intangible values and meanings embodied in or evoked by a place which make it important to the spiritual identity, traditional knowledge, art or practices of a cultural group. Spiritual value is strongly connected to social value.

Significance assessment for identified archaeological sites focusses on the social/spiritual, historic, scientific and aesthetic significance of Aboriginal heritage values as identified in *The Burra Charter* (Australia ICOMOS 2013). The identification of significance is developed in consultation with the registered Aboriginal stakeholders. Assessed values for the sites within the study area are detailed below.

Cultural / social significance

This area of assessment concerns the value(s) of a place, feature or site to a particular community group, in this case the local Aboriginal community. Aspects of social significance are relevant to sites, objects and landscapes that are important or have become important to the local Aboriginal community. This importance involves both traditional links with specific areas as well as an overall concern by Aboriginal people for sites generally and their continued protection. Aboriginal cultural significance may include social, spiritual, historic and archaeological values and is determined by the Aboriginal community.

It has been identified during the consultation process that the local area has cultural heritage value (social value) to the local Aboriginal community. No specific cultural or social values for the sites within the study area were provided by the registered Aboriginal stakeholders following the review of the draft CHAR, however they form part of a cultural landscape with high cultural significance.

Historic significance

Community consultation and historical research have not identified any information regarding specific historical significance of identified Aboriginal archaeological sites in or near the study area. No specific historical values for the sites within the study area were provided by the registered Aboriginal stakeholders following the review of the draft CHAR. Archaeologically, the study area does not contain these values in relation to Aboriginal heritage.

Scientific / archaeological significance

For archaeologists, scientific significance refers to the potential of a site to contribute to current research questions. Alternately, a site may be an in situ repository of demonstrably important information, for example rare artefacts of unusually high antiquity.

Scientific significance is assessed using criteria to evaluate the contents of a site, state of preservation, integrity of deposits, representativeness of the site type, rarity/uniqueness and potential to answer research questions on past human behaviour. Heritage NSW's recommended criteria for assessing archaeological significance include:

- Archaeological Research Potential - significance may be based on the potential of a site or landscape to explain past human behaviour and can incorporate the intactness, stratigraphic integrity or state of preservation of a site, the association of the site to other sites in the region (connectivity), or a datable chronology.

- Representativeness - all sites are representative of those in their class (site type/subtype) however the issue here relates to whether particular sites should be conserved to ensure a representative sample of the archaeological record is retained. Representativeness is based on an understanding of the regional archaeological context in terms of site variability in and around the study area, the resources already conserved and the relationship of sites across the landscape.

- Rarity – which defines how distinctive a site may be, based on an understanding of what is unique in the archaeological record and consideration of key archaeological research questions (i.e., some sites are considered more important due to their ability to provide certain information). It may be assessed at local, regional, state and national levels.

High significance is usually attributed to sites which are so rare or unique that the loss of the site would affect our ability to understand an aspect of past Aboriginal use/occupation of an area. In some cases, a site may be considered highly significant because it is now rare due to destruction of the archaeological record through development.

Moderate (medium) significance is attributed to sites which provide information on an established research question. Sites with moderate significance are those that offer the potential to yield information that will contribute to the growing holistic understanding of the Aboriginal cultural landscape of the project area. Archaeological investigation of moderately significant sites will contribute knowledge regarding site type interrelationships, cultural use of landscape features and occupation patterns.

Low significance is attributed to sites which cannot contribute new information about past Aboriginal use/occupation of an area. This may be due to site disturbance or the nature of the site's contents.

Aesthetic Values

Aesthetic values are often closely related to the social values of a site or broader cultural landscape. Aspects may include scenic sights, smells and sounds, architectural fabric and creative aspects of a place. The study area displays a low level of aesthetic value in relation to Aboriginal heritage. European land use practices, vegetation clearance and development have altered the natural landscape within and around the identified Aboriginal archaeological sites. The sites maintain their spatial relationship with the adjacent waterways but the primary aesthetic connection of this landscape has been lost. No specific aesthetic values for the sites within the study area were provided by the registered Aboriginal stakeholders following the review of the draft CHAR.

7.2 Statements of Significance

The study area contains three Aboriginal archaeological sites as defined under the *National Parks and Wildlife Act 1974*. The identified Aboriginal archaeological sites are:

Information removed out of respect for Aboriginal culture and community - contact Sydney Water for more details if required.

Based on the values assessment, the following statements of significance were developed for the sites.

Terrace Road Redbank Creek AFT 1
This site is located across a series of elevated terrace and crest landforms surrounding Redbank Creek and its tributary, north of Terrace Road. Test excavation determined the site retained relatively intact archaeological deposit of moderate to high density (peak density: 148/m^2). The site area is large, incorporating the extensions of the landforms confirmed to contain Aboriginal objects, even in areas of slightly higher disturbance near the road corridor. Site contents and type are representative of their class and are not especially rare. The site is a good example of Aboriginal archaeological patterning along the lower reaches of one of the main tributary streams of this section of the Hawkesbury River. Site integrity and intactness are good and the site displays good archaeological research potential to further inform on Aboriginal landscape use in this environmental context, and subsequent site taphonomy. The site is therefore assessed as displaying *moderate archaeological significance.*

Terrace Road Hawkesbury River AFT 1
This site is located on a low terrace crest which extends into the Hawkesbury River floodplain. Test excavation demonstrated moderate subsurface artefact density (peak density: 32/m^2). Artefact types and raw materials were typical of other sites in the region, and the site is representative of a subsurface archaeological deposit on a lower gradient landform at the margin of the floodzone, at a greater distance from the main watercourses. Some level of flood erosion was suggested within the upper profile, along with intermittent waterlogging of the landform, however soils were otherwise generally intact and retained moderate quantities of stone artefacts. Site integrity is moderate. The site type is not rare; however many comparable landforms in the area have been more directly affected by agriculture or development. In combination with the other identified sites within the study area, Terrace Road Hawkesbury River AFT 1 offers good archaeological research potential to increase our understanding of elevated Quaternary alluvial landforms adjacent to the Hawkesbury River. The site is therefore assessed as displaying *moderate archaeological significance.*

Norfolk Place Hawkesbury River AFT 1
This site is located on a defined crest landform on the edge of the primary Hawkesbury River floodplain. Test excavation identified intact, moderately deep alluvial soils and a moderate to high density of subsurface Aboriginal archaeological deposit. A range of artefact raw materials and types were identified, including retouched/modified tools, cores, and a number of artefacts with edge damage/usewear. Artefact distribution was closely correlated to the landform, with the highest densities on the most elevated and level part of the crest (peak density: 268/m^2). The site is representative of its type, being an archaeological deposit on elevated ground at the margin of a floodzone, however its archaeological value is increased due to the low levels of apparent disturbance, good level of site integrity and high quantity of artefacts preserved in an open context. Further investigation of the site would offer valuable information on Aboriginal landscape use in close proximity to the Hawkesbury River and site taphonomy in a dynamic environment which often adversely affects archaeological preservation. Norfolk Place Hawkesbury River AFT 1 is therefore assessed as displaying *moderate archaeological significance.*

8 Impact Assessment

8.1 Description of the proposed activity

The proposed activity relates to the need for a series of wastewater infrastructure upgrades in north-western Sydney to accommodate growth and development in the catchment serviced by the Richmond WRP and North Richmond WWTP. The wider project includes a new wastewater pumping station, new transfer main between Richmond WRP and North Richmond WWTP and a series of network upgrades including emergency storages, maintenance holes and emergency relief structures. The project will help to service population growth in the Richmond Precinct and would ensure ongoing compliance with the Environmental Protection Licence (EPL) into the future. The scope of work for the wider project is provided in Section 1.2.

The study area and impact assessment area for this CHAR comprises certain proposed upgrade and construction locations for the project located west of the Hawkesbury River at North Richmond. The remainder of the wider project area (east of the Hawkesbury River) was assessed as part of the Archaeological Assessment Report (KNC 2021) and no impact to Aboriginal heritage was identified in this area. This CHAR includes assessment for the components shown on Figure 2, including the new wastewater pumping station (SP0069) at North Richmond, the new pressure/transfer main for SP0096 west of the Hawkesbury River, three maintenance holes along Redbank Creek and one emergency relief structure (ERS) on Redbank Creek near the existing WWTP. Proposed works at each location are described below.

New wastewater pumping station SP0069

- Removal of trees as required
- Relocation of minor services
- Construction of temporary access roads
- Removal of the first flush system
- Relocation/demolition of the existing sludge pump system
- Construction of a temporary chlorine dosing unit
- Excavation to approximately 20m deep
- Construct new pumping station including associated electrical equipment
- Replace existing single 90L/s wet weather pump with two new 90L/s wet weather pumps
- Trenchless construction to connect the new pumping station with the existing pumping station prior to decommissioning of the existing one.

New pressure/transfer main for SP0096

- Trenched construction of new pressure main to transfer flows from SP0096 to Richmond WRP [NB. this CHAR and impact assessment relates only to the portion of the pressure main north/west of the Hawkesbury River]
- Disturbance within a construction corridor of 20 metres (10 metres either side of alignment)
- A portion of the pressure main between Terrace Road and the Hawkesbury River may be constructed using trenchless/underbore construction dependant on geotechnical assessment, however is conservatively assessed as impacted in this CHAR.

Maintenance holes along Redbank Creek

- Replacement of the maintenance hole covers

ERS on Redbank Creek

- Vegetation removal
- Underground pipework and concrete structure modification for the existing discharge ERS
- Replacement of valves in existing ERS

8.2 Impact reduction/avoidance

Sydney Water is committed to seeking project outcomes that protect and preserve Aboriginal heritage wherever possible. Early identification of Aboriginal heritage in the assessment process allows this to be considered during design where there is construction flexibility along the route. For the current project, the proposed route is largely constrained by topography/hydrology and the location of infrastructure including road corridors, the WWTP, and existing wastewater infrastructure along the creek valleys.

Sydney Water aims to minimise environmental disturbance and where possible, has co-located the proposed infrastructure along corridors previously disturbed by services and development. This results in a partial level of impact to sites identified adjacent to these disturbed corridors, where the site extends beyond the high disturbance areas. This reduces the overall impact to the sites; however, some level of impact is unavoidable due to the position of the required alignment.

8.3 Proposed impacts

Some level of ground disturbance is unavoidable for the project as a whole due to construction requirements. For the trenched pressure main construction sections west of the Hawkesbury River, the entirety of the study area corridor may be impacted by the construction of the proposal and associated works. For trenchless sections of the pressure main, the ground surface would not be impacted beyond the establishment of entry and exit pits at the beginning and end of these sections. As the use of trenchless construction methods depends on geotechnical assessment and is not confirmed, these areas have been conservatively assessed as impacted.

At the existing maintenance holes and ERS on Redbank Creek, the proposed activities comprise limited upgrade works to existing infrastructure at these locations. The proposed works would not be expected to result in additional impacts or disturbance beyond the area already used for the existing infrastructure. Similarly, the existing WWTP facility is located in a disturbed landscape and the proposed works are primarily located in areas of existing severe ground disturbance.

In total, three Aboriginal archaeological sites would be impacted by the proposal, specifically by the trenched construction of the SP0096 pressure main. Assessed impacts within the study area are detailed in Table 5 and shown in Figure 10.

Table 5. Proposed impact to Aboriginal archaeological sites within the study area

Site name	AHIMS ID	Type of harm	Degree of harm	Consequence of harm	Significance of harm
Information removed out of respect for Aboriginal culture and community - contact Sydney Water for more details if required.		Direct	Partial	Partial loss of value	Moderate
		Direct	Partial	Partial loss of value	Moderate
		Direct	Partial	Partial loss of value	Moderate

Figure 10. Proposed impact areas and Aboriginal heritage

9 Mitigating Harm

The CHAR assessment applied the principles of Ecologically Sustainable Development (ESD) to the current proposal. The principles of Ecologically Sustainable Development are defined in Section 6 of the NSW *Protection of the Environment Administration Act 1991*. The ESD principles relevant to Aboriginal cultural heritage within the study area are: the Precautionary Principle and the Principle of Inter-Generational Equity. The application of these principles in relation to the current proposal is discussed below.

9.1 The Precautionary Principle

The Precautionary Principle states "that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation".

The identified Aboriginal archaeological sites have been considered in relation to the proposed works. While conservation is the best approach when considering Aboriginal heritage, the complete avoidance of all Aboriginal archaeological sites within the study area was not possible due to the requirements of the project and limited area in which it could occur. The use of existing infrastructure and disturbance corridors where possible has reduced the overall impact footprint of the project and its effect on Aboriginal heritage. Unfortunately, some level of impact is unavoidable for the proposal as a whole.

Scientific confidence has been achieved through archaeological investigations including a detailed review of previous archaeological work in the region, comprehensive field survey and an archaeological test excavation program. A high level of scientific confidence relating to the site types, contents and archaeological significance has been achieved (Sections 4 and 6). In particular, the test program confirmed that the proposed impact area for the trenched pressure main contains moderate to high density subsurface Aboriginal archaeological deposits.

Regarding Aboriginal social/cultural heritage value, no specific cultural or social values expressed by these sites have been identified to date, however consultation has demonstrated that the sites occur within an overall landscape which holds Aboriginal cultural significance (Section 5). As detailed in Sections 6 and 7, the assessment has determined that the Aboriginal archaeological sites within the study area display moderate significance.

9.2 The Principle of Inter-Generational Equity

The Principle of Inter-Generational Equity states "that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations".

The archaeological sites located within the study area were evaluated in relation to intergenerational equity and in particular, the cumulative impact of the proposal on the Aboriginal heritage of the region. As discussed in Sections 4 and 6, previous archaeological investigations have identified a variety of Aboriginal archaeological sites in the region typical of the shale-sandstone transitional landscape in north western Sydney. Existing development, road construction, buried infrastructure including existing sewer/wastewater infrastructure, vegetation clearance, agricultural use, erosion and flooding have all affected the study area and its archaeology to some degree and would continue to do so, regardless of construction of the proposal.

Large parts of the study area are located within or alongside areas of disturbance associated with existing infrastructure, primarily roads and buried wastewater infrastructure along the creeklines. The upgrading of existing facilities in these areas, rather than the construction of new ones, reduces the cumulative impact to this landscape. Management measures to ensure non-impacted portions of sites are avoided by the proposed activities will be also be implemented (protective fencing, identification in the CEMP, toolbox talks).

9.3 Mitigation Measures

Suitable recommendations for the identified impacts to the sites have been developed based on ESD, environmental context and condition, background research and consultation with stakeholders. The proposed impact area contains portions of three moderately significant sites. At each of these, the significance of the proposed impact is assessed as moderate, given the nature and significance of the archaeology, extent of the proposed impact and the level of established disturbance within the impact area.

Sites of at least moderate significance require mitigation through salvage excavation if impacts cannot be avoided. All three sites within the study area display moderate significance based on their scientific value and potential to inform on Aboriginal landscape use within the region. Their archaeological value is linked to the information that they contain. Recovery of this information through archaeological salvage excavation would help to mitigate the impacts of the proposal.

The loss of intrinsic Aboriginal cultural value of impacted sites cannot be offset or mitigated; however, the salvaged information will assist in a better understanding of the local archaeological context, particularly as the north western fringes of Sydney continue to experience population growth and development. Salvage of partially impacted sites will provide a better understanding of the remaining portions of the sites outside of the direct impact areas and assist with future management.

Management measures should be implemented for Aboriginal objects situated outside the construction corridor to ensure avoidance of objects not covered by an AHIP. Management measures to be implemented include protective fencing and identification of 'no-go zones' on maps within the Construction Environmental Management Plan (CEMP). Aboriginal heritage should also be included in induction materials for all staff, employees and contractors on the project to ensure protection of adjacent site areas and awareness of Aboriginal heritage in the project area.

An AHIP is required for impacts to land and identified sites/objects prior to the commencement of pre-construction or construction activities associated with the proposal that would affect the identified sites. Proposed measures for mitigating harm to the sites are outlined in Table 6 below.

Table 6. Mitigation measures for impacted Aboriginal sites

Site name	AHIMS ID	Management and mitigation measures
Information removed out of respect for Aboriginal culture and community - contact Sydney Water for more details if required.		Given the moderate significance of the site and degree of proposed impact, salvage excavation of a representative sample of the impacted portion of the site is required prior to impact. AHIP required for impacted portion of site. Management measures to be implemented to ensure non-impacted portion of site is avoided by proposed activities (protective fencing, identification in the CEMP, toolbox talks).
		Given the moderate significance of the site and degree of proposed impact, salvage excavation of a representative sample of the impacted portion of the site is required prior to impact. AHIP required for impacted portion of site. Management measures to be implemented to ensure non-impacted portion of site is avoided by proposed activities (protective fencing, identification in the CEMP, toolbox talks).
		Given the moderate significance of the site and degree of proposed impact, salvage excavation of a representative sample of the impacted portion of the site is required prior to impact. AHIP required for impacted portion of site. Management measures to be implemented to ensure non-impacted portion of site is avoided by proposed activities (protective fencing, identification in the CEMP, toolbox talks).

10 Summary and Recommendations

Three Aboriginal archaeological sites containing Aboriginal objects have been identified within the Richmond Precinct Wastewater Network Upgrades CHAR study area. The three sites will be partially impacted by the proposal. An AHIP is being sought for Aboriginal objects within the boundaries of the impact area, incorporating the archaeological sites listed in Table 7.

AHIP

An application for an AHIP should be made under section 90A of the *National Parks and Wildlife Act 1974* for three Aboriginal archaeological sites (partial impacts). An AHIP is sought for the land and associated objects within the boundaries of the impact area (Figure 11). The AHIP is also sought for part of the specified Aboriginal sites and objects contained within the sites listed in Table 7.

Table 7. Known archaeological sites requiring AHIP and degree of harm

Site Name	AHIMS Number	Scope of AHIP	Consequence of Harm	Mitigation
Information removed out of respect for Aboriginal culture and community - contact Sydney Water for more details if required.		Partial	Partial loss of value	Salvage excavation of impacted portion
		Partial	Partial loss of value	Salvage excavation of impacted portion
		Partial	Partial loss of value	Salvage excavation of impacted portion

Site Protection

The location of the non-impacted site areas should be avoided by the proposed works. Protection measures should include identification in the CEMP as environmentally sensitive “no-go zones” on maps and workers inducted as to appropriate protection measures. Temporary protective fencing that is difficult to move/reposition during the construction works may be required along the AHIP boundary.

Salvage excavation

The AHIP should include provision for impact mitigation through archaeological salvage excavation. Salvage excavation would be required within the AHIP area at sites Terrace Road Redbank Creek AFT 1, Terrace Road Hawkesbury River AFT 1 and Norfolk Place Hawkesbury River AFT 1.

Salvage excavation must be completed prior to any activities (including pre-construction activities) which may harm Aboriginal objects at these locations. Salvage excavation activities would be undertaken in accordance with the methodology attached as Appendix D.

Salvaged Aboriginal objects

The short term management of collected Aboriginal objects is as follows:

- Any Aboriginal objects that are removed from the land by actions authorised by an AHIP, must be moved as soon as practicable to the temporary storage location (see below) pending any agreement reached about the long term management of the Aboriginal objects.
- The temporary storage location would be: Kelleher Nightingale Consulting Pty Ltd, Level 10, 25 Bligh Street, Sydney NSW 2000.
- Any Aboriginal objects stored at the temporary storage location must not be further harmed, except in accordance with the conditions of the AHIP.

The long term management of collected Aboriginal objects is as follows:

- Requirement 26 "Stone artefact deposition and storage” in the Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW (24 September 2010, available online at: http://www.environment.nsw.gov.au/resources/cultureheritage/10783FinalArchCoP.pdf) must be complied with.
- Recovered objects will be lodged with the Australian Museum in the first instance in accordance with the *Australian Museum Archaeological Collection Deposition Policy* (January 2012, available online at: http://australianmuseum.net.au/document/Protocols-for-the-deposition-of-archaeological-materials).
- If required, a variation will be sought for recovered objects to be held by the Aboriginal community or reburied. If reburial is to take place, registered Aboriginal stakeholders would be notified and given the opportunity to attend, and the reburial location would be registered on AHIMS.

Figure 11. AHIP application area

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Appendix A Advertisement for registration of interest

Public Notices

Notice for Registration of Interest

Sydney Water is proposing upgrades to the Richmond Water Recycling Plant and North Richmond Waste Water Treatment Plant network to facilitate growth in the catchment and meet current and known future regulatory requirements in Richmond and North Richmond, NSW. The project is located in the Hawkesbury local government area. The proponent is Sydney Water (Jill Berwick, Lead Environmental Scientist: Level 11, 1 Smith Street, Parramatta NSW 2150).

The proposal may be the subject of Aboriginal Heritage Impact Permit (AHIP) applications made under section 90A of the National Parks and Wildlife Act 1974. Sydney Water proposes to carry out consultation with Aboriginal communities in accordance with the Heritage NSW Aboriginal cultural heritage consultation requirements for proponents 2010. Information obtained from the consultation process may be used in the preparation of AHIP applications and will assist Heritage NSW in the consideration and determination of the AHIP applications. Kelleher Nightingale Consulting Pty Ltd has been engaged to facilitate the consultation process.

Sydney Water invites Aboriginal groups and/or Aboriginal people who hold cultural knowledge relevant to determining the significance of Aboriginal objects and/or places at Richmond and North Richmond to register interest in a process of community consultation with the contact shown below (on behalf of Sydney Water):

Kelleher Nightingale Consulting

Level 10, 25 Bligh Street

Sydney NSW 2000

phone 02 9232 5373

The closing date for registration is 9 June 2021.

Please be advised that in accordance with Heritage NSW requirements, we are required to record the names and contact details of each Aboriginal person who has registered an interest in this project and provide a copy of that record to the relevant Heritage NSW office and Local Aboriginal Land Council. If you are registering your interest, please let us know if you do not want your details forwarded to these organisations.

Appeared in:
Hawkesbury Gazette, Wednesday 26 May 2021, page 21

Appendix B Aboriginal Community Comments on Draft CHAR

DARUG CUSTODIAN
ABORIGINAL CORPORATION

DARUG CUSTODIAN
ABORIGINAL
CORPORATION

PO BOX 81 WINDSOR 2756
PHONE: 0245775181 FAX: 0245775098
MOBILE: 0415770163 Leanne Watson
0414962766 Justine Coplin
EMAIL: mulgokiwi@bigpond.com / justinecoplin@optusnet.com.au

Attention: KNC **Date:22/11/21**

Subject: 2029 Richmond/North Richmond Precinct

Dear Zac

Our group is a non- profit organisation that has been active for over forty years in Western Sydney, we are a Darug community group with over three hundred members. The main aim in our constitution is the care of Darug sites, places, wildlife and to promote our culture and provide education on the Darug history.

Our group promotes Darug Culture and works on numerous projects that are culturally based as a proud and diverse group. It has been discussed by our group and with many consultants and researches that our history is generic and is usually from an early colonists perspective or solely based on archaeology and sites. These histories are adequate but they lack the people's stories and parts of important events and connections of the Darug people and also other Aboriginal people that now call this area home and have done so for numerous generations.

This area is significant to the Darug people due to the evidence of continued occupation, within close proximity to this project site there is a complex of significant sites.

Landscapes and landforms are significant to us for the information that they hold and the connection to Darug people. Aboriginal people (Darug) had a complex lifestyle that was based on respect and belonging to the land, all aspects of life and survival did not impact on

the land but helped to care for and conserve land and the sustenance that the land provided. As Darug people moved through the land there were no impacts left, although there was evidence of movement and lifestyle, the people moved through areas with knowledge of their areas

and followed signs that were left in the landscape. Darug people knew which areas were not to be entered and respected the areas that were sacred.

Knowledge of culture, lifestyle and lore have been part of Darug people's lives for thousands of years, this was passed down to the next generations and this started with birth and continued for a lifetime. Darug people spent a lifetime learning and as people grew older they passed through stages of knowledge, elders became elders with the learning of stages of knowledge not by their age, being an elder is part of the kinship system this was a very complicated system based on respect.

Darug sites are all connected, our country has a complex of sites that hold our heritage and past history, evidence of the Darug lifestyle and occupation are all across our country, due to the rapid development of Sydney many of our sites have been destroyed, our sites are thousands of years old and within the short period of time that Australia has been developed pre contact our sites have disappeared.

The *Aboriginal cultural heritage consultation requirements for proponents* Section 4.1.8 refers to "Aboriginal organisations representing Aboriginal people who hold cultural knowledge". Recent consultation meetings have revealed that many of these Aboriginal organisations and individuals do not hold cultural knowledge of the Western Sydney area. The increasing involvement of such parties in cultural heritage management means that genuine local Aboriginal organisations are unable to properly care for our cultural heritage.

Many Aboriginal organisations listed in the OEH response letter do not contribute to the Aboriginal community of Western Sydney. Individuals listed in the OEH response letter do not represent the community and while they may be consulted with, should not be employed for their own personal financial benefit.

Our organisation is committed to providing benefits back to our local Aboriginal community through such measures as funding the local Aboriginal juniors' touch football team, painting classes for the local children and donating money to various charities. Employment in cultural heritage activities is source of income that organisations such as ours can use to contribute to beneficial activities and support within the community.

Darug custodian Aboriginal Corporation's site officers have knowledge of Darug land, Darug Culture,Oral histories, landforms, sites, Darug history, wildlife, flora and legislative requirements. We have worked with consultants and developers for many years in Western

Sydney (Darug Land) for conservation, site works, developments and interpretation/education strategie.

Darug Custodian Aboriginal Corporation have received and reviewed the report for 2029 Richmond/North Richmond Precinct.

We support the recommendations set out in this report.

Please contact us with all further enquiries on the above contacts.

Regards

Justine Coplin

Zac Thomas

From: lilly carroll <didgengunawalclan@yahoo.com.au>
Sent: Monday, 1 November 2021 7:29 PM
To: Zac Thomas
Subject: Re: Draft CHAR Review - 2029 Richmond/North Richmond Precinct - DNC

Follow Up Flag: Follow up
Flag Status: Flagged

Hi Zac

DNC is happy with everything
Cheers Paul

Sent from Yahoo Mail for iPhone

On Friday, October 29, 2021, 7:40 am, Zac Thomas <zac.thomas@knconsult.com.au> wrote:

> Dear registered Aboriginal stakeholder,
>
> Please find attached a cover letter and a copy of the draft Aboriginal Cultural Heritage Assessment Report for the proposed upgrades to the Richmond Water Recycling Plant and North Richmond Waste Water Treatment Plant network in Richmond and North Richmond, NSW.
>
> As a registered Aboriginal stakeholder for this project, we would like to invite you to review the report and provide us with any comments or feedback regarding the assessment and the Aboriginal cultural heritage significance of the study area/Aboriginal archaeological sites.
>
> Please forward any comments to myself or the office by **Friday 26 November 2021**. Thank you and we look forward to receiving your comments.
>
> Kind regards,
>
> **Zac Thomas**
>
> Heritage Administration Assistant
>
> **Kelleher Nightingale Consulting Pty Ltd**
>
> Level 10, 25 Bligh St
>
> Sydney NSW 2000

1

Zac Thomas

From: Philip khan <philipkhan.acn@live.com.au>
Sent: Thursday, 18 November 2021 11:52 AM
To: Zac Thomas
Subject: Re: Draft CHAR Review - 2029 Richmond/North Richmond Precinct - KYWG

Dear Zac,

Thank you for your CHAR for Richmond Water Recycling Plant and North Richmond Waste Water Treatment Plant network in Richmond and North Richmond, NSW. Aboriginal people have walked this land for tens of thousands of years and continue to do so, whilst managing and caring for country. We hold a deep connection to the land water, sky, and fire. We have passed on our knowledge from generation to generation through word of mouth, this continues to happen today. We look to the sky for guidance and follow the water ways and apply our knowledge to the land our mother as she provides to us many resources that we always give back to her in many ways. We have a belief system of kinship and followed lore, we also have a spiritual connection to the land and all that surrounds it. There are burials that we are not aware of the location of due to colonisation and disposition of the land we must be mindful of theses when excavating the land.
We at KYWG would like to recommend a cultural interpretation plan for the project, this can be achieved through native landscaping, art, digital displays, native edible gardens and mush more. It is important to have interpretation to better understand Aboriginal culture and to educate the wider community. We would like to agree to your recommendations, and we support you CHAR. We look forward to further consultation and working alongside you on this project.

Kind Regards
Kadibulla Khan

From: Zac Thomas <zac.thomas@knconsult.com.au>
Sent: Friday, 29 October 2021 7:41 AM
To: Philip khan <philipkhan.acn@live.com.au>
Subject: Draft CHAR Review - 2029 Richmond/North Richmond Precinct - KYWG

Dear registered Aboriginal stakeholder,

Please find attached a cover letter and a copy of the draft Aboriginal Cultural Heritage Assessment Report for the proposed upgrades to the Richmond Water Recycling Plant and North Richmond Waste Water Treatment Plant network in Richmond and North Richmond, NSW.

1

Zac Thomas

From: Rodney Gunther <waawaar.awaa@gmail.com>
Sent: Thursday, 4 November 2021 7:30 PM
To: Zac Thomas
Subject: Re: Draft CHAR Review - 2029 Richmond/North Richmond Precinct - WAAC

Hi Zac,

Waawaar Awaa Aboriginal Corporation supports the draft ACHAR for the following reasons:

- A mitigation program comprising archaeological salvage to be undertaken prior to construction for the impacted portion of the three identified sites.
- A land based AHIP be obtained under section 90 of the National Parks and Wildlife Act 1974 for the impact area of the proposal.
- The AHIP to include provision for archaeological salvage excavation within the impacted site areas.
- Salvage excavation should be completed prior to any works which may harm Aboriginal objects at these site locations.

- The AHIP should include Aboriginal objects associated with the impacted portions of the following sites:

1. Terrace Road Redbank Creek AFT 1 AHIMS tbc Partial impact Moderate significance
2. Terrace Road Hawkesbury River AFT 1 AHIMS tbc Partial impact Moderate significance
3. Norfolk Place Hawkesbury River AFT 1 AHIMS tbc Partial impact Moderate significance

- The location of the non-impacted site areas should be avoided by the proposed works.
- Protection measures should include identification in the Construction Environmental Management Plan as environmentally sensitive "no-go zones" on maps and workers inducted.
- Appropriate signage to identify "no-go zones".
- Temporary protective fencing to be erected during the construction works along the AHIP boundary.
- An Unexpected Finds Procedure to be incorporated into the Construction Environmental Management Plan.

regards

Rodney Gunther

On Fri, Oct 29, 2021 at 7:43 AM Zac Thomas <zac.thomas@knconsult.com.au> wrote:

> Dear registered Aboriginal stakeholder,
>
> Please find attached a cover letter and a copy of the draft Aboriginal Cultural Heritage Assessment Report for the proposed upgrades to the Richmond Water Recycling Plant and North Richmond Waste Water Treatment Plant network in Richmond and North Richmond, NSW.
>
> As a registered Aboriginal stakeholder for this project, we would like to invite you to review the report and provide us with any comments or feedback regarding the assessment and the Aboriginal cultural heritage significance of the study area/Aboriginal archaeological sites.

1

Zac Thomas

From: [redacted]
Sent: Tuesday, 16 November 2021 9:19 AM
To: Zac Thomas
Subject: Re: Draft CHAR Review - 2029 Richmond/North Richmond Precinct - [redacted]

Hi Zac,

Thank you for providing us with a copy of the draft Aboriginal Cultural Heritage Assessment Report for the Richmond Water Recycling Plant and North Richmond Waste Water Treatment Plant.

We would like to provide the following comments regarding the management and mitigation measures as per table 6 and the long term management of cultural material.

- Cultural heritage awareness training should be provided to all site personnel and contractors who may be involved in the construction works. This training should form part of the site induction process.

- Ongoing daily inspections of the protective fencing (for possible inadvertent damage) installed at the non-impacted sites should be conducted. These inspections should be included in the site SWMS and documented in the daily toolbox talks.

- Our preference would be for any cultural material to be reburied on site in a suitable location which would not be impacted by any future works/development.

We look forward to working with you on this project. If you require any further information please let us know.

Kind Regards

[redacted]

On Fri, Oct 29, 2021 at 7:42 AM Zac Thomas <zac.thomas@knconsult.com.au> wrote:

> Dear registered Aboriginal stakeholder,

1

Appendix C Aboriginal Community Consultation Log

RICHMOND PRECINCT WASTEWATER NETWORK UPGRADES, NORTH RICHMOND NSW DECEMBER 2021

Record of Consultation and Consultation Log

Aboriginal cultural heritage consultation requirements for proponents 2010

Step	Task Requirement	Action	Outcome
4.1.1	Identify if native title exists in relation to the project area.	Conducted a search of Native TitleVision on 07/05/2021. Wrote to National Native Title Tribunal (NNTT) for a list of registered native title claimants, native title holders and registered Indigenous Land Use Agreements (07/05/2021).	Native TitleVision search showed no Native Title claimants, native title holders or registered Indigenous Land Use Agreements in the vicinity of the study area (07/05/2021). Response received from NNTT (email dated 11/05/2021) with register search results for Hawkesbury LGA. No relevant claims in or around the study area.
4.1.2	Ascertain, from reasonable sources of information, the names of Aboriginal people who may hold cultural knowledge relevant to determining the significance of Aboriginal objects and/or places. Compile a list of Aboriginal people who may have an interest for the proposed project area and hold knowledge relevant to determining the cultural significance of Aboriginal objects and/or places.	Wrote to: Deerubbin Local Aboriginal Land Council (DLALC); Heritage NSW; Local Land Services (LLS); Native Title Services Corporation (NTSCORP Limited); Office of The Registrar, *Aboriginal Land Rights Act 1983* (ORALRA) for a list of Aboriginal owners; Hawkesbury City Council; The National Native Title Tribunal (NNTT) for a list of registered native title claimants, native title holders and registered Indigenous Land Use Agreements; (letters/emails dated 07/05/2021).	Responses received from: Heritage NSW (email/letter dated 31/05/2021); LLS (email received 10/05/2021); NNTT (email dated 11/05/2021); NTSCORP (email dated 13/05/2021) ORALRA (email dated 10/05/2021). A list was compiled from these responses of Aboriginal people who may have an interest in the study area and may hold knowledge relevant to determining the cultural significance of Aboriginal objects and/or places.
4.1.3	Written notification and advertisement: Write to the Aboriginal people whose names were obtained in step 4.1.2 and the relevant LALC(s) to notify them of the proposed project. Place a notice in the local newspaper circulating in the general location of the proposed project, explaining the project and its exact location. Notification by letter and newspaper must include: (a) the name and contact details of the proponent (b) a brief overview of the proposed project that may be the subject of an application for an	Wrote to the Aboriginal people whose names/groups were provided by parties listed above (letters/emails sent 31/05/2021), including: A1 Indigenous Services Aragung Aboriginal Cultural Heritage Site Assessments Amanda Hickey Cultural Services Butucarbin Aboriginal Corporation Badu Barraby Cultural Services B.H. Heritage Consultants Biamanga Bidjawong Aboriginal Corporation Bilinga Barking Owl Aboriginal Corporation Corroboree Aboriginal Corporation Callendulla Darug Aboriginal Cultural Heritage Assessments Darug Aboriginal Land Care Darug Boorooberongal Elders Aboriginal Corporation Darug Custodian Aboriginal Corporation	Responses for registration of interest from written notification and advertisement were received from 16 Aboriginal groups: DLALC (email response 01/06/2021) Darug Custodian Aboriginal Corporation (email response 10/05/2021) Paul Gale (email response 01/06/2021) Didge Ngunawal Clan (email response 01/06/2021) Waawaar Awaa Aboriginal Corporation (email response 01/06/2021) Wurrumay (email response 02/06/2021) Kamilaroi Yankuntjatjara Working Group (email response 02/06/2021) Warragil Cultural Services (email response 05/06/2021)

Step	Task Requirement	Action	Outcome
4.1.3 cont'd	AHIP, including the location of the proposed project (c) a statement that the purpose of community consultation with Aboriginal people is to assist the proposed applicant in the preparation of an application for an AHIP and to assist the Director-General of OEH in his or her consideration and determination of the application (d) an invitation for Aboriginal people who hold cultural knowledge relevant to determining the significance of Aboriginal object(s) and/or place(s) in the area of the proposed project to register an interest in a process of community consultation with the proposed applicant regarding the proposed activity (e) a closing date for the registration of interests.	Dhinawan Culture & Heritage Pty Ltd Dharug DJMD Consultancy Deerubbin Local Aboriginal Land Council Darug Land Observations Didge Ngunawal Clan Darug Tribal Aboriginal Corporation Ginninderra Aboriginal Corporation Goodradigbee Cultural & Heritage Aboriginal Corporation Gunjeewong Cultural Heritage Aboriginal Corporation Gilay Consultants Goobah Developments Guringai Tribal Link Aboriginal Corporation Gulaga Gunyuu HSB Consultants Jerringong Kamilaroi Yankuntjatjara Working Group Murra Bidgee Mullangari Aboriginal Corporation Muragadi Heritage Indigenous Corporation Mura Indigenous Corporation Minnamunnung Munyunga Murramarang Murrumbul Ngambaa Cultural Connections Ngunawal Heritage Aboriginal Corporation Nundagurri Paul Gale Pemulwuy CHTS Rane Consulting Sharon Hodgetts Thauaira Thoorga Nura Tocomwall Waawaar Awaa Wailwan Aboriginal Group Walbunja Walgalu Warragil Cultural Services Widescope Indigenous Group Wingikara Wori Wooilywa Wullung Wurrumay Yerramurra Yulay Cultural Services Yurrandaali Cultural Services Advertisement placed in *Hawkesbury Gazette, W*ednesday 26/05/2021, p21. The final closing date for registration of interest was the 14/06/2021.	A1 Indigenous Services (email response 06/06/2021) Gulaga (email response 08/06/2021) Muragadi (email response 10/06/2021) Barraby Cultural Services (email response 23/06/2021) Yurrandaali Cultural Services (email dated 23/06/2021) Yulay Cultural Services (email response 23/06/2021) Two further Aboriginal Stakeholders registered but requested their details be withheld, see Section 4.1.5.
4.1.4	A minimum of 14 days from the date the letter was sent or notice published in the newspaper to register an interest.	Final closing date for registration of interest was at least 14 days from the date the letter was sent or publication of the advertisement. The final closing date for registration of interest was the 14/06/2021	Copy of newspaper notice attached to CHAR.
4.1.5	Must advise Aboriginal people who are registering an interest that their details will be	Two Aboriginal stakeholders specified they did not want their details released.	Two Aboriginal stakeholders specified they did not want their details released.

Step	Task Requirement	Action	Outcome
	forwarded to Heritage NSW and the LALC unless they specify that they do not want their details released.		
4.1.6	Make a record of the names of each Aboriginal person who registered an interest. Provide a copy of that record and copy of the notification from step 4.1.3 to Heritage NSW and LALC.	List of registered stakeholders compiled. Two Aboriginal stakeholders specified they did not want their details released.	Record of registration for the project sent to DLALC and Heritage NSW on 15/06/2021.
4.1.7	LALCs holding cultural knowledge relevant to determining the significance of Aboriginal objects and places in the proposed project area who wish to register an interest to be involved in consultation must register their interest as an Aboriginal organisation rather than individuals.	Deerubbin Local Aboriginal Land Council registered interest as an organisation on 01/06/2021. Provided contact details for the LALC.	Deerubbin Local Aboriginal Land Council registered interest as an organisation. Provided contact details for the LALC.
4.1.8	Where an Aboriginal organisation representing Aboriginal people who hold cultural knowledge has registered an interest, a contact person for that organisation must be nominated. Aboriginal cultural knowledge holders who have registered an interest may indicate they have appointed a representative to act on their behalf. Where this occurs, the registered Aboriginal party must provide written confirmation and contact details of those individuals to act on their behalf.	Inform stakeholders registering their interest as an organisation that contact information and contact person must be nominated.	Aboriginal stakeholders who have registered as an organisation name also provided contact details and names of representatives for each organisation.
4.2	Presentation of information about the proposed project	Aboriginal stakeholders provided with specific information regarding the proposed project (letters dated 31/05/2021, 15/06/2021 and 23/06/2021). Informal discussions also held via phone call during the registration of interest and methodology review period.	No formal responses to the provision of project information were received.
4.3.1-4.3.2	Notification of proposed assessment methodology	Information regarding the proposed cultural heritage assessment methodology and proposed test excavation was sent to all registered stakeholders with an invitation to review and provide comment (letters dated 15/06/2021). Stakeholders were provided with a 28 day period for review (closure of review period on 13/07/2021).	Formal responses to the proposed assessment methodology were received from nine stakeholder groups, including A1 Indigenous Services (A1), Darug Custodian Aboriginal Corporation (DCAC), Kamilaroi-Yankuntjatjara Working Group (KYWG), Muragadi Heritage Indigenous Corporation (MHIC), Waawaar Awaa Aboriginal Corporation (WAAC), Warragil Cultural Services (Warragil), Wurrumay Pty Ltd (Wurrumay), Yulay Cultural Services (Yulay) and one Registered Stakeholder who chose to withhold their details. A1 expressed that they had reviewed the project information and supported the proposed assessment methodology. A1 indicated a preference to be involved in any future consultation and fieldwork (email dated 20/06/2021).

Step	Task Requirement	Action	Outcome
4.3.1-4.3.2 contd.			DCAC stated that they had received and reviewed the project information and assessment methodology, and supported the recommended methodology for the assessment (email/letter dated 21/06/2021). KYWG stated that they agreed with the proposed assessment methodology and supported the proposed approach (email dated 29/06/2021). MHIC stated that they had reviewed the project information and proposed assessment methodology, and agreed with the assessment recommendations (email dated 15/06/2021). WAAC stated that they supported the proposed assessment methodology, particularly the need for test excavation in areas of archaeological sensitivity that could not be avoided by the proposal (email/letter dated 16/06/2021). Warragil expressed agreement with the proposed assessment approach, particularly the test excavation component of the assessment (email dated 30/06/2021). Wurrumay stated that they had read and agreed with the proposed assessment methodology (email dated 22/06/2021). Yulay stated that they had reviewed the project information and agreed with the proposed assessment methodology for the project (email dated 24/06/2021). One of the stakeholders who chose to withheld their details in accordance with item 4.1.5 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (OEH 2010a) stated that the proposed assessment methodology was consistent with their views for identifying and assessing Aboriginal heritage (email dated 09/07/2021). This stakeholder also noted the importance of involving Aboriginal stakeholders in impact assessments as part of a duty of care to Aboriginal heritage.
4.3.3	Gathering information about cultural significance	Aboriginal stakeholders were invited to provide information about cultural significance of the area and identified Aboriginal archaeological sites. Aboriginal stakeholders invited to provide information on cultural significance at all stages of the assessment process.	Many registered stakeholders have been previously involved with cultural heritage assessments within the region and a high level of knowledge existed with stakeholders. Cultural values have been provided throughout the consultation process. Additional cultural values for the study area have been provided by stakeholders throughout the consultation process. DCAC placed strong importance on the care of Darug sites, places, wildlife and the promotion of their culture and history. DCAC noted that the general area of the project was significant due to archaeological evidence of continued

Step	Task Requirement	Action	Outcome
4.3.3 cont'd.			occupation, with significant site complexes in the vicinity. The connection of sites in the landscape was identified as a key feature of Aboriginal cultural importance: "Darug sites are all connected, our Country has a complex of sites that hold our heritage and past history… evidence of the Darug lifestyle and occupation are all across our Country" (email/letter dated 21/06/2021). DCAC also noted during the CHAR review process the cultural importance of the wider landscape and particular landforms within it, both for the information they hold and the connection they provide for Darug people to their culture and history (letter/email dated 22/11/2021). KYWG expressed that the study area was highly important to Aboriginal people, with a settlement history over tens of thousands of years and expressing the responsibility to "care for the land as she cares for us" (email dated 29/06/2021). KYWG stated that "We hold a deep connection to the land, water, sky, and fire. We have passed on our knowledge from generation to generation through word of mouth, this continues to happen today. We look to the sky for guidance and follow the water ways and apply our knowledge to the land our mother as she provides to us many resources that we always give back to her in many ways. We have a belief system of kinship and followed lore, we also have a spiritual connection to the land and all that surrounds it" (email dated 18/11/2021). Wurrumay expressed that their membership had ancestral connection to the project area (email dated 02/06/2021). One of the stakeholders who chose to withheld their details highlighted the importance of understanding environmental context when assessing Aboriginal heritage, noting that "cultural connections to landscape spread far and wide over many types of terrain" (email dated 09/07/2021).
4.4	Review of draft cultural heritage assessment report	The completed draft C*ultural Heritage Assessment Report* was provided to registered Aboriginal stakeholders for review and comment (letter dated 29/10/2021). A 28 day period was provided for review and comment (closure of comment period 26/11/2021). Stakeholders invited to comment on cultural significance of study area and identified Aboriginal heritage.	Formal responses to the draft CHAR were received from five stakeholder groups, including DCAC, Didge Ngunawal Clan (DNC), KYWG, Waawaar Awaa Aboriginal Corporation (WAAC) and one Registered Stakeholder who chose to withhold their details. DCAC stated that they supported the draft CHAR and the recommendations in the report (letter/email dated 22/11/2021). DNC expressed agreement with the draft CHAR and stated they were 'happy with everything' (email dated 01/11/2021). KYWG stated that they agreed with the recommendations and supported the draft CHAR (letter/email dated 18/11/2021).

Step	Task Requirement	Action	Outcome
4.4 contd.			KYWG also suggested possible cultural heritage interpretation for the project. WAAC (email dated 04/11/2021) supported the proposed salvage program, the application for an AHIP, the avoidance and protection of non-impacted site areas, and the inclusion of an unexpected finds procedure in the CEMP. One of the stakeholders who chose to withheld their details in accordance with item 4.1.5 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (OEH 2010a) provided the following comments on the proposed mitigation and management measures (email dated 16/11/2021): inclusion of cultural heritage awareness training during site inductions for all staff, and ongoing (daily) inspections of the protective fencing, to be included in SWMS and toolbox talks. The stakeholder also expressed a preference for reburial of salvaged artefacts on Country.

Appendix D Salvage Excavation Methodology

Research Aims

The main aims of the proposed salvage excavation program are:

- To salvage a representative sample of the identified archaeological sites prior to impact.
- To analyse the salvaged archaeological material to gain and conserve knowledge and understanding of the scientific and cultural information exhibited by the activities associated with landforms along Redbank Creek and the Hawkesbury River.

The further scientific aim of the salvage excavation program would be to determine the subsurface integrity, extent, spatial distribution and nature of the cultural deposit and the specific types of associated archaeological/cultural activities.

- Determining the integrity of the deposit involves assessing the degree of disturbance which is present.
- Determining the statistical extent of the sites and/or activity areas involves identifying the boundaries associated with the identified archaeological deposit.
- Assessing the spatial distribution involves identifying the presence/absence of archaeological material across the identified archaeological sites.
- The nature of the sites refers to the type of activities indicated by the artefactual material (e.g. primary production, domestic knapping, hunting camps). The goal would be to retrieve entire assemblages from specific activities if such activities were present.
- Retrieved assemblages would be compared with the results from other relevant archaeological projects in the region in order to assess significance.

Research Questions

The results of the proposed salvage excavation would increase our understanding of subsurface archaeology within the study area. In particular, research would focus on the archaeologically-identifiable cultural activities that took place at the junction of the shale/sandstone landscapes and major resource zones of the surrounding area. Archaeologically these junctions are important because the soil matrix of shale facilitates artefact survivability in open context, which is normally very limited in sandstone environments.

The location of the sites where salvage is proposed also needs to be considered in the wider landscape context. The sites are spatially associated with a series of terraces and elevated landforms around Redbank Creek and its tributary, and two more elevated crests/terraces which jut out into the main Hawkesbury River floodplain. Test excavation determined that these areas display relatively intact soils containing a moderate to high quantity of Aboriginal objects. The specific combination of landform, elevation and location on the margin of the floodzones would have made them attractive locales for Aboriginal occupation and (with generally low levels of landscape disturbance) has allowed them to preserve archaeological deposits. Archaeological salvage investigation of these sites must therefore also consider the geomorphology of the landform, site taphonomy and survivability of the deposit. Understanding how flooding and erosion impact on archaeological sites is becoming increasingly important in interpreting the flow of archaeology within a landscape, particularly in association with a major landscape feature such as the Hawkesbury River. The salvage program also offers an opportunity to compare and contrast several factors; namely, the archaeology of an elevated landform above Redbank Creek in direct comparison to elevated landforms above the Hawkesbury River, and an elevated (residual) crest above the Hawkesbury floodplain in comparison to a lower level (alluvial) terrace in close proximity.

What can we expect?

It is anticipated that differences in stone tool assemblages may be related to different cultural activities (e.g. primary reduction vs maintenance flaking). Results from the test excavation program indicate that the sites may display assemblages with different characteristics, possibly representing different activities or site uses. The science of archaeology is paramount to any research question and it is important to stress that the goal for the salvage program for all excavated sites is straight forward: to retrieve a viable sample for comparative analysis using established techniques (see Field Methods below). In this regard interpretation would not precede data collection. The proposed archaeological program would systematically sample the relevant areas using standard techniques with the outcome being a viable, robust and comparable sample. Analysis of the sample would follow and interpretations would be made distinctly separate from the results.

> **Question 1**: What cultural activities are archaeologically identifiable on the crest associated with Terrace Road Redbank Creek AFT 1, compared to those on landforms associated with the Hawkesbury River floodplain (Terrace Road Hawkesbury River AFT 1 and Norfolk Place Hawkesbury River AFT 1)? Are there differences in activities between these locations?

Question 2: Similarly, are there identifiable differences between Terrace Road Hawkesbury River AFT 1 (lower level alluvial landform) and Norfolk Place Hawkesbury River AFT 1 (elevated residual landform) despite their close spatial proximity and similar association with the Hawkesbury?

Question 3: If so, are these differences likely reflective of a true dissimilarity in cultural activities between the landforms/sites? (Bearing in mind the different taphonomic and geomorphological processes operating on each site).

Question 4: What do the results indicate about the archaeology of similar landforms along the lower reaches of Redbank Creek and bordering the Hawkesbury floodplain? Do the sites display generalised or unique geomorphological or taphonomic features?

Question 5: Do the sites display any unique or distinguishing traits that may be the result of their location in a transitional shale/sandstone landscape?

Archaeological Salvage Areas

Salvage excavation would be undertaken on the impacted portions of identified archaeological sites Terrace Road Redbank Creek AFT 1, Terrace Road Hawkesbury River AFT 1 and Norfolk Place Hawkesbury River AFT 1. The proposed impact corridor and AHIP area is 20 metres wide and salvage would be undertaken within this corridor within the impacted site areas (refer Figure 10). Salvage excavation of the sites would focus on the extraction of collections of artefacts related to activity areas and geomorphic information.

FIELD METHODS

The goal of the field excavation program is to recover significant assemblages of artefacts and investigation of contributing geomorphic processes.

Salvage Program

In order to achieve the most robust and comparable result, KNC advocates an open area salvage excavation. The first phase in open area salvage is to establish the statistical boundaries of the previously identified archaeological deposit. This approach is designed to salvage the spatial properties of the site as shown in the lithic continuum; in other words, recording the spread of activities across the site and wider landscape.

Phase 1

A series of 1 m^2 squares are excavated on a transect grid overlain on each site to confirm the spread of lithics and related geomorphic activity. Phase 1 squares would be positioned to complement and augment the information from the previous test excavation program at the sites.

Geocentric Datum of Australia 1994 (GDA94) coordinates would be recorded for each square to enable three dimensional modelling. Statistical salvage following this method is highly beneficial because it creates a robust inter-site sample, sufficiently random, critical for regional comparative analysis. No other method is as efficient or effective.

Where Phase 1 identifies information bearing deposit, Phase 2 excavation will be completed. Information bearing deposits are identified by triggers such as: significant quantities of artefacts, variations in raw material, unusual artefacts, chronological material and/or taphonomic indicators. In this context chronologic material is anything that can be used to date artefacts or deposit: charcoal or charcoal bearing deposit (e.g. hearth ash), sandy deposit, gravels (e.g. aluminium feldspar).

Phase 2

Open area salvage, Phase 2 will expand to encompass entire activity areas. It is anticipated that up to 100m^2 will be excavated during the salvage program. Suggested minimum salvage for each site is as follows:

Terrace Road Redbank Creek AFT 1	25m^2
Terrace Road Hawkesbury River AFT 1	20m^2
Norfolk Place Hawkesbury River AFT 1	25m^2

Individual excavation squares measuring 1 m^2 would be hand excavated in stratigraphic units (Unit A, Unit B, etc.). Squares would be excavated until the basal layer or culturally sterile deposit is reached (potentially up to 70cm below the surface). All excavated deposit would be wet sieved using nested 5.0 mm and 2.5 mm sieves.

Where suitable deposit occurs, carbon samples will be collected and analysed for material relating to both the archaeology and geomorphology. Where appropriate, cosmogenic and radiometric dating of soils and rock surfaces will be applied (Nishiizumi et al. 1986, 1993).

The location of each excavated square would be identified on a surveyed plan of the site. Stratigraphic sections detailing the stratigraphy and features within the excavated deposit would be drawn and all squares would be photographed. Soil samples as well as thin section profiles (where feasible) would also be collected. The stratigraphy of all excavated areas would be fully documented and appropriate records archived.

Analysis

Artefacts would be analysed on a comparable level with previous analyses of excavated assemblages. Information derived from this analysis; in particular the identification of specific artefact types and their distributions and associations; would be used to put together interpretations about how sites were used, where sites were located across the landscape, the age of sites and to assess cultural heritage values. By comparing different areas it would be possible to determine whether there were differences in the kinds of activities carried out and if different activities were related to different landforms.

A range of stone artefacts may be present across the salvage areas and the analysis would expand accordingly to account for artefact variability. All information would be recorded in database form (MS Excel). Various types of evidence would be used to determine the kinds of activities that were carried out. A short description of the proposed analysis in outlined below.

- Field analysis would record basic data, such as material type, number and any significant technological characteristics, such as backing or bipolar techniques; added to this would be any provenance data such as pit ID and spit number. The purpose of the field recording is twofold: 1) establish a basic recording of artefacts retrieved and 2) to allow on-going assessment of the excavation regime (e.g. whether higher stratigraphic resolution is required while digging).
- Detailed (laboratory) analysis would entail recording a larger number of characteristics for each individual artefact. These details would be recorded in matrices suitable for comparative analysis (e.g. multivariate and univariate) of the excavated assemblage on a local and regional basis.
- Lithic characteristics to be recorded cover a range of basic information but are not limited to these categories (see example below). For transparency, terms and category types would in large part be derived from Holdaway and Stern (2004).

Sample Categories		
Record Number	% Cortex	Flake Type
Pit ID	Length	Termination Type
Spit Number	Width	Core Type
Count	Thickness	Number of Scars (Core)
Raw Material	Weight	Scar Type (Core)
Colour	Modification	Shape of Flake
Quality	Reduction Type	Platform Type

- A detailed explanation and glossary would be provided with the final excavation report.
- Minimum Number of Flake (MNF) calculations formulated by Hiscock (2002) would be undertaken where applicable (although past experience indicates MNF calculations would not be required for this excavation program).

The analysis of artefacts recovered during the excavation program would be undertaken in a transparent and replicable fashion so as to permit the comparison of the entire excavated assemblage with data from other areas. This would also allow for an interpretation of the study area's archaeological significance.

Field Team

KNC directors, Dr Matthew Kelleher and Alison Nightingale, would be responsible for the salvage excavation program. Dr Matthew Kelleher would direct the excavation component of the Aboriginal archaeological assessment. Matthew has extensive experience in managing archaeological excavations and research projects. Matthew would also be the principal contact for the overall Aboriginal archaeological assessment for the project. The salvage excavation will be undertaken in partnership with registered Aboriginal stakeholders.