Greater Parramatta and Olympic Peninsula Water Cycle Management – Aquatic Biodiversity Impact Assessment

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Sydney Water

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Prepared by:
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Executive Summary

Sydney Water is proposing to build and operate a new water resource recovery facility (WRRF) at Camellia-Rosehill. The new WRRF is needed to provide additional wastewater capacity to support growth across the northern suburbs of Sydney, and in the Greater Parramatta and Olympic Peninsula (GPOP) growth corridor. The WRRF and associated infrastructure together form the GPOP Water Cycle Management (WCM) project (the Project).

The additional growth would place pressure on the existing northern suburbs wastewater network, which includes the Northern Suburbs Ocean Outfall Sewer (NSOOS) and the North Head WRRF. These critical assets provide wastewater services to around 1.7 million people, and with current growth projections would reach capacity by 2031.

The GPOP WCM project has been designed to be efficient, sustainable, and cost effective for the community, as well as resilient and adaptable for future water uses.

The main elements of the Project include:

- a new WRRF at Camellia-Rosehill to treat wastewater to produce advanced treated water
- upgrades to the existing pumping station at Camellia
- a new wastewater transfer pipeline from Camellia pumping station to the WRRF
- a new and repurposed brine pipeline to transfer brine from the WRRF to the NSOOS
- a new river release pipeline to transfer advanced treated water from the WRRF to a release structure in Parramatta River at Meadowbank.

The Project is State Significant Infrastructure (SSI) and Sydney Water is preparing an Environmental Impact Statement (EIS) to support an application to the Minister for Planning and Public Spaces.

This aquatic biodiversity impact assessment (ABIA) aimed to address the project-specific Secretary's Environmental Assessment Requirements (SEARs) issued by the Department of Planning, Housing and Infrastructure (DPHI) and current guidelines and legislation in identifying any potential impacts of the Project on aquatic biodiversity.

The approach to the assessment included a detailed desktop review of literature and databases, constraints mapping, field-based investigations and review of other specialist studies and water quality / hydrodynamic modelling.

Results of the desktop review and field investigations found the existing environment within the Upper Parramatta Estuary and impact assessment area to be a highly modified, yet ecologically functional environment that supports diverse aquatic and riparian habitats. These habitats range from riparian corridors, mangroves, saltmarsh, intertidal rocky reef and artificial habitats (e.g. seawalls, wharves and pilings). Mangroves, consisting primarily of the grey mangrove (*Avicennia marina*), are the most prevalent intertidal habitat in the impact assessment area with dense stands occurring around Sydney Olympic Park, Duck River, and Meadowbank. Saltmarsh habitats, recognised as a Threatened Ecological Community (TEC), are restricted to small, fragmented patches, particularly in Homebush Bay, Newington Nature Reserve, Duck River and Wentworth Point. Small areas of intertidal rocky reef

and more extensive artificial habitats (sandstone seawall) are located in the vicinity of the proposed release point but support a limited assemblage of intertidal invertebrates (oysters, barnacles and gastropods) and macroalgae (e.g. filamentous green algae) in comparison with those found in the lower estuary. Seagrass beds were absent from the upper estuary and impact assessment area.

The subtidal environment was characterised by soft sediments (fine silts and muds) with a legacy of industrial and urban contamination. These sediments are likely to be ecologically functional, supporting typical (if not depauperate) assemblages of infaunal and epifaunal macroinvertebrates which provide a food source for fish and shorebirds.

Parramatta River, Duck River and Vineyard Creek function as Key Fish Habitat (Type 2 – moderately sensitive), supporting at least 34 estuarine species, such as yellowfin bream (*Acanthopagrus australis*), sea mullet (*Mugil cephalus*), and dusky flathead (*Platycephalus fuscus*) along with diadromous eels in tributaries. The upper estuary also supports many waterbirds and migratory species, with up to 80 threatened or migratory taxa identified as potentially present. Of these, shorebirds such as the sharp-tailed sandpiper (*Calidris acuminata*), Australian pied oystercatcher (*Haematopus longirostris*), white-fronted chat (*Epthianura albifrons*), bar-tailed godwit (*Limosa lapponica baueri*) and white-bellied sea eagle (*Haliaeetus leucogaster*) were frequently recorded in the study locality and considered to have a high likelihood of occurrence.

This ABIA has identified a range of potential construction impacts associated with the Project, including direct disturbance to aquatic and riparian habitats (including KFH), temporary mobilisation of sediments and legacy contaminants (including metals and dioxins), changes to water quality, and localised disturbance from project related work vessels. While some works, such as open trenching, riverbank excavation and placement of the concrete mattress and diffusers, will result in the permanent loss or alteration of existing habitats, these areas are small in scale, of generally low ecological value or represent already disturbed environments. Potential indirect impacts to waterways and aquatic biodiversity, including increased turbidity, mobilisation of contaminants, and risks associated with acid sulfate soils, can be effectively managed through standard construction safeguards (such as sediment containment), site-specific management plans, and targeted monitoring of contaminants.

During operation, the presence of new infrastructure on the riverbed will alter the existing soft sediment habitat but is expected to increase habitat complexity and may provide surfaces for colonisation by sessile organisms. Modelling indicates that changes to hydrodynamics and water quality parameters due to normal operation of the WRRF will be negligible or close to background levels, with some parameters showing overall improvement relative to existing conditions (including in consideration of climate change and other cumulative catchment effects such as stormwater overflows). Residual risks from contaminants and nutrient enrichment are considered low and will be managed through ongoing monitoring and adaptive management.

Based on the modelling undertaken, operation of the WRRF is expected to provide many improvements in the water quality of the Parramatta River. These improvements generally consist of lower concentrations of nutrients, pathogens and algal biomass, as well as higher levels of dissolved oxygen. These improvements in water quality are expected within the immediate vicinity of the release location as well as the broader estuary with potential associated improvements in aquatic health, KFH and biodiversity.

The implementation of an ambient water quality monitoring and management program (to be developed by Sydney Water in consultation with the New South Wales Environment Protection Authority (NSW EPA)), provides an additional safeguard against potential for elevated levels of nutrients, small

reductions in salinity and slight increases in surface water temperatures. The residual risk of contaminant mobilisation can also be monitored and addressed e.g. with instream sediment retention devices such as silt curtains where feasible.

Potential cumulative impacts with other local projects are considered minor, provided that established controls are applied.

Providing that all mitigation and management plans are implemented and that appropriate water quality monitoring (and adaptive management) is undertaken, no significant or long-term impacts to KFH, threatened species, Matters of National Environmental Significance (MNES), ecological communities, sensitive or protected lands are anticipated, and the Project is not expected to exacerbate any listed Key Threatening Processes (KTPs). No requirements for offsetting of impacts to aquatic biodiversity are required because the Project would not result in significant adverse impacts on aquatic biodiversity or sensitive environmental values of the Parramatta River and its tributaries.

Acronyms / Abbreviations

Acronym / Abbreviation	Full Name
ABIA	Aquatic Biodiversity Impact Assessment
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guideline
ASS	Acid Sulfate Soils
ASSMP	Acid Sulfate Management Plan
BAM	Biodiversity Assessment Method
BC Act	*Biodiversity Conservation Act 2016*
BDAR	Biodiversity Development Assessment Report
CCMP	Construction Contamination Management Plan
CEMP	Construction Environment Management Plan
CPHR	Conservation Programs, Heritage & Regulation
CM Act	*Coastal Management Act 2016*
DCCEEW	Department of Climate Change Energy, the Environment and Water
DPHI	Department of Planning, Housing and Infrastructure
DPIE	NSW Department of Planning, Industry and Environment
DPIRD	Department of Primary Industries and Regional Development
DO	Dissolved Oxygen
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning & Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPL	Environment Protection Licence
FM Act	*Fisheries Management Act 1994*
GPOP	Greater Parramatta and Olympic Peninsula
GPOP WCM	Greater Parramatta and Olympic Peninsula Water Cycle Management Project
HDD	Horizontal Directional Drilling
HEVAE	High Ecological Value Aquatic Ecosystem
IMP	Introduced Marine Pest
KFH	Key Fish Habitat
KTP	Key Threatening Process
MNES	Matters of National Environmental Significance
NSOOS	Northern Suburbs Ocean Outfall Sewer
NSW	New South Wales
PCT	Plant Community Type
PMST	Protected Matters Search Tool
POEO Act	*Protection of the Environment Operations Act 1997*
RCE	Riparian Channel and Environmental Inventory
RO	Reverse Osmosis
ROV	Remote Operated Vehicle
SEARs	Secretary’s Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SQGV	Sediment Quality Guideline Value
SSI	State Significant Infrastructure
SWMP	Soil and Water Management Plan
TN	Total Nitrogen
TSS	Total Suspended Solids
WCM	Water Cycle Management

WQO	Water Quality Objective
WQRM	Water Quality Response Model
WRRF	Water Resource Recovery Facility
WRRP	Waste and Resource Recovery Plan

1 Introduction

1.1 Background

Sydney Water is proposing to build and operate a new water resource recovery facility (WRRF) at Camellia-Rosehill. The new WRRF is needed to provide additional wastewater capacity to support growth across the northern suburbs of Sydney, and in the Greater Parramatta and Olympic Peninsula (GPOP) growth corridor. The WRRF and associated infrastructure together form the GPOP Water Cycle Management project (the project).

The additional growth would place pressure on the existing northern suburbs wastewater network, which includes the Northern Suburbs Ocean Outfall Sewer (NSOOS) and the North Head WRRF. These critical assets provide wastewater services to around 1.7 million people, and with current growth projections would reach capacity by 2031.

The GPOP WCM project has been designed to be efficient, sustainable, and cost effective for the community, as well as resilient and adaptable for future water uses

The Project is a State Significant Infrastructure (SSI) under Schedule 3, section 1(1) of the Planning Systems SEPP. This is because Sydney Water would otherwise be the determining authority and has concluded that an Environmental Impact Statement (EIS) is required in accordance with section 5.7(1) of Environmental Planning and Assessment Act (EP&A Act). The approval authority is the New South Wales (NSW) Minister for Planning and Public Spaces. Impacts on ecological Matters of National Environmental Significance (MNES) will also be assessed pursuant to the requirements of the *Environmental Protection and Biodiversity Conservation* (EPBC) Act. Significant impacts on MNES relevant to aquatic biodiversity have not, however, been identified in this ABIA and therefore a referral to the Commonwealth Minister for the Environment has not been advised.

An aquatic ecology literature review (Stantec, 2024) and site investigations were undertaken in 2024 for the Project. Where relevant, results of this review have been included in this assessment. A detailed overview of the Project is provided in Section 2.

1.2 Aims and Objectives

The aquatic biodiversity impact assessment (ABIA) aims to address the project-specific Secretary's Environmental Assessment Requirements (SEARs) issued by the Department of Planning, Housing and Infrastructure (DPHI) on 25 September 2024, current guidelines and legislation in identifying any potential impacts of the Project on aquatic biodiversity. SEARs relevant to aquatic biodiversity aspects of the Project are provided in (Section 1.3, Table 1-1). In order to address the relevant SEARs, the following technical reports were also reviewed as part of the ABIA:

- Surface Water and Geomorphology Impact Assessment (Aurecon, 2025)
- Hydrodynamics and Water Quality Impact Assessment (Sydney Water, 2025a)
- Waste Management Impact Assessment (Sydney Water, 2025b)

- Sediment size and chemistry for cores retrieved from the John Whitton Bridge potential release site (Birch and Batley, 2025)
- Biodiversity Development Assessment Report (BDAR), (Arcadis, 2025).

The scope of the ABIA relates to all aspects of aquatic biodiversity relevant to the Project up to the high mean water mark (HMWM) including all aquatic flora and fauna but excluding predominantly terrestrial species (covered in the Biodiversity Development Assessment Report – Arcadis, 2025). In particular, it considers potential direct and indirect impacts of construction works near watercourses and releases of treated water into the aquatic environment.

1.3 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements (SEARs) addressed as part of this ABIA are identified in Table 1-1 below.

Table 1-1 Project SEARs addressed by the ABIA

Key Issue and desired performance outcome	Requirement	Report Section where SEARs addressed
Biodiversity		
The project design considers measures to avoid and minimise impacts on terrestrial and aquatic biodiversity. Offsets and / or supplementary measures are assured which are equivalent to residual impacts of project construction and operation.	7. Impacts on biodiversity values not covered by the Biodiversity Assessment Method (BAM) must be assessed. This includes a threatened aquatic species assessment (under Part 7A of Fisheries Management Act 1994 (FM Act)) to address whether there are likely to be any significant impact on listed threatened species, populations or ecological communities listed under the FM Act.	5.1.7
	8. Identify whether the project, or any component of the project, would be classified as a Key Threatening Process (KTP) in accordance with the listings in the BC Act, FM Act and the EPBC Act.	5.1.9
	9. Assess the potential impacts to Key Fish Habitat and / or threatened species from the release of treated wastewater into the Parramatta River.	5.2.3
	10. Assess the potential impacts to Key Fish Habitat and / or threatened species from the release of brine to a wastewater system with an ocean outfall or demonstrate how the project will be consistent with the existing environment protection licence (EPL 378).	Not assessed as part of this ABIA scope. Refer to Chapter 7 of EIS.
	11. Demonstrate how the design and construction of the project avoids, minimises and mitigates impacts to Key Fish Habitat.	5.3
	12. Detail the measures for avoiding and/or minimising impacts on native riparian vegetation, including identification of buffer zones for waterway crossings.	5.3
Contamination		
	The ABIA will consider the risks of contaminant mobilisation on aquatic biodiversity	5.1.3 and 5.2.2
Noise and Vibration		
	The ABIA will consider potential impacts of noise and vibration on aquatic biodiversity	5.1.5

Key Issue and desired performance outcome	Requirement	Report Section where SEARs addressed
Traffic and Transport		
	The ABIA will consider potential impacts on aquatic biodiversity of increased vessel traffic and disturbance	5.1.5
Soils		
	The ABIA will consider any risks from ASS on the receiving ecological environment	5.1.3
Waste		
	The ABIA will consider potential environmental impacts from the excavation, handling, storage on site and transport of waste particularly in relation to sediment/leachate control, noise and dust on the aquatic environment	5.1.2
Protected and Sensitive Lands		
	1. Impacts of the project on environmentally sensitive land and processes (and the impact of processes on the project) including, but not limited to: (a) land defined as a "coastal environment area" under the State Environmental Planning Policy (Resilience and Hazards) 20213 (b) coastal hazards identified in studies completed by local councils or state agencies (including risk mitigation strategies that reduce coastal hazards exposure and funding of such strategies) (c) coastal processes (including tides, sediment movement etc.) associated with adopted risk mitigation actions (d) protected areas (including land and water) managed BCS NSW DCCEEW and / or DPI Fisheries under the NPW Act and the Marine Estate Management Act 2014 (e) Key Fish Habitat as mapped and defined in accordance with the (FM Act) (f) waterfront land as defined in the Water Management Act 2000 (g) land or waters identified as Critical Habitat under the FM Act or EPBC Act or areas of outstanding biodiversity value under the BC Act (h) biodiversity stewardship sites, private conservation lands and other lands identified as offsets.	5.1.8
Water - Hydrology		
Long term impacts on surface water and groundwater hydrology	6. Surface and groundwater hydrology impacts (both quality and source) of the construction and operation of the project and any ancillary facilities (both built elements and	5.1.4

Key Issue and desired performance outcome	Requirement	Report Section where SEARs addressed
(including drawdown, flow rates and volumes) are minimised. The environmental values of nearby, connected and affected water sources, groundwater and dependent ecological systems including estuarine and marine water (if applicable) are maintained (where values are achieved) or improved and maintained (where values are not achieved).	discharges) in accordance with the current guidelines, including: (a) natural processes within rivers, wetlands, estuaries, marine waters and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge (b) effects to upstream and downstream rivers, wetlands, estuaries, marine waters, floodplain areas and water-dependent fauna and flora (including groundwater dependent ecosystems) (c) impacts from permanent and temporary interruption or interference of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for geotechnical settlement associated with surface water bodies (e) direct or indirect increases in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses	
Water Quality		
	1. Water Quality (surface and groundwater) impacts on waterways potentially impacted by the project, including but not limited to the Parramatta River, Homebush Bay and Haslams Creek, including: (a) existing background levels (b) details on the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the project, including the indicators and associated trigger values or criteria for the identified environmental values (g) the significance of any identified impacts including consideration of the relevant ambient water quality outcomes (h) details on how construction and operation of the project will, to the extent that the project can influence, ensure that:	5.1.2 and 5.2.3

Key Issue and desired performance outcome	Requirement	Report Section where SEARs addressed
	i. where the NSW WQOs for receiving waters are currently being met, they will continue to be protected ii. where the NSW WQOs are not currently being met activities will work toward their achievement over time iii. the objectives of making the Paramatta River swimmable can be met iv. migration of contamination is considered and how it will be managed and minimised. (j) demonstration that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented. This also includes consideration and management of frac out from the temporary loss of drilling fluids and inappropriate storage of chemicals and fuels (k) Identification of sensitive receiving environments (which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments (l) proposed water quality monitoring programs, including monitoring locations, monitoring frequency and the parameters that will be monitored pre-construction, during construction and during operation, including justification for these.	

1.4 Relevant Legislation and Guidelines

1.4.1 Commonwealth Legislation

1.4.1.1 Environment Protection and Biodiversity Conservation (EPBC) Act 1999

The EPBC Act protects nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as MNES. MNES relevant to aquatic biodiversity are:

- Wetlands of international importance.
- Nationally listed threatened species and ecological communities.
- Migratory species; and

- Commonwealth marine areas.

The significance of impacts on MNES is determined in accordance with the *Significant Impact Guidelines 1.1 — Matters of National Environmental Significance* (Department of the Environment, 2013).

Any action that is likely to have a significant impact on a MNES is classified as a 'controlled action' and is referred to the Minister for the Environment and Water (Australia) for approval.

1.4.2 State Legislation

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

The EP&A Act is the primary legislation that permits or prohibits development in the state of NSW. The Act provides a framework for socially and economically responsible development that also seeks to protect the environment. While its primary focus is on planning and development control, it plays a central role in the protection of aquatic biodiversity and in advancing principles of environment, sustainability, and governance (ESG) including the precautionary principle, intergenerational equity, and biodiversity conservation. It outlines the legal framework through which development is planned and assessed including requirements for integration with other legislation relevant to the aquatic environment (e.g. the Fisheries Management Act 1994) to provide a holistic framework for aquatic environment protection.

The EP&A Act also provides a mechanism for other Environmental Planning Instruments (EPIs) that are specific to development on a state, regional and local scale. EPIs relevant to this report include several State Environmental Planning Policies (SEPPs) which are addressed below.

1.4.2.1.1 State Environmental Planning Policy (Resilience and Hazards) 2021

The State Environmental Planning Policy (Resilience and Hazards) – RHSEPP – provides planning and environmental controls associated with development within coastal areas, potential/actual hazardous or offensive development and land that requires remediation.

The location of the activities being undertaken in the Upper Parramatta River and its tributaries are within the Coastal Use Area and the Coastal Environment Area mapped in the RHSEPP. These are defined as follows:

Coastal Environment Area: This area encompasses natural coastal features such as beaches, rock platforms, coastal lakes, lagoons, and undeveloped headlands. The focus here is on preserving the natural environment and ensuring that development does not adversely impact these features.

Coastal Use Area: This area includes land that is used or has the potential to be used for urban development, commercial activities, and recreational purposes. It aims to balance development with the protection of coastal resources.

Chapter 2, Division 3 (Coastal Use) and Division 4 (Coastal Environment) provide the following relevant considerations for the aquatic biodiversity assessment:

2.10 Development on land within the coastal environment area

(1) Development consent must not be granted to development on land that is within the coastal environment area unless the consent authority has considered whether the proposed development is likely to cause an adverse impact on the following:

(a) the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment,

(b) coastal environmental values and natural coastal processes,

(c) the water quality of the marine estate (within the meaning of the Marine Estate Management Act 2014), in particular, the cumulative impacts of the proposed development on any of the sensitive coastal lakes identified in Schedule 1,

(d) marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms,

(e) existing public open space and safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability,

(f) Aboriginal cultural heritage, practices and places,

(g) the use of the surf zone.

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

(a) the development is designed, sited and will be managed to avoid an adverse impact referred to in subsection (1), or

(b) if that impact cannot be reasonably avoided, the development is designed, sited and will be managed to minimise that impact, or

(c) if that impact cannot be minimised, the development will be managed to mitigate that impact.

This assessment has considered the impacts of the project and have considered clause 2.10(1) and (2) in Section 5.1.8 of this ABIA.

2.11 Development on land within the coastal use area

(1) Development consent must not be granted to development on land that is within the coastal use area unless the consent authority:

(a) has considered whether the proposed development is likely to cause an adverse impact on the following:

(i) existing, safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability,

(ii) overshadowing, wind funnelling and the loss of views from public places to foreshores,

(iii) the visual amenity and scenic qualities of the coast, including coastal headlands,

(iv) Aboriginal cultural heritage, practices and places,

(v) cultural and built environment heritage, and

(b) is satisfied that:

(i) the development is designed, sited and will be managed to avoid an adverse impact referred to in paragraph (a), or

(ii) if that impact cannot be reasonably avoided, the development is designed, sited and will be managed to minimise that impact, or

(iii) if that impact cannot be minimised, the development will be managed to mitigate that impact, and

(c) has taken into account the surrounding coastal and built environment, and the bulk, scale and size of the proposed development.

This assessment has considered the impacts of the Project and have considered clause 2.11(1) in Section 5.1.8 of this ABIA.

1.4.2.2 State Environmental Planning Policy (Planning Systems) 2021

The State Environmental Planning Policy (Planning Systems) – Planning Systems SEPP – aims to identify state significant development and infrastructure. This is in the form of specific sites or by identifying criteria for a project that will allow consideration as significant to a region or the broader state.

Under Section 5.16 of the EP&A Act, the Planning Secretary has prepared environmental assessment requirements, or SEARs which set out the minimum assessment requirements including aquatic biodiversity to be considered. The SEARs relevant to aquatic biodiversity are outlined in Section 1.3 and will be addressed throughout this ABIA.

1.4.2.3 State Environmental Planning Policy (Biodiversity and Conservation) 2021

The *State Environmental Planning Policy (Biodiversity and Conservation) 2021* – BCSEPP – plays an essential role in the conservation and management of biodiversity and threatened species in NSW.

Chapter 6, Part 6.2, Division 2 (Controls on development generally) provide the following relevant considerations for the ABIA:

6.7 *Aquatic biodiversity*

(1) In deciding whether to grant development consent to development on land in a regulated catchment, the consent authority must consider the following—

(a) whether the development will have a direct, indirect or cumulative adverse impact on terrestrial, aquatic or migratory animals or vegetation,

(b) whether the development involves the clearing of riparian vegetation and, if so, whether the development will require—

(i) a controlled activity approval under the Water Management Act 2000, or

(ii) a permit under the Fisheries Management Act 1994,

(c) whether the development will minimise or avoid:

(i) erosion of land abutting a natural waterbody, or

(ii) sedimentation of a natural waterbody,

(d) whether the development will have an adverse impact on wetlands that are not in the coastal wetlands and littoral rainforests area,

(e) whether the development includes adequate safeguards and rehabilitation measures to protect aquatic biodiversity,

(f) if the development site adjoins a natural waterbody, whether additional measures are required to ensure a neutral or beneficial effect on the water quality of the waterbody.

(2) Development consent must not be granted to development on land in a regulated catchment unless the consent authority is satisfied of the following:

(a) the direct, indirect or cumulative adverse impact on terrestrial, aquatic or migratory animals or vegetation will be kept to the minimum necessary for the carrying out of the development,

(b) the development will not have a direct, indirect or cumulative adverse impact on aquatic reserves,

(c) if a controlled activity approval under the Water Management Act 2000 or a permit under the Fisheries Management Act 1994 is required in relation to the clearing of riparian vegetation, the approval or permit has been obtained,

(d) the erosion of land abutting a natural waterbody or the sedimentation of a natural waterbody will be minimised,

(e) the adverse impact on wetlands that are not in the coastal wetlands and littoral rainforests area will be minimised.

This assessment has considered the impacts of the Project and have considered the above clauses in Section 5.1.8 and 5.1.1 of this report.

1.4.2.4 Fisheries Management (FM) Act 1994

The *Fisheries Management Act 1994* (FM Act) contains provisions for the conservation of fish stocks, key fish habitat (KFH), biodiversity, threatened species, populations and ecological communities. The FM Act regulates the conservation of fish, marine vegetation and some aquatic macroinvertebrates, and the development and sharing of NSW fishery resources for present and future generations. Part 7 of the FM Act identifies requirements for the protection of aquatic habitats. Part 7A lists threatened species, populations and ecological communities, as well as key threatening processes (KTPs) for species, populations and ecological communities in NSW waters. Section 220ZZ of the FM Act outlines significant impact considerations to threatened species, populations and ecological communities listed under the FM Act.

All types of marine vegetation (including seagrass, macroalgae, mangroves and saltmarsh), whether alive or dead, are protected under the FM Act.

If declared SSI, a permit under Sections 201, 205 or 219 of FM Act are not required. This report has assessed the potential impacts associated with fisheries management, threatened species, threatened ecological communities and KFH in line with the FM Act and has considered these impacts in Section 5.1.7.

A key aim of the FM Act is to maintain and improve KFH throughout NSW. Impacts to KFH are assessed and offset in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management (NSW DPI, 2013).

1.4.2.5 Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) contains provisions for the conservation of threatened species, populations and ecological communities and areas of outstanding biodiversity value (AOBV) including aquatic species not covered in the FM Act (e.g., marine mammals, reptiles and birds). Section 7.3 of the BC Act requires proponents of activities subject to Part 5 of the EP&A Act to determine whether the works will have a significant impact on threatened species, populations and/or ecological communities, or AOBV. The test for significant impact is described in Section 7.3 of the BC Act.

If a significant impact is likely to occur, the proponent of the activity must prepare a species impact statement in accordance with Section 7.2 of the BC Act. Alternatively, the proponent can prepare a biodiversity development assessment report.

1.4.2.6 Coastal Management Act 2016

The *Coastal Management Act 2016* (CM Act) aims to manage the coastal environment in NSW in a manner consistent with the principles of ecologically sustainable development for the social, cultural and economic wellbeing of the state.

Coastal Use Areas and Coastal Environment Areas in the *State Environmental Planning Policy (Resilience and Hazards) 2021* (RHSEPP) are mapped within the study locality and must be considered as part of this assessment. The assessment has considered the objectives of Part 2 of the CM Act which are the same as the matters considered as part of the RHSEPP detailed above.

1.4.3 Guidelines

Other relevant guidelines that have been considered in this assessment include the following:

- Aquatic Ecology in Environmental Impact Assessment – EIA guideline (NSW Government Department of Planning 2003)
- Policy and Guidelines for Fish Habitat Conservation and Management (Department of Primary Industries, Update 2013)
- Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries, 2003)
- NSW Wetlands Policy (DECCW, 2010).

2 Project Description

2.1 Project Overview

The main elements of the Project include:

- a new WRRF at Camellia-Rosehill to treat wastewater to produce advanced treated water
- upgrades to the existing pumping station at Camellia
- a new wastewater transfer pipeline from Camellia pumping station to the WRRF
- a new and repurposed brine pipeline to transfer brine from the WRRF to the NSOOS
- a new river release pipeline to transfer advanced treated water from the WRRF to a release structure in Parramatta River at Meadowbank.

The location of main elements of the Project is provided in Figure 2-1. Further details of each component of the project are provided in Table 2-1.

The Project is State significant infrastructure and Sydney Water is preparing an Environmental Impact Statement (EIS) to support an application to the Minister for Planning and Public Spaces.

Table 2-1 Project description

Project Component	Detailed Description
WRRF	The WRRF would have capacity to treat 70 megalitres per day (ML/d). The WRRF would produce advanced treated water to minimise impacts on receiving waterways. The reverse osmosis (RO) treatment process within the WRRF would generate brine as a by-product. The main components of the WRRF include: • inlet works • primary, secondary and tertiary wastewater treatment process units • advanced treatment processes involving reverse osmosis • disinfection systems • biosolids handling facilities • odour control facilities. The WRRF would require a range of process infrastructure such as tanks, bioreactors and digestors. The operation of the WRRF would also require ancillary facilities such as an administration building and associated car park, chemical storage and stormwater infrastructure.
Camellia pumping station upgrades	The existing Camellia pumping station would be upgraded to divert wastewater to the WRRF. Upgrades would include the installation of new pumps to deliver wastewater flows to the new WRRF while remaining pumps would pump excess existing flows and brine produced by the WRRF to the NSOOS via existing pressure mains. New connections would be installed to divert the wastewater into the transfer pipeline. The existing site sheds would be replaced with a new electrical switch room along the eastern boundary of the site.
Transfer pipeline	The transfer pipeline is about 2.2 km in length and would transfer wastewater from the Camellia pumping station to the WRRF.
Brine pipeline	The brine pipeline is about 5.2 km in length and would transfer brine from the WRRF to the NSOOS for treatment and offshore discharge at North Head WRRF. A new pipeline would be constructed between the WRRF

Project Component	Detailed Description
	and Camellia pumping station, along the same alignment as the transfer pipeline. Between the Camellia pumping station and the NSOOS the brine pipeline would repurpose an existing pipeline.
River release pipeline and release structure	The river release pipeline is about 7.6 km in length commencing at the WRRF and within the suburbs of Silverwater, Newington, Sydney Olympic Park and Meadowbank. The river release pipeline would discharge up to 63 ML of advanced treated water per day into the Parramatta River at Meadowbank. In the rare event that the treatment equipment is undergoing maintenance or is not at specification, tertiary (high quality) treated water would be discharged instead. It is expected this may occur for 2 days, around twice a year. Above ground infrastructure includes two concrete bridge-style aerial crossings over minor waterways in Meadowbank Park, and an approximately 8 m high barometric loop located near the existing toilet block in Meadowbank. The river release structure involves eight smaller pipelines that extend out underneath the sandstone seawall and along the riverbed of the Parramatta River. The pipelines would vary in length, with the longest extending about 130 m. Diffusers would release water to enable mixing.
Land ownership and location	The WRRF would be located on Sydney Water owned property at the intersection of Colquhoun and Devon Street, Rosehill (Lot 1, Deposited Plan 1308385). The WRRF site comprises an area of 21.41 ha (see Figure 2-1) and is located within the City of Parramatta Local Government Area (LGA). Upgrades to the existing sewage pumping station at Camellia are also located on Sydney Water property within the City of Parramatta LGA. Pipeline alignments are generally within the road corridor, Council or Crown land or Sydney Water easements, except for the transfer and brine pipelines beneath Rosehill Gardens Racecourse.
Construction activities	Key activities for construction of the WRRF will include: • site establishment • delivery of materials • earthworks • civil works • structure construction • installation of mechanical and electrical plant and equipment • landscaping and rehabilitation • commissioning. The new sections of pipelines from the WRRF to Camellia pumping station and the river release location, would be constructed using a combination of trenching and horizontal directional drilling (HDD) techniques. Between Camellia pumping station and the NSOOS, the existing rising main would be relined and repurposed to form part of the brine pipeline. The upgrade of Camellia pumping station would include augmentation of underground infrastructure, installation of pumps, and upgrade of power supply.
Construction program	Construction of the Project would commence in 2028 with a duration of around 36 months. Operation is planned to commence in 2031.

2.2 Construction Program and Details

An indicative program for construction staging is outlined in Table 2-2. Construction is likely to occur within the indicative program identified below; however, it would typically be for a shorter period. For example, the works within the Parramatta River for the construction of the river release structure are anticipated to take about six months.

Table 2-2 Indicative program and construction staging

Project element	Indicative timeframe for construction
WRRF	Mar 2028 – Sep 2031
Camellia pumping station upgrade works	May 2028 – Mar 2031
Transfer (two pipelines) and brine pipeline (one pipeline)	Jul 2028 – Mar 2030
Brine pipeline (relining)	Oct 2028 – Mar 2030
River release pipeline	Jul 2028 – Mar 2030
River release structure	Oct 2029 – Mar 2030
Commissioning	Mar 2030 – Sept 2031

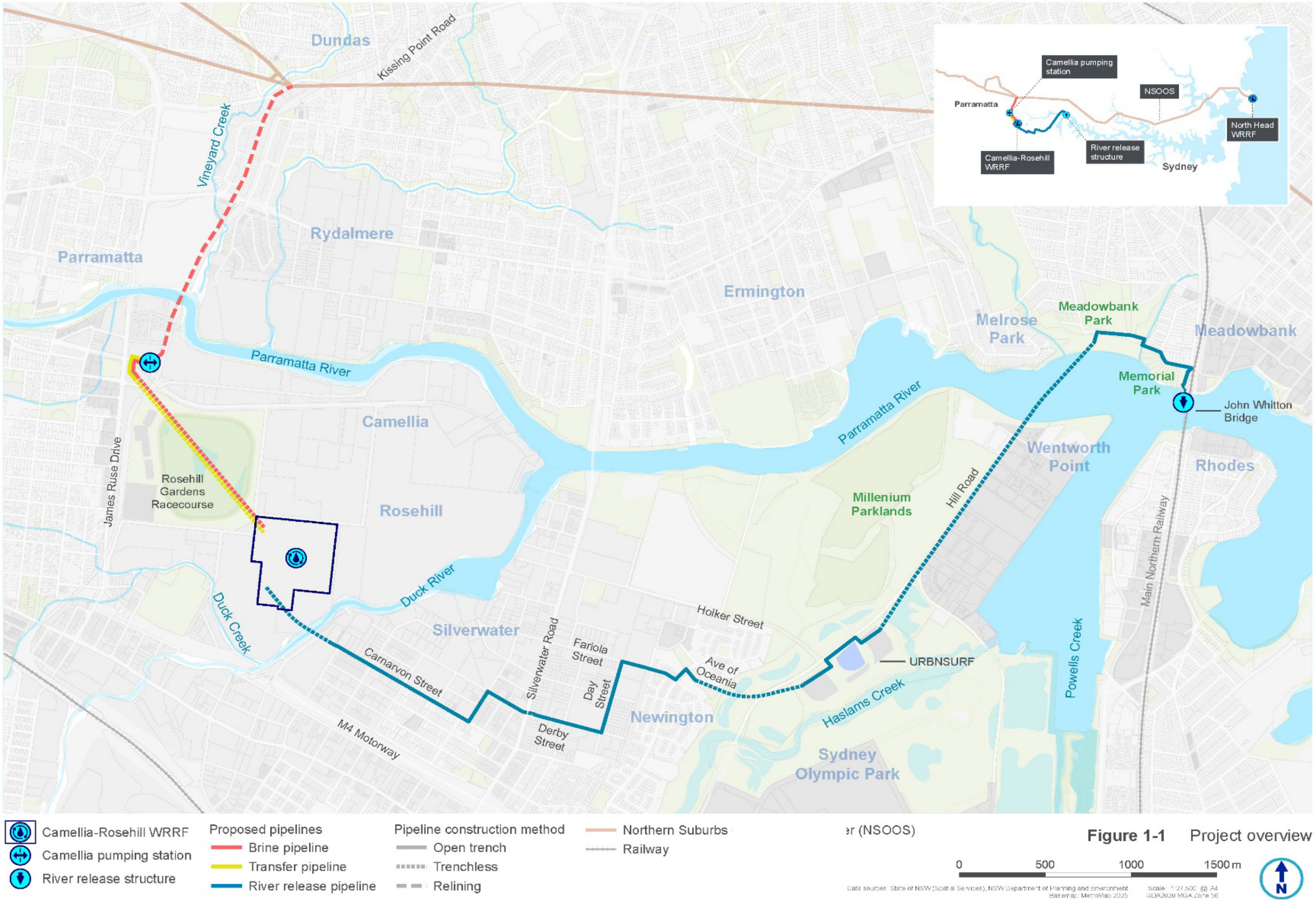


Figure 2-1 Project overview

2.3 Considerations for the Aquatic Biodiversity Assessment

The key features of the Project that will need to be considered as part of the aquatic biodiversity assessment are activities potentially affecting aquatic habitats and watercourses within the identified 'impact areas'. Based on the latest Project Description and Figures provided by Sydney Water (Figure 2-3 to Figure 2-7), the following impact areas will be assessed as part of this ABIA:

- Pipeline crossings (where these are open trenched)
- Open trenched pipelines adjacent to or within a watercourse
- Construction compounds adjacent to watercourses
- Advanced treated water release point

Pipeline Crossings

Although there are five locations across the study area where pipelines transect watercourses, these will all be underbored crossings, that is they would be constructed using HDD where pipes are installed without the need to dig up open trenches to lay the pipes. A launch pit (to launch the HDD drilling machines) and retrieval pit (to retrieve the pipe sections) will be required. While trenchless construction is not suitable for all pipe installation, it minimises the impact to environmentally sensitive issues. HDD will be used to cross beneath Rosehill Gardens Racecourse, Duck River and under sensitive wetland areas e.g. around the Sydney Olympic Park wetlands (Newington / Narawang Wetland) (Figure 2-1, Figure 2-3 to Figure 2-7). The HDD sections will remain open and ungrouted at the surface to avoid pressure buildup and the risk of fracturing of surrounding formations is considered low. HDD pipeline crossings are not therefore expected to have any significant direct or indirect effects on aquatic biodiversity within the study area.

Brine pipeline crossings of Vineyard Creek and upstream of the Parramatta River will also only require relining of an existing pipeline. Where re-lining is required, this would also be done via excavation of existing pits.

Open Trenched Pipelines

Open trenched pipelines are where a trench is excavated to the required depth and alignment. The pipes are assembled together and placed on a level surface at the bottom of the trench. Once the pipe is laid, the trench is backfilled and any vegetation rehabilitated as needed. In this case, the only sections of open trenching will be:

- from Carnarvon St to Silverwater Rd. followed but a section that is micro-tunnelled before open trenched up to Pierre De Coubertin Park at Newington.
- section to the north of Rosehill Gardens Racecourse that will be open trenched up to Camellia pumping station.
- an approximately 500 m section of the river release pipeline around URBNSURF at Sydney Olympic Park.

- a section of river release pipeline from an HDD pit at Meadowbank Park along an approximately 1 km alignment to John Whitton Bridge (Figure 2-1 and Figure 2-7). This crosses an unnamed channel and Charity Creek, then runs through Memorial Park (Meadowbank) until it reaches the barometric loop before extending out to the release point and diffuser heads into the Parramatta River. These two waterways will be by-passed via two concrete bridge-style aerial crossings. Construction and operation of these crossings will therefore not directly impact on these waterways.

In general, it is expected that the process for trenching and pipeline construction would be as follows:

1 – Site establishment and mobilisation, installation of environmental controls, erosion and sediment control.

2 – Site earthworks, including excavation for trenches and launch and receival pits for trenchless pipe sections.

3 – Installation of pipe bedding material and pipeline, as well as backfilling of trench. Civil works such as pipeline and ancillary infrastructure will also be installed during this stage.

4 – Commissioning.

5 – Landscaping works and rehabilitation.

Construction Works Adjacent to Watercourses

The Project will require construction compounds to store equipment and materials and provide site office facilities and parking for construction staff. They will be required throughout the construction phase of the Project at several locations close to the Project. Nine construction compounds have been identified that occur in close proximity to watercourses. These include:

- C8 – Vineyard Creek (Figure 2-3)
- C11 and C12 – Parramatta River crossing (near Western Sydney University), (Figure 2-3)
- C17 – near Duck River (Figure 2-5),
- C27 – URBNSURF (Figure 2-6)
- C28, C29, C31, C30 – Near John Whitton Bridge Crossing (Figure 2-7).

River Release Structure in Parramatta River at Meadowbank

Construction of the river release structure in the Parramatta River at Meadowbank (near John Whitton Bridge) would include a pipeline set that splits into eight parallel smaller pipes, each with a diameter of about 0.3 m below ground. The eight pipes would enter the Parramatta River at the carpark to the west of John Whitton Bridge. The pipes would lay on a geosynthetic fabric and grout mattress, to prevent disturbance of sediments on the riverbed. Pipeline protection that may consist of several concrete mattresses (or similar) would lie across the pipes to ‘anchor’ them to the riverbed. The pipelines would extend between about 75 to 130 m into the river releasing treated water via duck-billed diffusers between the first and third piers of the bridge. The pipes have been sized to allow for sufficient clearance between maritime traffic using Parramatta River. An indicative figure of the release structure and diffuser arrangement is provided in Figure 2-2.

A coffer dam would be constructed to connect the underground end of the pipelines to the sections of pipe on the riverbed. The sandstone wall on the riverbank and any disturbed riparian vegetation would be reinstated.

Construction of the river release structures at Parramatta River is anticipated to take up to approximately six months. Initial instream work e.g. construction of coffer dam, is expected to take place over one main weekend (Friday afternoon to Monday morning), with extra follow-up weekend works expected.

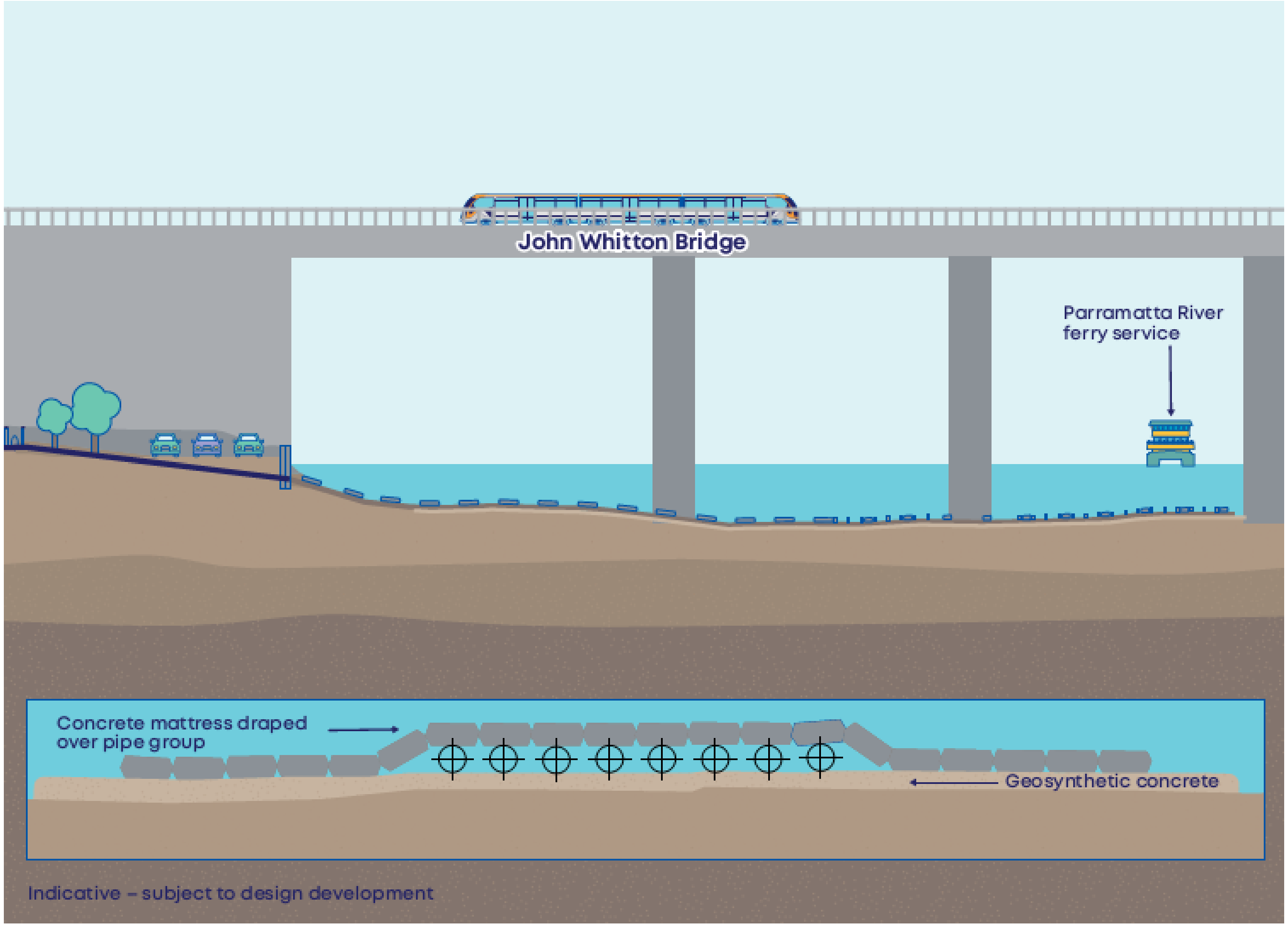


Figure 2-2 Diagram of proposed river release pipeline and diffuser design at John Whitton Bridge

Timing

Where reasonable and feasible, construction will be carried out during standard working hours as defined by the Draft Construction Noise Guideline (EPA, 2020). Due to the size and duration of the project, out of hours work will be required for certain locations and activities of the Project.

Figure 2-3 Construction impacts Vineyard Creek and Parramatta River upstream crossing

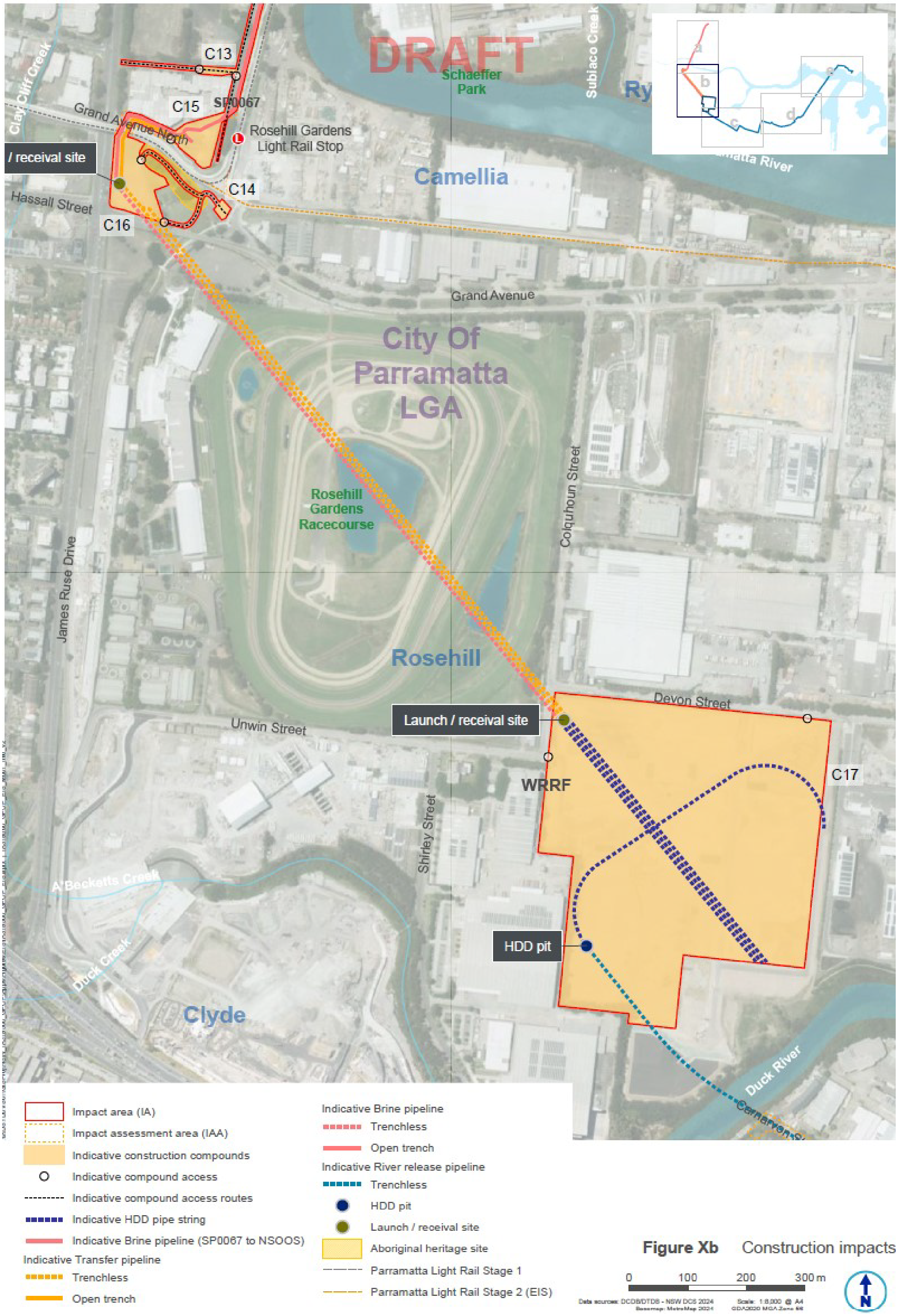


Figure 2-4 Construction Impacts at Rosehill and Duck River

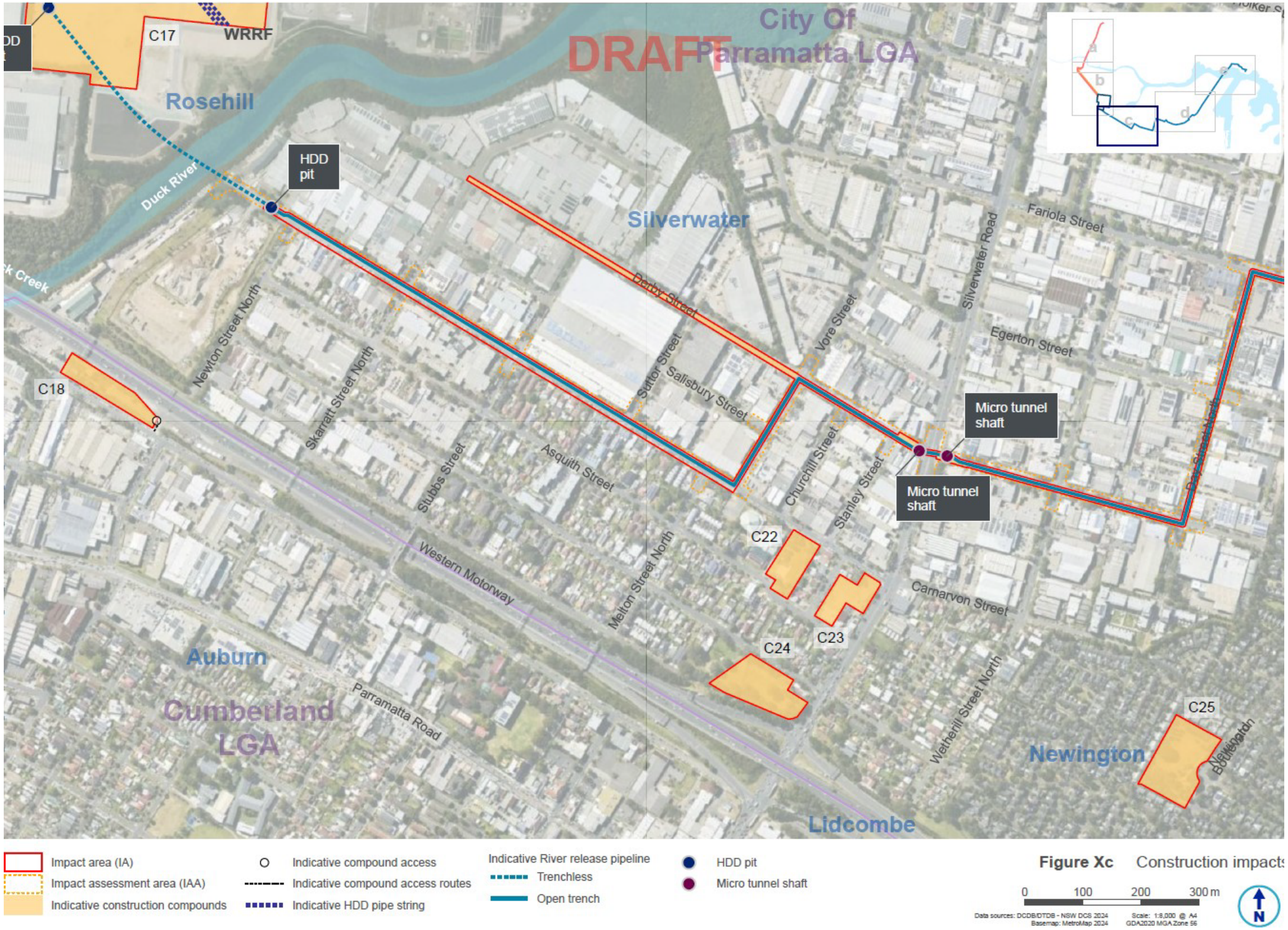


Figure 2-5 Construction Impacts at Duck River crossing

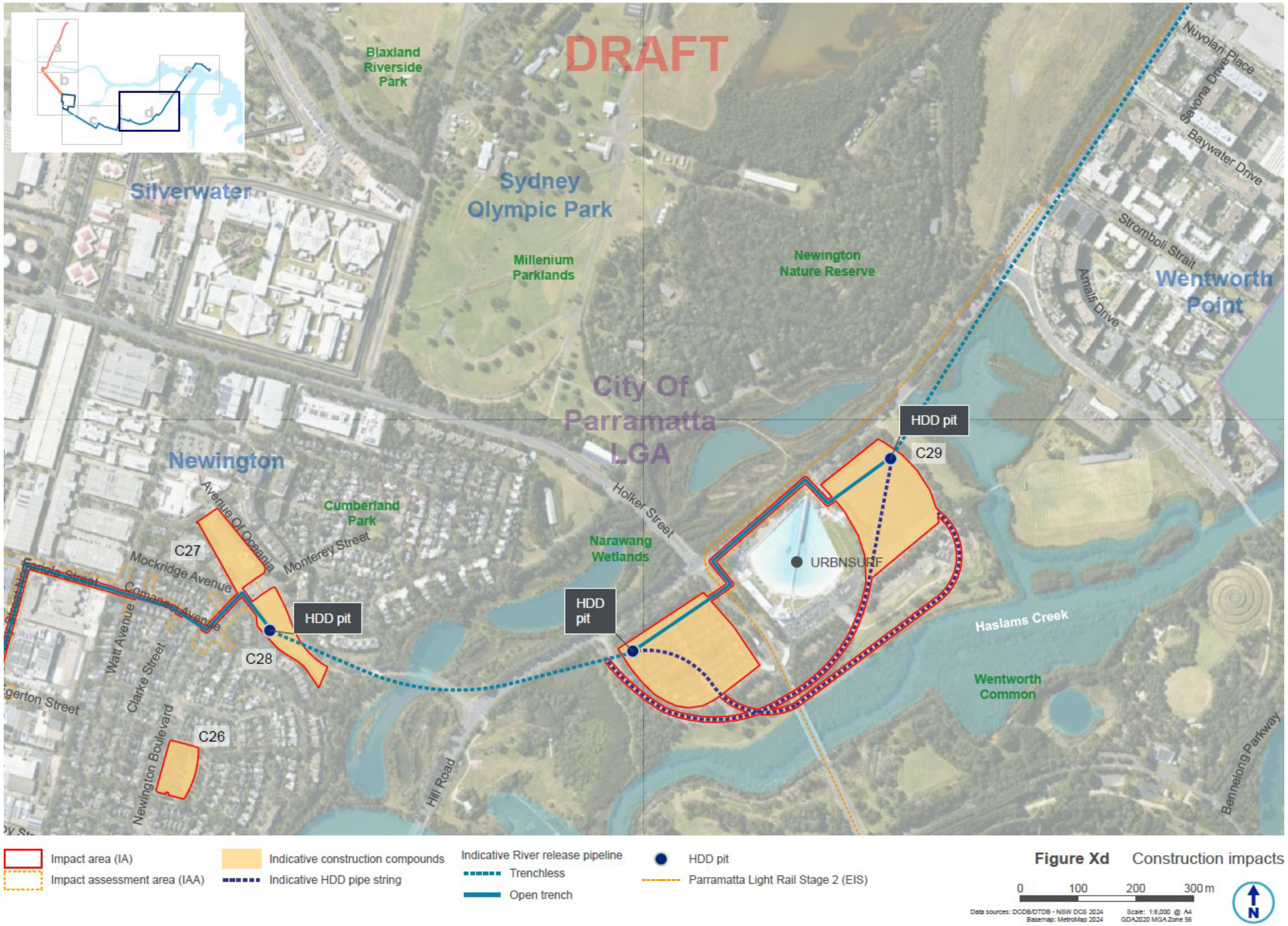


Figure 2-6 Construction Impacts at Narawang Wetlands at Newington

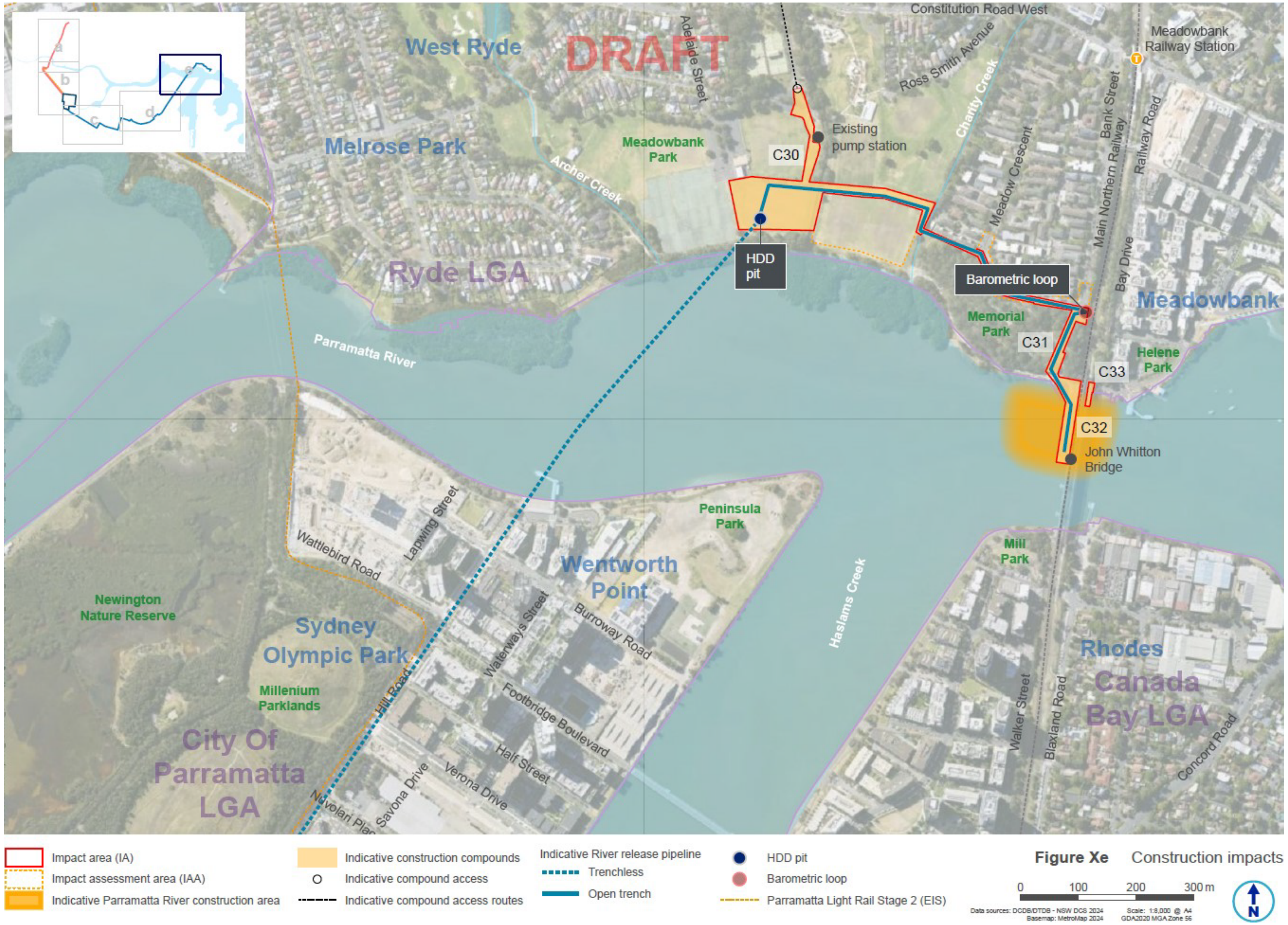


Figure 2-7 Construction Impacts at Meadowbank release site (near John Witton Bridge)

3 Methods

The occurrence of aquatic/terrestrial species and habitats within the search area was identified through a desktop review of existing information on aquatic and terrestrial habitat, vegetation and fauna. This included identifying threatened, protected and migratory species and marine pests, available in existing reports and from online database records of species and their distributions. A field survey was also undertaken to confirm the occurrence and extent of habitats, flora and fauna within the impact assessment areas where aquatic biodiversity could potentially be affected (referred to as the 'survey sites').

3.1 Geographic Terms

The following geographic terms are used throughout this report

Study locality: The general study locality as indicated by the extent of the overview map in Figure 3-1. This locality covers the aquatic intertidal and subtidal area extending from James Ruse Drive to Ryde Bridge, 7 km downstream. The study locality forms the boundary for database searches associated with biodiversity values, threatened species and threatened ecological communities.

Impact assessment area: The maximum area that would be impacted by the Project (as indicated by the full extent of Figure 3-1). This also includes the extent of modelled water quality changes as described in Section 5.2.3.

Survey areas – refers to locations where site inspections were undertaken and areas where aquatic biodiversity could potentially be affected due to construction or operational activities (see Figure 3-1). These include:

- Parramatta River release study site: at Meadowbank and John Whitton Bridge
- Existing stormwater system (Duck River opposite Carnarvon Street)
- Vineyard Creek
- Wentworth Point.

Impact areas: Impact area specific to pipeline corridors – typically 20 m wide (10 m either side of the pipelines) as indicated by red polygons on Figure 2-3 to Figure 2-7. Other impact areas include the footprint of the WRRF, pumping station, construction compounds and direct impact footprint from the release pipeline.

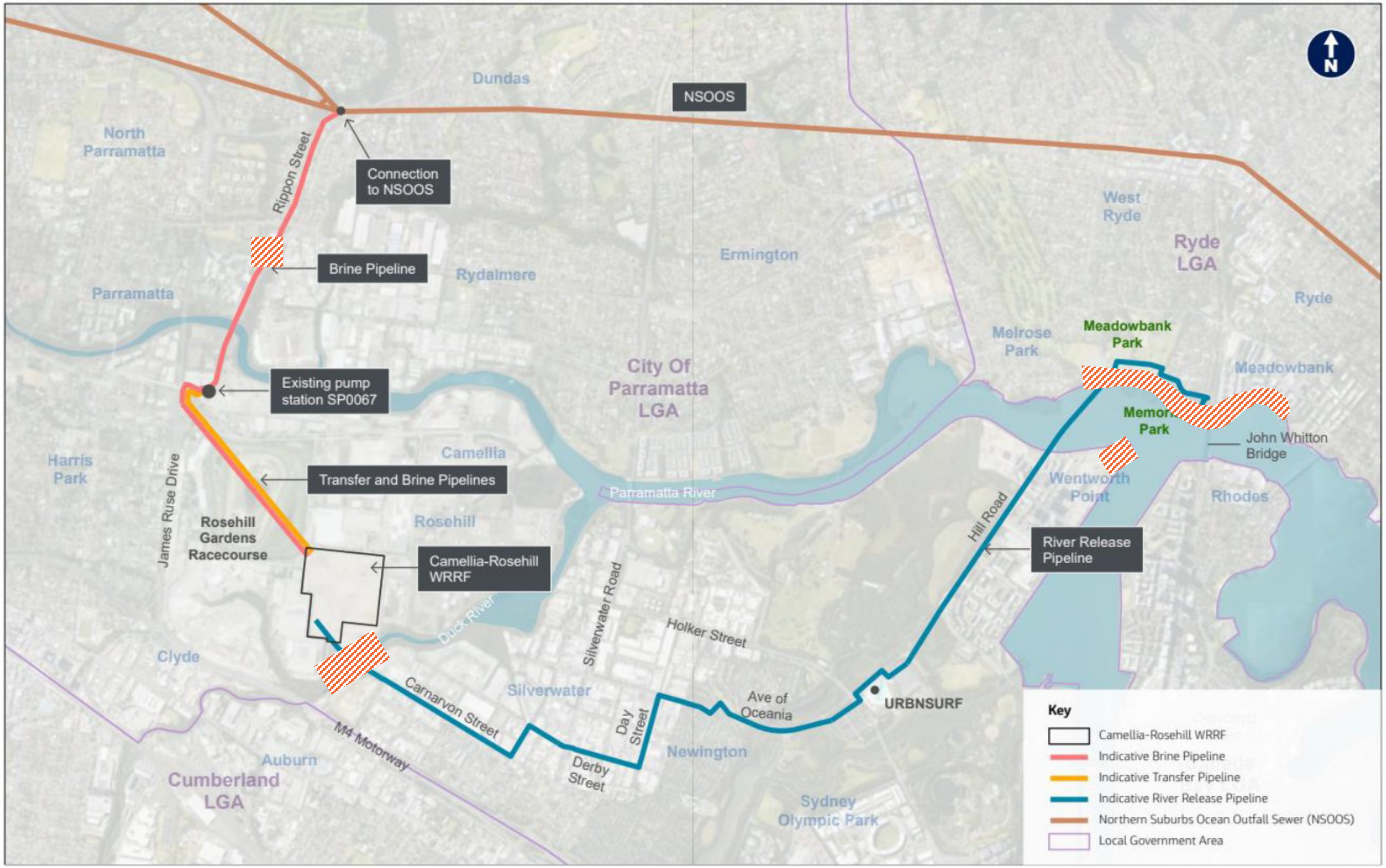


Figure 3-1 Overview map indicating extent of aquatic biodiversity survey areas (striped orange polygons)

3.2 Desktop Review

As part of the desktop review, technical reports, electronic databases and the internet were consulted to determine the potential occurrence of sensitive receptors such as:

- Threatened species, populations or ecological communities listed under the FM Act, BC Act and EPBC Act. Note that this included only aquatic species (fish, aquatic invertebrates, marine reptiles, marine mammals, aquatic flora, and avifauna that are dependent on aquatic habitats). All primarily terrestrial fauna and flora were assessed as part of the BDAR (Arcadis, 2025).
- Key Fish Habitat as mapped and defined in accordance with the FM Act
- Protected and sensitive areas (including land and water) managed by Conservation Programs, Heritage & Regulation (CPHR) of DCCEEW and / or DPIRD Fisheries under the NPW Act and the Marine Estate Management Act 2014
- Land or waters identified as Critical Habitat under the FM Act or EPBC Act or areas of outstanding biodiversity value under the BC Act
- Biodiversity stewardship sites, private conservation lands and other lands identified as offsets
- Waterfront land as defined in the Water Management (WM) Act 2000
- Key Threatening Process (KTP) identified in the BC Act, FM Act and the EPBC Act
- Areas of Outstanding Biodiversity Value identified in the BC Act.

Databases consulted included:

- Commonwealth (DCCEEW) Protected Matters Search Tool (PMST): http://www.environment.gov.au/epbc/protected-matters-search-tool;
- NSW BioNet: http://www.bionet.nsw.gov.au;
- NSW DPIE-EES Threatened Biodiversity Data Collection: http://www.environment.nsw.gov.au/threatenedspecies;
- NSW DPI Listed Protected Fish Species: https://www.dpi.nsw.gov.au/fishing/closures/identifying;
- Atlas of Living Australia (ALA): http://www.ala.org.au/;
- Birdlife Australia Database: https://birdata.birdlife.org.au/;
- i-naturalist: https://www.inaturalist.org/
- Commonwealth Map of Marine Pests https://www.marinepests.gov.au/pests/map;
- Aerial imagery from Nearmap, available from: http://apps.nearmap.com/ was used to identify important or protected habitat types (e.g. seagrass, mangroves, saltmarsh).
- Local Management Plans and reports as relevant.

- Local and state government vegetation mapping resources including.
  - NSW SEED Portal: https://www.seed.nsw.gov.au including:
    - TECs in the Greater Sydney Region; and
  - NSW DPI (Fisheries) Spatial Data Portal https://webmap.industry.nsw.gov.au/Html5Viewer/index.html?viewer=Fisheries_Data_Portal, including:
    - Resilience and Hazards SEPP - Coastal Wetlands and Littoral Rainforest (and associated buffer areas).
    - NSW DPI estuarine macrophyte mapping.
    - Fish Communities and Threatened Species Distribution of NSW (NSW DPI 2016).
- Areas of Outstanding Biodiversity Value register: https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity/areas-of-outstanding-biodiversity-value/ identiiearea-of-outstanding-biodiversity-value-register;
- NSW DPI Critical Habitat register: http://www.dpi.nsw.gov.au/fisheries/species-protection/conservation/what/register;
- NSW DPI key fish habitat maps: http://www.dpi.nsw.gov.au/fishing/habitat/publications/pubs/key-fish-habitat-maps;
- Commonwealth (DCCEEW) Register of Critical Habitat: http://www.environment.gov.au/cgi-bin/sprat/public/publicregisterofcriticalhabitat.pl;
- NSW Resilience and Hazards SEPP (Coastal Management) maps: http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=SEPP_CoastalManagement; and
- Locations of NSW marine parks and reserves available from NSW DPI Marine Parks website: https://www.dpi.nsw.gov.au/fishing/marine-protected-areas/marine-parks.

In addition to this, information was sourced from peer reviewed journals, technical reports and other databases to establish information relating to:

- Background water quality; and
- Tolerance of aquatic species known to occur in the study area compared to key water quality parameters.

3.2.1 Likelihood of Occurrence Assessment

For each aquatic threatened species, migratory species and threatened ecological community (TEC) identified within the database search and literature review, a likelihood of occurrence assessment was undertaken. This assessment determined how likely it is that each species and community is present in the impact areas and indicative construction area within Parramatta River using the criteria detailed in Table 3-1. Species and communities are considered 'likely to occur' (i.e., a moderate to high likelihood of occurrence) where:

- The species or community is 'known' or 'predicted' to occur in the Interim Biogeographic Regionalisation for Australia (IBRA) subregion in which the proposal is located; and
- The impact areas contain habitat features or components associated with the species or community or there are records of the species or community in the impact areas.

Table 3-1 Likelihood of occurrence criteria

Likelihood of Occurrence	Criteria
None	The habitat within the impact areas is unsuitable for the species.
Low	It is unlikely that the species or community inhabits the impact area, if it did, it would likely be a transient visitor. Criteria for this category may include: • The impact areas do not support the specific habitat types or resources required by the species or community. • The impact areas are beyond the current distribution of the species or community or is isolated from known populations. • Non-cryptic flora species or community not observed during targeted surveys.
Moderate	Potential habitat for the species or community occurs within the impact areas. Criteria for this category may include: • Species or community previously recorded in contiguous habitat albeit not recently (>10 years). • Habitat present, but poor quality, depauperate or modified types and/or resources. • Species or community has potential to utilise habitat during migration or seasonal availability of resources. • Cryptic flora species or community with potential habitat within the impact areas that have not been targeted by surveys (for example, surveys were not undertaken within the flowering season).
High	It is likely that the species or community would inhabit or utilise habitat within the impact area. Criteria for this category may include: • Species has been recently and/or regularly recorded in the impact area or surrounds. • Uses habitat types or resources that are present in the impact area that are abundant and/or in good condition. • Is known or likely to maintain resident populations surrounding the impact areas. • Is known or likely to visit the impact areas during regular seasonal movements or migration.
Known	The species was recorded within the impact areas.

3.3 Field Methods

Inspections of aquatic habitats were undertaken during two separate field trips, the first undertaken on 04 April 2024 and the second on 31 January 2025. The following survey sites were assessed:

- Waterway crossing survey sites:
    - Vineyard Creek – Railway Street, railway bridge (April 2024).
    - Duck River – opposite Carnarvon Street (April 2024 and January 2025).
    - Wentworth Point (April 2024); and
    - Treated water release location (or river release structure location) at Meadowbank, near John Whitton Bridge (January 2025).

The site inspections were undertaken on foot at all sites apart from Duck River where a small canoe was needed to allow access to the study site. A remotely operated underwater vehicle (ROV) was also deployed at the treated water release location near John Whitton Bridge to provide additional information on the subtidal substratum and habitat.

The field tasks undertaken at each study site are described below.

- **Habitat Mapping**: Prior to the site inspections, presumptive habitat maps were developed for each study site based on the latest Nearmap imagery and any other publicly available map layers indicating main habitat types. An area approximately 500 m up and downstream of the John Whitton Bridge release point (northern bank only) and an area approximately 50 m up and downstream of the other survey areas was assessed.

  In the field the predominant habitat types and associated species were described and boundaries of mapped habitats verified within the surveyed stretch of river. Maps were then updated with any additional information.

- **RCE Assessment**: A modified version of the Riparian Channel and Environmental Inventory (RCE) method was used to characterise and score the overall condition of each study site. This assessment involves evaluation and scoring of the characteristics of the adjacent land, the condition of riverbanks, channel and bed of the watercourse, and degree of disturbance evident at each study site. The maximum score (52) indicates a stream with little or no obvious physical disruption and the lowest score (13) indicates a heavily channelled, highly disturbed stream without any riparian vegetation. RCE scores for each site were calculated and assigned an overall condition score.

- **Fish Habitat Type and Waterway Class Assessment**: Fish habitat type and waterway class were assigned based on the NSW Fisheries Policy and Guidelines for Fish Habitat Conservation and Management (NSW DPI 2013) indices and descriptors.

Any other features of note (existing stormwater drains, sources of pollutants, odours etc.) were recorded at each study site. Any incidental species sightings were recorded in a species inventory.

3.4 Study Limitations

- The desktop review is reliant on the accuracy of data from online mapping tools and databases, and indicative proxy information (i.e., data relating to similar habitats in other, similar estuaries) only, and so cannot be considered definitive.
- Biodiversity values observed at the survey sites during field inspections should not be seen as a complete/comprehensive inventory, as the surveys were a qualitative, one-off ‘snapshot’ at a specific point in time only and do not account for any seasonal or temporal variability.
- No targeted surveys were undertaken to identify the presence of threatened species or communities. This was also not considered necessary for the purpose of this assessment.
- A benthic invertebrate survey was not conducted, and our assessment of the infaunal invertebrate assemblage was based on desktop information only.
- The RCE scoring system provides a simplified description of the aquatic habitat and does not fully represent its complex and changing nature. The inventory also gives equal weightings to each of the descriptors and may therefore mask certain elements and differences in the habitat of each site. The scores should therefore be used as a generalised assessment only.

4 Results

4.1 Desktop Review

4.1.1 Overview of Parramatta River Estuary

The Parramatta River catchment discharges into ‘Sydney estuary’, a collective of connected drowned river valleys located within the Sydney metropolitan area on the east coast of NSW, Australia (Roy et al., 2001; Birch, 2017). Sydney estuary comprises Sydney Harbour (or ‘Port Jackson’), Middle Harbour and estuarine extents of associated tributaries including Parramatta River, Lane Cove River and Middle Harbour Creek (Birch and Lee, 2018; Birch et al., 2022; West and Williams, 2008).

The estuarine section of the Parramatta River (Parramatta River Estuary) is considered to begin from an arbitrary line across the estuary in upper Sydney Harbour connecting Woolwich to Birchgrove, ~11 km upstream from Sydney Heads (Cardno, 2008). The Parramatta River Estuary extends ~19 km from that line upstream to the Charles Street Weir in Parramatta, above which the river water is fresh.

The Parramatta River Estuary covers 13.7 km^2 of surface area, representing ~24 percent of the surface area of the entire Sydney estuary, and holds ~70 GL of water (NSW DPE, 2024). The entire Parramatta River catchment covers ~252 km^2, with land-use dominated by urban development (NSW DPE, 2024). Land cleared for agriculture, horticulture and industrial uses each account for relatively small fractions of land-use, while ~ten percent of the catchment is forested. These land-use patterns contribute to changes in water quality and influence the distribution and health of aquatic habitats within the estuary.

The Duck River catchment is 42 km^2 and also receives flows from Duck Creek, Little Duck Creek and A’Becketts Creek, which are all located within the Parramatta City Council Local Government Area. Within the Project impact assessment area, the channel is in a semi natural state containing regionally significant areas of natural bushland and wildlife habitat adjacent to industrialised and highly urbanised areas. The Vineyard Creek catchment is ~4.2 km^2, with land-use comprising predominantly urban, residential, commercial and industrial developments (Cardno, 2008).

4.1.2 Hydrology and Sedimentology

The Parramatta River estuary has been partitioned into three distinct ‘estuary zones’ that broadly correspond to different sedimentary environments; the ‘riverine channel zone’, the ‘fluvial delta zone’ and the ‘central mud basin zone’ (Roy et al., 2001; West and Williams, 2008). The Project is situated within the ‘riverine channel zone’ in the lower Parramatta River Estuary. This zone extends from the Charles Street Weir downstream to the Ryde railway bridge (West and Williams, 2008) and includes the impact assessment area for the Project. This zone categorisation suggests that while waters in the river channel are generally brackish with salinities typically low (i.e., <10 ppt, depending on depth) and dominated by freshwater input, there is still tidal influence on water levels and movement (Roy et al., 2001).

Salinity concentrations in Sydney Harbour including the impact assessment area are mainly driven by the balance between the restricted freshwater inflow from the catchments running to the estuary (mainly Parramatta, Lane Cove and Middle Harbour), precipitation and evaporation. Land runoff and several small creeks that flow into the Harbour during rain events also influence the salinity. The rainfall pattern in Sydney is erratic and strongly influenced by El Niño & La Niña weather cycles (Johnston et al. 2015). For instance, average mean monthly rainfall ranged from a minimum of 69.1 mm in September to a maximum of 130.6 mm in June between the years 1859 and 2010 (Lee et al. 2011). Nevertheless, the Sydney catchment can be characterised as having dry conditions, punctuated by infrequent, high-precipitation events (rainfall >50 mm day).

The main types of sediments in the riverine channel zone would be expected to be fluvial sand and/or muddy sand and are expected to be largely unvegetated (Roy et al., 2001; Birch, 2017).

4.1.3 Water Quality

In general, water quality in the lower Parramatta River estuary is strongly influenced by catchment point sources, diffuse sources and in-estuary processes including biological interactions and interactions with sediments, climate and hydrodynamic processes (Cardno, 2008). Sediment contamination due to urbanisation and industrialisation of the catchment has also impacted on water quality within the estuary, with extensive alteration of the estuarine foreshore-limiting tidal flushing in some areas, leading to further impairment of water quality (See Section 4.1.4).

Key water quality parameters that relate to the Project have been monitored by Sydney Water at eight sites including:

- X five sites upstream of release point (PJ01A, PRWFN, PRWFW, PRWFE, PRMB03)
- X three sites downstream of the John Whitton Bridge release point (PRMB02, PRMB01, PRRH)

The location of sampling sites is shown in Figure 4-1.

Figure 4-1 Water and sediment quality sampling sites

Testing was conducted between March 2024 and September 2025. Testing was conducted on a weekly basis; however, monitoring at three Wentworth Point sites (PRWFN, PWRFW, PRWFE) was discontinued in September 2024, when design progressed to the John Whitton Bridge, and monitoring at sites PRMB01, PRBM02, and PRBM03 commenced. Samples were collected from 0.3 m below the surface (surface) and 0.3 m above the bed (bottom). Metals were sampled once a month.

A summary of results compared against the Parramatta River Water Quality Objectives (WQOs) and ANZG (2018) Default Guideline Values (DGVs) for metals, is shown in Table 4-1. The WQOs provide guideline levels for the protection of aquatic systems with the aim to maintain or improve the ecological condition of waterbodies and their riparian zones over the long term. These guidelines are, however, separate to the conditions that Sydney Water will be required to meet under their Environment Protection Licence (EPL) as per the Protection of the Environment Operations Act 1997 (POEO Act).

Table 4-1 Summary of results of surface water quality sampling undertaken by Sydney Water at sites within the Project impact area between March 2024 and June 2025 compared against Parramatta River Water Quality Objectives (WQOs), ANZG and ANZECC guidelines.

WQ Indicator	WQO ANZG/ANZECC DGV (Metals)	Range Min	Range Max	Mean	Total number of samples (n)	Percentage of samples exceeding Guidelines (%)
Salinity (µS/cm)	n/a	4814	52305	43791	744	n/a
pH	7.0 – 8.5	7.0	8.2	7.7	768	0
Total suspended solids (mg/L)	n/a	3	400	22	762	n/a
Total Nitrogen (mg/L)	0.3	0.08	2.60	0.49	768	85
Total Phosphorus (mg/L)	0.03	0.03	0.21	0.07	767	99
Soluble Reactive Phosphorus (mg/L)	0.005	0.00	0.11	0.03	767	99
Oxidised Nitrogen NOx-N Low Level (mg/L)	0.015	0.01	1.41	0.11	768	64
Ammonia NH3 - N Low Level (mg/L)	n/a	0.01	0.69	0.09	589	n/a
Chlorophyll – a (mg/m^3)	4	0.4	149	8	768	66
Total Aluminium (µg/L)	37	29	762	183	192	95
Total Cobalt (µg/L)	6.1	0.3	0.6	0.4	48	0
Total Copper (µg/L)	1.3	0.9	10.9	3.2	192	91
Total Iron (µg/L)	540	36	1400	303	192	14
Total Manganese (µg/L)	300	10.5	71.1	26.7	192	0
Total Lead (µg/L)	4.4	0.4	10.4	2.5	192	9
Total Zinc (µg/L)	8.0	3.0	84.0	16.4	192	80
Total Cadmium (µg/L)	5.5	0.0	0.0	0.0	192	0

WQ Indicator	WQO ANZG/ANZECC DGV (Metals)	Range Min	Range Max	Mean	Total number of samples (n)	Percentage of samples exceeding Guidelines (%)
Total Selenium (µg/L)	11	0.2	0.2	0.2	192	0
Total Mercury (µg/L)	0.1	0.0	0.0	0.0	48	0
Enterococci (CFU/100mL)	Secondary contact (recreation) Median bacterial content in fresh and marine waters maximum number in any one sample: 450-700 organisms/100 mL (> 700 organisms/100 mL))	10	6100	192	768	7
E. Coli (CFU/100mL)	n/a	1	5600	170	756	n/a

Salinity

Salinity is a measure of the salt content of water and can be expressed in different ways. Conductivity is an estimate of salinity that measures the ability of water to conduct an electric current based on the number of ions in the water. Estuaries have a much higher electrical conductivity (typically from 20,000 to 40,000 µS/cm) than freshwater, which is comparable to the range recorded within the impact study area. For comparison, the electrical conductivity of seawater would be around 50,000 µS/cm (SA Water 2021). As salinity increases, conductivity also increases.

Salinity in parts per thousand (ppt) is a direct measure of salinity based on the total amount of dissolved salts in water. While many aquatic estuarine species are adapted to tolerate broad fluctuations in salinity (i.e. are euryhaline), some can survive only within certain salinity ranges, so changes in salinity levels may result in changes to the diversity and composition of species present.

According to data collected by Birch and Lee (2018) the average salinity of the Parramatta Estuary and Homebush Bay is 29.1 and 29.5 ppt, respectively. However, salinities in this zone of the Parramatta River Estuary have been recorded (and modelled) to be persistently higher during periods of quiescence in terms of high-volume rainfall events (Birch and Lee, 2018; Sydney Water, 2023). For example, mean, maximum and minimum salinity levels recorded for the estuary during quiescent periods (little rainfall prior to sampling) were 30.7, 32.5 and 27.4 ppt respectively. This is likely exacerbated by the presence of the weir and lack of regular freshwater input (Taylor et al. 2018).

Temperature

Significant changes in surface water temperature or stratification outside the normal range of variability for extended periods has potential to influence aquatic biota. This can occur via thermal stress, impacts on spawning or reproduction and altered trophic interactions. It may also favour conditions suitable for invasive pest species, pathogens and parasites. Changes in the thermocline and stratification could also have a barrier effect on some mobile species.

Monthly average surface temperatures in Sydney Harbour (including the Lower Parramatta River) vary from 24.8°C in summer to 15.8°C in winter (Johnston et al. 2015) and is affected by several factors such as freshwater inputs, extent of mixing between fresh and marine water by winds and tides as well as anthropogenic inputs e.g. discharges from power plants, municipal or industrial effluent. The bathymetry and depth of the impact assessment area will also likely affect the local temperature and flushing regime. The cumulative effect of climate change is also a potential long-term factor for consideration and may have implications for estuarine environments which are predicted to experience temperature increases more rapidly than the global average for oceans and atmosphere.

Dissolved Oxygen (DO)

Low levels of dissolved oxygen (DO) can have an adverse effect on aquatic organisms. It may also produce conditions that cause sediments to release previously bound nutrients and toxicants into the water column. Extreme low levels of DO have been known to cause large, estuary-wide fish kill events in riverine estuaries in NSW under certain, rare environmental conditions, particularly in the Northern Rivers region of the north coast (Walsh et al. 2004) and recently in the Menindi Lakes of the Darling-Baaka River, which occurred in March 2023 (NSW DPI 2024).

A 2011 report averaged Sydney Water data for DO (2005 -2011) at different sites in the Parramatta River including: Homebush Bay, Silverwater Bridge, Iron Cove, Duck River and Parramatta Weir (Montoya 2015). DO levels were within the WQO range for protection of aquatic systems (80 – 110 percent saturation) at all sites apart from Silverwater Bridge (which was just below 80 percent saturation) and Duck River (where DO was approximately 70 percent saturation).

Nutrients

Nutrients, including nitrogen and phosphorus are transported to the Lower Parramatta River by urban stormwater (Beck and Birch, 2014), with the majority of nutrient loads delivered during moderate rainfall (5–50 mm day^{-1}) conditions. Nutrients accumulate close to discharge points and may remain in the estuary (Birch et al. 2010). According to Birch et al. (2010) and Birch et al. (1999), under high-rainfall conditions (>50 mm day−1), the estuary becomes stratified, and nutrients are either removed directly in a plume, or indirectly by advective/dispersive remobilisation. Nutrients are reported to have accumulated in bottom sediments in concentrations up to 50 times greater than pre-anthropogenic levels (Birch et al. 1999).

High levels of nutrients, particularly nitrogen and phosphorus, can result in excessive growth of aquatic plants. This may lead to problems such as eutrophication, reduction in DO, and subsequent changes in biodiversity.

Sydney Water data (2005 – 2011) reported by Montoya (2015), found average total nitrogen concentrations were elevated at Homebush Bay, Silverwater Bridge, Iron Cove, Duck River and Parramatta Weir and at most sites within Sydney Harbour sampled as part of the study. A later study however (Correa et al. 2020), found concentrations were generally low throughout the lower Parramatta River Estuary. Results of Sydney Water testing in 2024 -2025 indicate that total nitrogen levels exceeded the WQOs in most of the samples collected with the mean level (0.49 mg/L) just above the upper WQO (0.3 mg/L).

Similarly, the average total phosphorus was elevated above the WQO of 0.03 mg/L in almost all samples collected by Sydney Water in the 2024 – 2025 sampling period with a mean of 0.07 mg/L. A similar result was evident in Parramatta River sites sampled between 2005 – 2011.

Chlorophyll-a is a general indicator of plant biomass, whereby increased levels may be indicative of eutrophic condition. Chlorophyll-a measured within the impact assessment area was on average 8 mg/m^3 and exceeded the WQO of 4 mg/m^3 in a large proportion of samples collected over the 2024 – 2025 sampling period.

pH

pH is a measure of the acidity or alkalinity of a waterbody. Changes in pH can impact the ability of aquatic organisms to maintain basic functions such as respiration. pH also controls the bioavailability of metals, nutrients and other organic molecules. Potential sources of changes to pH in the lower Parramatta River include changes in the level of organic matter within the system, runoff from low pH soils and changes in salinity. Based on the recent data collected by Sydney Water, pH levels are within the WQO range across all samples tested over the sampling period. pH may also be influenced by acid sulfates if disturbed and oxidised (see Section 4.1.4.5).

Turbidity and Suspended Solids

Elevated turbidity in estuaries can significantly reduce biodiversity by decreasing light penetration, hindering plant growth, and impacting animal habitats and feeding behaviours. This can lead to shifts in community composition, potentially favouring species tolerant of low light and poor visibility, while negatively impacting others that rely on clear water and visual cues for foraging (Lunt et al. 2019).

Robinson GRC Consulting (1999) monitored turbidity levels within the upper reaches of the Parramatta River Estuary over the period of 1990 - 1997. The mean turbidity values for the Parramatta River, downstream of the weir, ranged around 15-20 NTU during dry weather to over 50 NTU following wet weather, due to the influx of suspended sediment associated with bank erosion and overland flow. The mean annual turbidity for the surface waters immediately downstream of the Silverwater Bridge was recorded at 7.7 NTU while bottom waters had a turbidity value of 21.9 NTU, indicating the influence of stratification on turbidity.

Laxton (1997) and Birch and O'Hea (2007), monitored monthly TSS and turbidity for the lower Parramatta River and Duck River from 1990 to 1996. Median turbidity and TSS were 11.9 NTU and 7.6 mg/L respectively.

Birch and O'Hea (2007) collected water samples at ten sites in Homebush Bay during 2004 under three weather conditions: calm, calm/heavy-rain, and high-wind/heavy-rain. A summary of total suspended solids and turbidity values measured during the sampling periods is presented in Table 4-2 below. Results of 2024 – 2025 testing indicate the mean TSS within the impact assessment area is notably higher than reported in these earlier studies.

Table 4-2 Total suspended solids and turbidity for Homebush Bay from Birch and O'Hea (2007)

Conditions		Turbidity (NTU)	TSS (mg/L)
Calm (quiescent) conditions	Mean	7.2	7
	Range	1.4 – 10.3	3.2 – 8.5
High precipitation	Mean	29.4	17.2
	Range	13.9 – 48.7	7.8 – 18.5
High wind/heavy rainfall	Mean	56.8	20.8
	Range	3.3 – 138.3	11.2 – 41.6

Biological Parameters

Biological indicators are more of a public health issue rather than a risk to aquatic biodiversity but certain strains of Enterococci bacteria from wastewater may have potential to cause pathogenic infections and disease in fish (e.g. Zahran et al. 2019), although this has been mostly documented in an aquaculture context. High densities of enterococci indicate the water has been contaminated with faecal material from human and/or animal sources (e.g. wastewater overflows, domestic and native animals). At times the enterococci levels within the surface waters of the impact study area have exceeded guideline levels on 54 out of 768 sampling events (Table 4-1). When compared to recreational microbial assessment categories (NHMRC 2008) mean enterococci levels (CFU/100mL) would be in the Category ‘B’ range (Table 4-3).

Table 4-3 Recreational microbial water quality assessment categories – enterococci (NHMRC 2008)

Category	Microbial water quality assessment category (95th percentile – intestinal enterococci/100mL)
A	<40
B	41 - 200
C	200 - 500
D	>500

Metals

Many metals are essential for organisms’ metabolic activity at low levels, but at higher concentrations may become toxic leading to physiological responses, bioaccumulation and potential ecosystem disruption. The major input source of metals into Sydney Harbour is catchment-derived stormwater, which has superseded industry and other common sources as the main contribution of anthropogenic metals to the estuary (Birch et al. 2024). Birch et al. (2024) also identified road-derived metals as a major contributor of metals to this stormwater and consequently to contamination of the estuary.

Results of the 2024 – 2025 water quality sampling (Table 4-1), indicated that total copper, lead and zinc all exceeded the DGV for 95 percent protection of aquatic species on a number of sampling occasions and that the mean concentrations for copper and zinc also exceeded the DGVs, whereas the mean concentrations recorded for lead was below the DGV.

Residual Chemicals from Treated Wastewater

When sewage effluent is treated with Reverse Osmosis (RO) technology, several residual chemicals can still be present in the treated water. These typically include disinfection by-products, Volatile Organic Compounds (VOCs), trace amounts of metals and complexing agents which bind with other chemicals to help with their removal (Linge et al. 2012). While RO technology is highly effective at reducing these contaminants, some residuals can still remain, depending on the quality of the incoming water and the efficiency of the RO system. These are only likely to present a risk to biodiversity if present in sufficiently high enough concentrations.

4.1.4 Sediment Quality

4.1.4.1 Grain Size Distribution

Birch (2017) has previously characterised the broad grain-size composition of riverbed sediments in the main channel of the lower Parramatta River Estuary and Duck River (including the impact assessment area) as comprising >80 percent silt and mud i.e. <62.5 µm grain size.

As part of preliminary studies for this Project, sediment vibrocores (n=15) were taken from soft sediments within the impact assessment area at Meadowbank (near John Whitton Bridge), on 31 September and 01 October 2024 by Birch and Batley (2025) up and downstream of the proposed release site (Figure 4-1). The mean length of core recovered was 2.3 m with core lengths varying between 3.0 m and 1.8 m. Samples were taken from surface, mid and deep sections of the vibrocores for analysis of metals, polyaromatic hydrocarbons (PAHs) and dioxins. The exact depth of these samples depended on the overall core length, however, surface samples were generally considered within the top 12 cm. Given the concern to aquatic biodiversity relates to the potential for mobilisation of surficial sediments, results of surface sediment testing only, are reported here.

Surface grain size across all sample sites was characterised by a high percentage of silt (between 80.0 – 88.0 percent) with smaller fractions of sand (5.5 – 11.0 percent) and clay (3.0 – 9.4 percent). Grain size composition was also similar when comparing sites in the centre of the channel with those in the bay (cores S10, S11).

It was observed that sediments in the centre of the channel immediately upstream (S3 and S4) and downstream (core S5) of the bridge were black, highly organic and fine grained in a zone where water velocities would be expected to be high, and sediment would have been expected to be coarser e.g. from winnowing of fines. A summary of sediment grain size results recorded for each site is provided in Figure 4-2 and Figure 4-3 below.

Channel Sediment Surface Cores

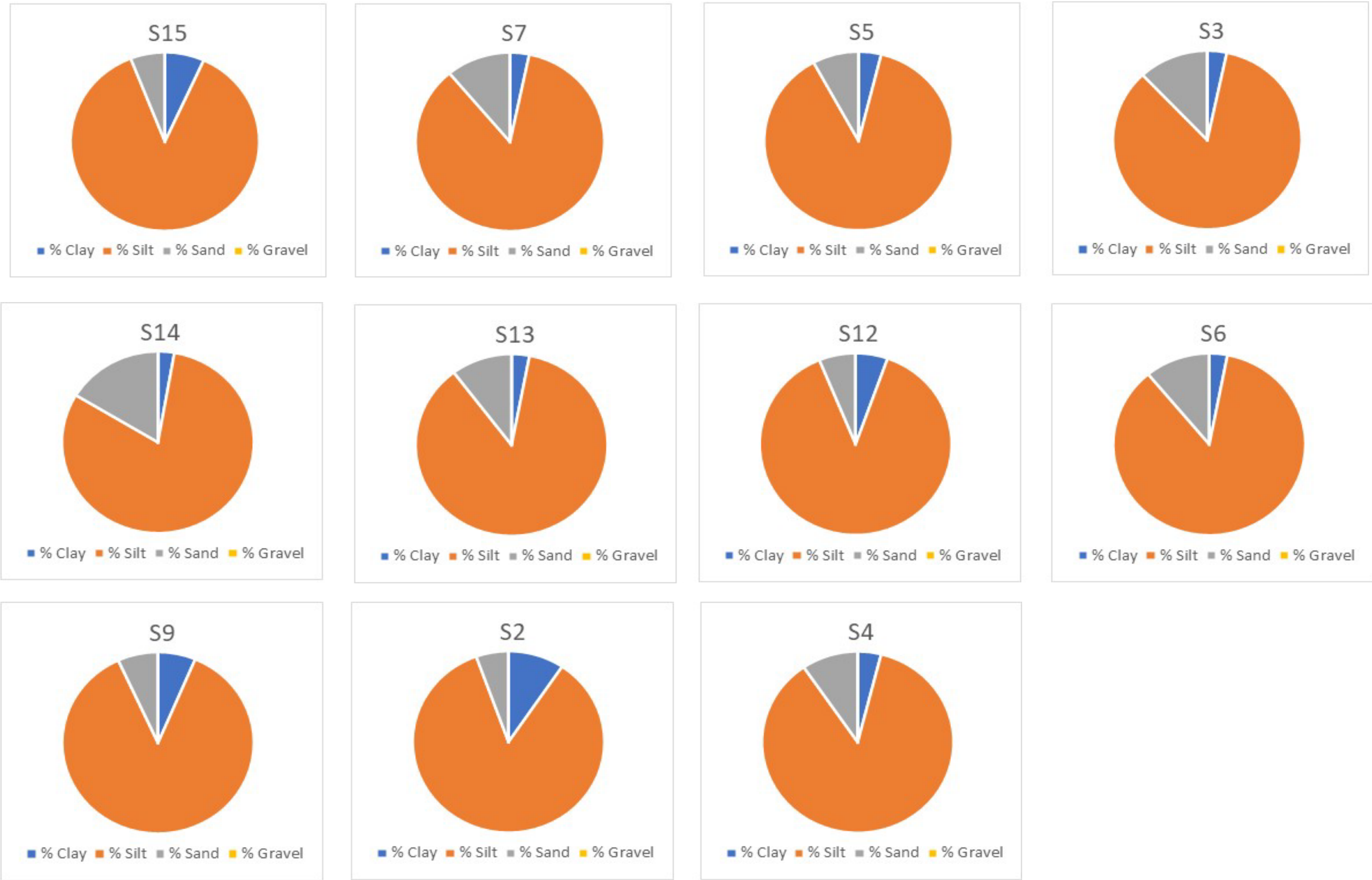
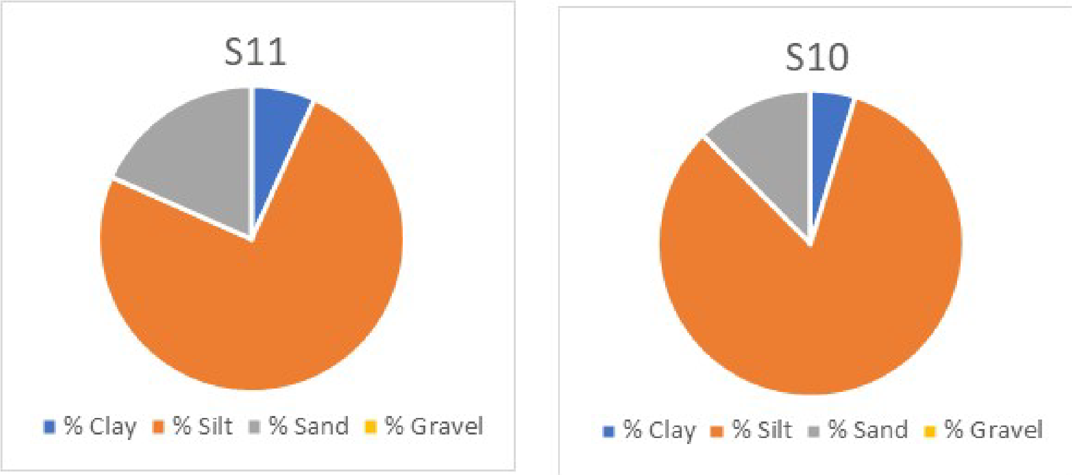


Figure 4-2 Sediment grain size distribution (%) in channel surface sediments collected by vibrocore in and September and October 2024

Bay Sediment Surface Cores



Nearshore Sediment Surface Cores

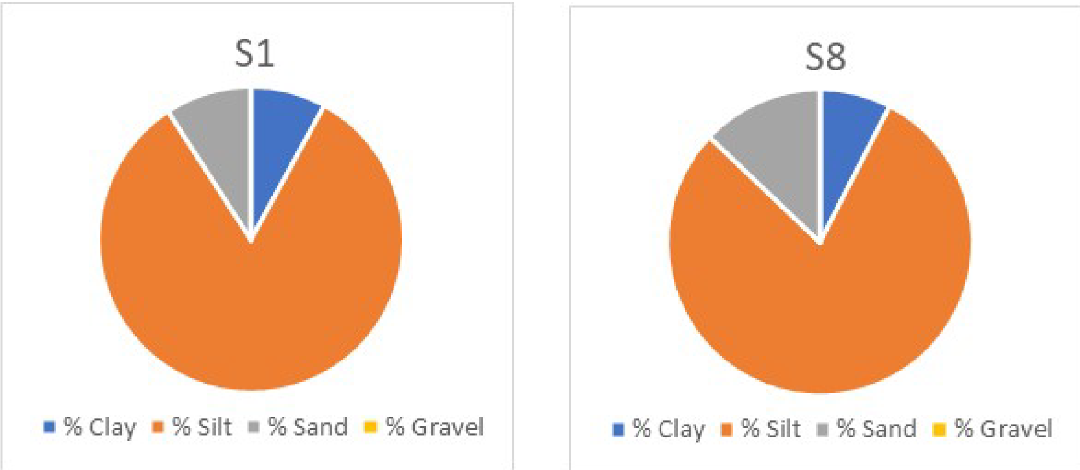


Figure 4-3 Sediment grain size distribution (%) in bay and nearshore surface sediments collected by vibrocore in September and October 2024

4.1.4.2 Metals

The distribution of metallic and organometallic contaminants is fairly well characterised in Sydney Harbour and considerable research has been directed toward mapping sediment contaminants. Birch et al. (2020) reported high concentrations of zinc, copper, lead and chromium in sediments sampled from various locations throughout the lower Parramatta River Estuary relative to other selected ports and estuaries around the world. High concentrations of lead in Homebush Bay sediments can be attributed to the historical presence of paint manufacturing (Birch et al. 2015), while the high metal concentrations in sediments throughout the lower estuary (including Duck River) in general can also be attributed to other historical riverside industry and contributions via ongoing urban stormwater runoff (Birch, 2017). These contaminants may have frequent adverse effects on biota and biological communities (Birch et al. 2020).

In Australia, Sediment Quality Guideline Values (SQGVs) are used as threshold concentrations for contaminants in sediments, below which adverse effects on aquatic organisms are expected to be rare. These guideline values are used as screening tools (i.e. they are not regulatory limits) and have been set for many common metals and toxicants that can be found in the estuarine environment, although they are not available for all toxicants in which case an understanding of levels at other reference locations relative to the location of interest can be useful instead. The SQGVs are classified as follows:

SQGV-Low: This value is based on the Effects Range Low (ERL). It represents a concentration below which harmful effects on aquatic life are unlikely. If contaminant levels are below this threshold, the sediment is generally considered to pose a low ecological risk.

SQGV-High: This is based on the Effects Range Median (ERM). It represents a concentration above which harmful effects are frequently observed. If contaminant levels exceed this threshold, there is a high probability of adverse ecological effects.

Values between SQGV-Low and SQGV-High pose a possible risk and effects may occur occasionally.

Similar to the results of Birch et al. (2020), results of the independent 2024 testing at John Whitton Bridge also showed that metal concentrations of zinc, copper, lead and chromium were elevated and also exceeded SQGVs for sediment toxicants at many of the sites for which surface sediments were sampled. Other metals including arsenic also exceeded SQGVs at certain sites. Results are summarised below:

- Total zinc in surface sediment was elevated well above the SQGV-High of 410 mg/kg at all sites apart from S1 and S2 with concentrations ranging between 450 and 780 mg/kg.
- Total copper in surface sediments exceeded the SQGV-Low of 65 mg/kg at all sites (with values ranging between 83 and 130 mg/kg). The exception to this were sites S1 and S2 with concentrations of 19 and 28 mg/kg respectively, that were well within the guideline range.
- Total lead in surface sediments exceeded the SQGV-Low value of 50 mg/kg at all sites except for S1 (immediately upstream of the release site) where the lead concentration was 40 mg/kg. The highest concentrations of lead were recorded at sites S7, S8, S12 and S13 which all recorded a value of 220 mg/kg, which is the same as the SQGV-high value.
- Total chromium in surface sediments exceeded the SQGV-Low of 80 mg/kg at all sites except S1, S2 and S10 (which were below the SQGV-Low value). The greatest exceedance (280 mg/kg) was recorded at S13 located in the channel downstream of John Whitton Bridge.
- Total arsenic in surface sediments exceeded the SQGV-Low of 20 mg/kg only at S1 (immediately upstream of the release site: 48 mg/kg).

Other metals that were tested for included cadmium, cobalt, nickel, calcium and manganese of which only cadmium and nickel have a default SQGVs available. Concentrations of both these metals in surface sediments were below the SQGVs across all sites.

While SQGVs for calcium are not available, it was noted that concentrations of this metal were elevated at S1 and S2 (with values of 66,000 and 22,000 respectively), which was over ten times that of most other sites.

4.1.4.3 Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are a group of organic compounds composed of multiple aromatic rings. They are primarily formed during the incomplete combustion of organic materials such as coal, oil, gas, wood, and tobacco. PAHs can enter the marine environment through various pathways, including atmospheric deposition, runoff from roads, industrial discharges, and oil spills (Vagi et al. 2021). Their effects on marine biota can include toxicity and carcinogenicity and they can bioaccumulate in marine organisms, particularly in shellfish and sediments.

Sediments in the lower Parramatta River Estuary have also been found as slightly to moderately at risk of contaminant toxicity from PAHs (Birch, 2017). Common PAHs found across the Harbour included fluoranthene, pyrene, benz(a)athrasene, chrysene, benzo(a)pyrene, benzofluoranthenes, ideno(1,2,3, cd)pyrene and benzo(ghi)perylene.

McCready et al. (2000) sampled sediments for PAHs at 128 sites across Sydney Harbour and the lower Parramatta River including the impact assessment site in November/December 1998. This included one site located near John Whitton Bridge and four sites in Duck River. Notably high concentrations were recorded from sites at Duck River where contaminant input from petrochemical industries was considered the likely source. PAH concentration and composition at the site near John Whitton Bridge was similar in comparison to the majority of sites throughout the Harbour where there is ‘potential’ for PAHs to cause adverse ecological affects to sensitive species.

The ANZECC/ARMCANZ (2000) SQGV-Low and SQGV-High for Total PAHs are 10,000 µg/kg and 50,000 µg/kg respectively. Results of the 2024 sampling of sediments up and downstream of John Whitton Bridge recorded Total PAH concentrations that ranged between 1320 µg/kg at S3 and 7070 µg/kg at S15, therefore all samples were below the SQGV-Low threshold.

It was noted that at the time of sample collection a strong hydrocarbon odour was reported at core S3 in the centre of the channel upstream of the bridge and possibly at S13 downstream of the bridge, while an oil sheen was observed in the core sample from S12.

4.1.4.4 Dioxins

Dioxins are a group of compounds that are persistent environmental pollutants. They include polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and certain polychlorinated byphenyls (PCBs). These compounds are by-products of various industrial processes and can enter the marine environment through atmospheric deposition, runoff, and wastewater discharge. Dioxins can bioaccumulate in marine organisms potentially leading to endocrine disruption, suppression of the immune system and may be carcinogenic (She et al. 2016). Commercial fishing in Sydney Harbour has been banned since 2006 due to concerns over dioxin levels in fish and invertebrates. The source of the dioxin residue in Sydney Harbour is believed to be the Homebush Bay area, which has had a long history of industrial use.

Although there are no Australian sediment quality guidelines for dioxins, a conservative SQGV for dioxin-like compounds in both fish and sediments for Sydney Harbour was established by Manning and Batley (2023) and there are US EPA and Canadian guidelines that can be used as benchmarks (US EPA, 1993 and Canadian Council of Ministers of the Environment, 2001). These guidelines use a measure of Picograms of International Toxic Equivalent per gram (I-TEQ/g)) which is the toxic potential of a mixture of dioxins, furans, and some PCBs, expressed in terms of the equivalent concentration of the most toxic dioxin, 2,3,7,8-TCDD.

Surface sediment testing in the Homebush Bay area has previously recorded dioxin contaminant levels ranging from 90 to 154,000 pg I-TEQ/g, with a mean of 7,600 pg I-TEQ/g which significantly exceeds any US EPA or Canadian guideline values. Sites closer to the Sydney Harbour bridge have been recorded as having levels of dioxin like contaminants on, or just below, the US EPA criteria (Montoya, 2015).

Noting that the Toxic Equivalency Factor (TEF) for 2,3,7,8-TCDD (TCDD) is 1.0, results of sediment quality testing undertaken near John Whitton Bridge during September and October 2024 can be directly compared to US EPA and Canadian guidelines (expressed as pg I-TEQ/g). Results found levels of 2,3,7,8-TCDD ranged between 5.5 pg/g at core S3, and up to 500 pg/g at core S8. This generally exceeds most total toxic equivalent US EPA guidelines for the protection of fish, benthos and ecosystems (US EPA, 1993, Canadian Council of Ministers of the Environment, 2001). It also exceeds the conservative Sydney Harbour SQGV for dioxin-like compounds in both fish and sediments established at 70 pg TEQ/g dry weight by Manning and Batley (2023).

4.1.4.5 Acid Sulfate Soil

Acid sulfate soil/sediment (ASS) is the common name given to naturally occurring soils and sediments that contain iron sulfate (pyrite). Acid sulfate soils/sediments are defined as either:

- Actual ASS (AASS) - highly acidic soils or sediments with pH <4, or
- Potential ASS (PASS) - soils or sediments containing sulfuric material that have not been oxidised but have potential for oxidation to generate high acidity.

ASS's are naturally found in coastal floodplains, estuaries, and wetlands, including areas around the Parramatta River and Sydney Harbour. These only become a risk to aquatic life if disturbed and oxidised such that sulphuric acid is formed. If not appropriately managed this can enter adjacent watercourses, lower the pH of the waterway and lead to a range of negative impacts on water quality and health of aquatic ecosystems.

Based on risk maps, there is a high probability of ASS occurring in bottom sediments within the main channel of the Parramatta River and Duck River, as well as at or near the ground surface at the adjacent intertidal mangroves at the Meadowbank Park playing fields (Figure 4-4). The lower section of Vineyard Creek (Figure 4-6) and parts of Sydney Olympic Park also contain high probability ASS but these areas would not be disturbed by open trenching.

4.1.5 Estuarine Habitats and Biota

The lower Parramatta River Estuary supports a variety of important habitats, including artificial and modified habitats along with diverse intertidal and subtidal habitats. Representative habitat types within the Project locality are identified and described in the following sections.

4.1.5.1 Riparian Habitats

Riparian vegetation refers to the ecological communities fringing the banks of watercourses - where the aquatic environment meets the terrestrial ecosystem. These corridors provide critical ecosystem services, including erosion control, nutrient filtration, carbon sequestration, and habitat provisioning (Riis et al., 2020). By stabilising riverbanks and filtering run-off, riparian plants help maintain water quality and reduce sedimentation, supporting fish, macroinvertebrates, and other organism's dependent on healthy in-stream conditions. Leaf litter and woody debris entering the water from riparian zones also create physical complexity and organic matter for aquatic species, underpinning food webs and foraging resources.

Historically, the Parramatta River was bounded by substantial riparian forests that formed the transition between terrestrial woodland communities and aquatic habitats (McLoughlin, 2000). Since European settlement, however, riparian vegetation in the Parramatta River estuary has undergone profound changes (McLoughlin, 2000). Early clearing for agriculture, industry, and urban development removed much of the native riparian forest, degrading streambank stability and increasing nutrient and sediment inputs into the river. Over time, these disturbances contributed to the expansion of mudflats and mangrove communities - particularly the grey mangrove (*Avicennia marina*) - in parts of the estuary, even as the total area of wetland and other riparian plant communities diminished (McLoughlin, 2000).

Many areas within the broader Parramatta River catchment are undergoing restoration and management to improve the resilience of riparian ecosystems. Local councils, community groups, and state agencies have initiated riparian planting programs, weed control measures, and pollution reduction strategies to protect and rehabilitate remaining habitat. Despite widespread alterations, pockets of intact riparian vegetation still exist in the estuary as described in Section 4.2.

4.1.5.2 Mangroves and Saltmarsh

Mangroves, mudflats and saltmarsh are intertidal or supratidal habitats characterised by partial or intermittent inundation of saline or brackish water. While water quality parameters are inherently dynamic in estuaries, these habitats and associated communities can potentially be affected by systemic changes or permanent shifts in various aspects of water condition. Grey mangrove is the dominant species along the Parramatta River and forms the most extensive marine vegetation community (Yerman, 2003; NSW DPI, 2024a). Large stands of grey mangrove (*Avicennia marina* subsp. *australasica*) exist along the boundary of Meadowbank Park, west of John Whitton Bridge, with a total extent of approximately 5.49 ha (NSW DPI, 2024c). Smaller patches of mangroves line the foreshore of Anderson Park, east of John Whitton Bridge (Figure 4-4). Large and dense mangrove stands (approximately 70 ha – NSW DPI, 2024a) exist in the Sydney Olympic Park suburb, concentrated in Bicentennial Park and the Newington Nature Reserve.

Mangroves consisting mainly of grey mangrove and to a lesser extent river mangrove fringe the branch of Duck River that discharges into the Parramatta River (Figure 4-5). Only the lower reaches of Vineyard Creek are characterised by mangroves and as such many of these locations are designated as coastal wetlands with associated buffer areas under the Resilience and Hazards SEPP 2021.

Saltmarsh habitat is intermittently inundated with saline water resulting in hypersaline soil, which very few species of plants are able to occupy. Saltmarsh communities provide habitat and food for fauna and contribute to estuarine health through filtration and carbon sequestration. Saltmarsh is particularly important as a 'nursery' habitat, with the shallow water and dense vegetation providing shelter from predators for juvenile fish (Daly, 2013).

Seablite (*Suaeda australis*) and samphire (*Sarcocornia quinqueflora*) are the most common saltmarsh species found in the Parramatta River along with native spinach (*Tetragonia tetragonioides*), sea rush (*Juncus kraussii*), sand couch (*Sporobolus virginicus*) and creeping brookweed (*Samolus repens*) (Williams et al. 2011). The species composition of individual patches of saltmarsh is influenced by many factors, including sediment composition, tidal influence, and patch size (Williams et al. 2011). A total of 29 native plant species was recorded in saltmarsh patches of the Parramatta River Estuary by Williams et al. (2011), with species richness decreasing downstream. The extent of saltmarsh in the Parramatta River appears to have declined since European settlement based on several historical accounts (McLoughlin, 2000). As with mudflats, saltmarsh is vulnerable to the expansion of mangrove forests (Williams et al. 2011; Friess et al. 2019).

The establishment of saltmarsh in Wentworth Point appears to be relatively recent, following land reclamation between the 1930s and 1970s (Williams et al. 2011). The variety of species identified through Stantec field investigations included but was not limited to; seablite (*Sueda australis*), samphire (*Salicornia quinqieflora*), New Zealand spinach (*Tetragonia tetragonioides*), saltwater couch (*Sporobolus virgincus*), saltmarsh rush (*Juncus kraussi*), and swampweed (*Selliera radicans*) species.

Recent surveys and aerial photography have identified multiple small patches of saltmarsh along Duck River. These patches vary in size and are distributed throughout the estuarine portions of the river with the characterising species including *Sarcocornia quinqueflora* (beaded glasswort) and *Sporobolus virginicus* (saltwater couch). There is approximately 0.33 ha of saltmarsh on the north-east point of the Wentworth Point foreshore and 0.05 ha on the northern riverbank, at Melrose Park adjacent to Lancaster Ave. Additionally, approximately 6.5 ha of saltmarsh exists in Homebush Bay, at the edge of Bicentennial Park and within the Olympic Park Waterbird Refuge. The Newington Nature Reserve contains approximately 12 ha of saltmarsh. Saltmarshes in Sydney Olympic Park contain the largest population of the threatened plant *Wilsonia backhousei* in Sydney (OEH, 2018). These areas are, however, outside of the study site.

4.1.5.3 Rocky Reef

The Parramatta River estuary contains a range of intertidal and subtidal hard substrata, including natural rocky reefs (Mayer-Pinto et al. 2015). These habitats are essential for maintaining biodiversity in the estuarine environment, providing critical habitat for marine taxa such as invertebrates, fish, and macroalgae. Subtidal hard substrates in the estuary contribute significantly to the productivity of the ecosystem by offering shelter, food sources, and breeding grounds for various organisms.

Additionally, macroalgal communities are an important feature of these hard substrates throughout the Parramatta River Estuary. This includes a wide diversity of habitat-forming macroalgae such as common kelp (*Ecklonia radiata*), fucoids (e.g. *Sargassum* sp.), red algae (e.g. *Dictyota dichotoma* and *Zonaria* sp.), sea lettuce (*Ulva* sp.) and corallines (e.g. *Amphiroa anceps* and *Corallina officinalis*) all of which are important for the structure and functioning of hard-substrata habitats in the Parramatta River Estuary (Underwood et al. 1991). The distribution and composition of macroalgal communities vary across the estuary, with more diverse and abundant species typically found towards the downstream reaches where water quality and light availability are better (Farrant and King, 1982; Hedge et al. 2014). In contrast, the area around the Parramatta River, experiences higher levels of turbidity and other anthropogenic impacts that reduce the light penetration required for macroalgae to thrive.

Consequently, the macroalgal community in these upstream regions is often minimal, with low diversity, and lacking in large, habitat-forming species.

4.1.5.4 Artificial Habitats

Throughout Sydney estuary, more than 50 percent of the natural shorelines have been replaced with artificial structures, and approximately 22 percent of the estuary has been reclaimed for urban development (Chapman and Bulleri, 2003; Birch et al. 2009). These artificial habitats, while providing essential functions like habitat for marine biota, support different species assemblages when compared to natural habitats. The biodiversity supported by these modified environments often differs from that of natural systems, and ecological processes such as sediment stabilisation and nutrient cycling may be less efficient (Connell and Glasby, 1999; Mayer-Pinto et al. 2015).

The Parramatta River Estuary contains numerous artificial and modified habitats, including seawalls, wharves, and other infrastructure such as pilings and revetments. Common sessile organisms found on artificial substrates through the Parramatta River Estuary include oysters, barnacles, tubeworms, macroalgae, and sponges, while mobile species such as gastropods, fish, and echinoderms also utilise these habitats (Bulleri et al. 2005). Field surveys undertaken for this study in the lower estuary found relatively low numbers of sessile fauna on artificial substrates, likely a result of frequent ferry wash disrupting settlement or impaired water quality. Common intertidal species observed include gastropods such as black nerite (*Nerita atramentosa*), striped mouth conniwink (*Bembicium nanum*), and isopods such as wharf louse (*Ligia exotica*). Oysters, primarily Sydney rock oysters (*Saccostrea glomerata*) and pacific oysters (*Magallana gigas*), also occur in patchy distributions. Further information on field surveys can be found in Section 4.2.

4.1.5.5 Seagrass Beds

Seagrasses are a functional group of marine flowering plants that live and reproduce entirely within sea water. Like terrestrial angiosperms, seagrasses have leaves and roots, produce flowers and seeds, and depend on light for photosynthesis (NSW DPI, 2007). Seagrasses provide significant contributions to the productivity of marine and estuarine environments and form an important habitat and food source for marine and estuarine fauna (NSW DPI, 2007; Romero et al. 2006). Seagrasses also contribute to the maintenance of water quality (Connolly et al. 2018) and stabilisation of sediments through their complex underground root and rhizome systems (Larkum et al. 2006).

Seagrass distribution is influenced by a range of factors, including salinity, depth, temperature, seabed stability, wave energy and estuary type, as well as the evolutionary stage of the estuary (Roy et al., 2001; Kirkman and Kuo, 2012). Seagrasses including *Zostera muelleri* and *Halophila ovalis* and the endangered *Posidonia australis* are distributed throughout the Parramatta River Estuary, with the most extensive beds existing in the central mud basin (i.e. between Gladesville and Middle Harbour) and marine tidal delta zones of the estuary (West and Williams, 2008). These zones, being in the more downstream reaches of the Parramatta River Estuary, Sydney Harbour and Middle Harbour, exhibit the most suitable environmental conditions for seagrass growth, such as adequate water clarity and light availability (West and Williams, 2008). The distribution of seagrass beds becomes sparser in the Parramatta River Estuary, with these areas dominated by species more tolerant to variable environmental conditions, such as *Z. muelleri* and *H. ovalis* (West & Williams, 2008; NSW DPI, 2024). There are no seagrasses mapped in the impact assessment areas and none were found during the field site inspections.

The closest known seagrass beds to the Meadowbank release site are located approximately 2.8 km downstream in Morrisons Bay, and 3.5 km downstream in Glades Bay, with more extensive beds present in Hen and Chicken Bay, approximately 5.7 km downstream (NSW DPI, 2024a). These beds comprise of Zostera sp. and Halophila sp. (NSW DPI, 2024a). Despite historical records indicating the presence of seagrass beds upstream of Morrisons Bay, it is highly unlikely that any seagrass would now be found around or upstream of the proposed release site.

4.1.5.6 Soft Sediments

Soft sediments in the Parramatta River estuary are primarily muddy or silty, reflecting a history of urban development, industrial activity, and natural deposition processes. Low energy environments - combined with sporadic freshwater inflows from the Charles Street Weir - facilitate the accumulation of fine particles and organic matter.

These intertidal and subtidal soft sediment habitats are rich in organic materials that help drive detritus-based food webs (Bishop & Kelaher, 2008; Kelaher et al., 2013) which in turn support communities of infauna (including polychaetes, small crustaceans, and bivalves). These provide food resources for fish, larger macroinvertebrates and shore birds, including threatened and/or migratory species.

Historically, intertidal mudflats were more widespread in the Parramatta River Estuary following European settlement and expanded with increased sedimentation (McLoughlin, 2000). Today, mudflats are relatively scarcer in the Parramatta River Estuary, having either been reclaimed, developed, or invaded by vegetation.

These ecosystems are highly stratified, with layers characterised by varying levels of oxygen and nutrients (Reid, 2020). Connection between these layers provided by processes such as bioturbation by invertebrates and other animals, and connections between mudflats and other habitats providing external sources of organic matter, are essential to their functioning (Stelling-Wood et al., 2022). While oxygen levels and flow regimes in these soft sediments can vary, particularly during or after storm events, most resident infauna cope with high levels of suspended solids and periodic salinity Although these communities may be less diverse than in clearer, downstream and marine dominated reaches, they remain important for supporting fish, crustaceans, and other fauna higher up the estuarine food web. Contaminants such as heavy metals and hydrocarbons remain embedded in some sediment layers (Birch et al. 2020), influencing the composition and function of these communities. Despite this, Sydney Harbour is one of the most diverse harbours along the coast of NSW for infaunal organisms, especially polychaetes which comprise up to 75 percent of sediment's macrofauna with great abundances of individuals from the families Arabellidae, Spionidae, Nephytidae, Cirratulidae, Maldanidae and Capitellidae (Johnstone et al. 2015). The microbiota in soft sediments also have a central role in the functioning of ecosystems as they form the basal elements of many food chains, affect sediment chemistry and restrict nutrient availability (Griffiths 1977 in Johnston et al. 2015).

Near the Meadowbank Park/John Whitton Bridge release location, soft sediments were observed to be silty mud, with legacy contamination identified throughout sediment sampling. Though the sediments in the lower estuary are associated with turbid and brackish conditions, they still host infaunal assemblages that adapt to fluctuating conditions such as changing salinity and periodic low dissolved oxygen.

4.1.6 Fish and Mobile Macroinvertebrates

The lower Parramatta River functions as a Type 2, Class 2 (moderate key fish habitat) - a permanently flowing estuarine system sustaining a variety of fish and macroinvertebrate populations. Surveys of the lower Parramatta River using publicly available citizen science data (iNaturalist) indicate that at least 34 finfish and estuarine macroinvertebrate species have been recorded, including 19 fish species, 13 molluscs, and two crustaceans. While many of these species appear only once or twice in the dataset, popular recreational fishing targets, such as mulloway (*Argyrosomus japonicus*), yellowfin bream (*Acanthopagrus australis*), and dusky flathead (*Platycephalus fuscus*), are recorded more frequently. Other sources confirm the presence of tagged yellowfin bream and sea mullet (*Mugil cephalus*), and possibly mulloway, in the lower estuary (Taylor et al. 2018), as well as tagged bull sharks (*Carcharhinus leucas*) (Smoothey et al. 2019). Historic sampling by Roach & Runcie (1998) and Alquezar et al. (2006) further illustrates the presence of common local species, including yellowfin bream, sea mullet, and smooth toadfish (*Tetractenos glaber*).

Duck River and Duck Creek are also mapped as key fish habitat. Species recorded specifically in Duck Creek are yellowfin bream (*Acanthopagrus australis*), sea mullet (*Mugil cephalus*) and flattail mullet (*Gracimugil argenteus*). These were recorded from around the confluence of Duck Creek by Roach & Runcie (1998). The only native species specifically recorded in Vineyard Creek include the diadromous long- and/or short-finned eels (*Anguilla reinhardtii* and *A. australis*, respectively) (WSU, 2024).

Although survey data in some parts of the lower Parramatta River are limited, comparative information from nearby estuarine systems (namely the Hawkesbury River Estuary) suggests that a broad range of finfish and macroinvertebrates likely use waters within the impact assessment area at least intermittently. It is noted, however, that fishing

4.1.7 Marine Pests and Diseases

A number of 'marine pest lists' currently exist in Australia and vary among jurisdictions. There is also a national list - The Australian Priority Marine Pest List (APMPL). In NSW, a list of introduced marine pests (IMPs) of concern are listed under Schedule 2 of the NSW Biosecurity Act 2015 as 'prohibited matter' and under Schedule 1, Part 2 of the NSW Biosecurity Regulation 2017 as 'notifiable matter'. Prohibited Matter includes pests, diseases and weeds that are not found in NSW. Notifiable matter generally includes species that are found in NSW and if not managed appropriately may have a severe effect on the economy, environment or community. Other IMPs also occur in NSW, which are not regulated (or actively managed) via listing as prohibited or notifiable. These species may already be known to present invasive characteristics or have potential to become invasive. These include Pacific oyster (*Crassostrea gigas*), non-native ascidian (*Botrylloides giganteus*); and red algae (*Pachymeniopsis lanceolata*). Although there are potentially hundreds of IMPs that could establish in the Parramatta River Estuary, not all of these are harmful. The following marine pests have been recorded in Sydney Harbour and have potential to occur in the lower Parramatta Estuary (Cardno, 2022):

- Pacific oyster.
- Yellowfin goby (*Acanthogobius flavimanus*).
- European green crab (*Carcinus maenas*); and
- Caulerpa (*Caulerpa taxifolia*).

Sydney Harbour is at risk of infestation from the marine pest *Caulerpa taxifolia* (Caulerpa) (NSW DPI, 2013). Caulerpa is a fast-growing marine alga native to tropical Australia and the South Pacific (NSW DPI, 2016). This species is known to alter physical and chemical habitat affecting biodiversity. Populations have been recorded in Port Jackson but generally in the lower part of the harbour and not as far upstream as the Project study locality. As it is vegetative, small fragments can break off and spread via boats and other waterway equipment used in construction.

A large number of viral, bacterial and parasitic diseases affecting finfish, molluscs, crustacean and amphibians are known within NSW waterways. The most renowned include Red Spot Disease, QX oyster disease and Pacific Oyster Mortality Syndrome (POMs) (NSW DPI, 2018). Red Spot Disease (or Epizootic ulcerative syndrome) is a fungal disease endemic in a number of waterways in NSW. This disease can affect many species of finfish and presents as red lesions or deep ulcers which can then be susceptible to secondary bacterial infections. Although the freshwater and estuarine waterways of the Sydney region have not reported Red Spot Disease outbreaks, it is known to occur in all NSW waterways. QX oyster disease and POMs are high risk to the oyster aquaculture industry, although none currently operate within the study area. Factors influencing infections and outbreaks can include changes in environmental conditions (salinity, temperature, water quality), contaminants from human activities including sewage disposal.

4.1.8 Threatened and Migratory Species

Threatened species are those that are listed as vulnerable, endangered or critically endangered under either State or Commonwealth Legislation. Listed species are determined through a rigorous scientific assessment of the threatened status of the species using a set of criteria.

Migratory species are those animals that migrate to Australia and its external territories or pass through or over Australian waters during their annual migrations. Listed migratory species may also include any native species identified in an international agreement approved by the Minister for the Environment.

A review of the PMST and BioNet databases indicated there are 80 threatened and migratory marine or estuarine species that have the potential to occur in the study locality. Of these species, 70 were birds, six were fish and five were marine reptiles. All terrestrial migratory birds, reptiles, mammals (including bats), amphibians, and invertebrates were excluded from the assessment. Additionally, flora species were refined to only include those species that exist in relation to aquatic/estuarine environment or form part of riparian vegetation.

Six species (all waterbirds and shorebirds) were considered to have a high likelihood of occurrence within the impact areas due to recent records within or in the vicinity of the impact areas. Nine species (also waterbirds and shorebirds) were considered to have a ‘moderate’ likelihood of occurrence in the impact areas due to presence of potentially suitable habitat and records of occurrence in the vicinity (Table 4-4).

No species of fish or marine reptiles were considered to have any likelihood of occurrence within the study locality or impact areas (likelihoods of occurrence were either ‘low’ or ‘none’ for these species).

A full list of the likelihood of occurrence can be found in Appendix A.

Table 4-4 Likelihood of occurrence summary

Scientific Name	Common Name	BC Act / FM Act	EPBC Act	Source	Likelihood of Occurrence
Birds					
Calidris acuminata	Sharp-tailed Sandpiper	P	M	(PMST-K) ALA	High Suitable habitat could be present within the impact areas. Many records of this bird in the broader area
Calidris canutus	Red Knot	P	V	(PMST-K)	Moderate. Suitable habitat could be present within the impact areas.
Calidris ferruginea	Curlew Sandpiper	E	CE, M, Ma	(PMST-K) 169 (BioNet)	Moderate. Suitable habitat could be present within the impact areas.
Calidris tenuirostris	Great Knot	V	E	(PMST-K) 1 (BioNet)	Moderate. Suitable habitat within the impact areas.
Epthianura albifrons	White-fronted Chat	V	-	184 (BioNet)	High Suitable habitat within the impact areas and many records in the vicinity. Several records in the vicinity of impact areas.
Gallinago hardwickii	Latham's Snipe, Japanese Snipe	-	V, M, Ma	(PMST-K) ALA	High Suitable habitat is within the vicinity of the impact areas, large number of records in the broader vicinity.
Haematopus longirostris	Australian Pied Oystercatcher	E	-	1 (BioNet) ALA	High Suitable habitat is within the vicinity of the impact areas. Several records in the vicinity of the impact area.
Haliaeetus leucogaster	White-bellied Sea Eagle	V	-	313 (BioNet) ALA	High Suitable habitat is within the vicinity of the impact areas; they may transit through impact areas. Large number of records in the broader vicinity.
Ixobrychus flavicollis	Black Bittern	V	-	4 (BioNet)	Moderate Suitable habitat could be present within the impact areas.
Limosa lapponica baueri	Nunivak Bar-tailed Godwit,	-	E	(PMST-K)	High

Scientific Name	Common Name	BC Act / FM Act	EPBC Act	Source	Likelihood of Occurrence
	Alaskan Bar-tailed Godwit			ALA Records	ALA records within impact areas and the vicinity
Limosa limosa	Black-tailed Godwit	V	E	(PMST-K)	Moderate. Some foraging habitat present in the impact areas.
Numenius madagascariensis	Eastern Curlew	-	CE, M, Ma	(PMST-K) ALA	Moderate Some foraging habitat present in the impact areas.
Pandion cristatus	Eastern Osprey	V	-	5 (BioNet) ALA	Moderate Prefers specific habitat not in the impact areas, but records in the vicinity. Could be transient visitor.
Tringa nebularia	Common Greenshank	-	E, M, Ma	(PMST-K)	Moderate Species may forage in impact areas, records in the broader vicinity.
Threatened Ecological Communities					
Subtropical and temperate coastal saltmarsh		-	V	(PMST-L)	Moderate. Suitable salt-tolerant plant species present in the impact areas

Key:
EP = endangered population
CE = critically endangered
E = endangered
V = vulnerable
M = migratory (EPBC Act only)
Ma = marine (EPBC Act only)
ALA = Atlas of Living Australia Record

4.1.9 Threatened Ecological Communities

An ecological community is a naturally occurring assemblage of plants, animals and other organisms with its structure, composition and distribution determined by a variety of abiotic factors. Ecological communities are listed as threatened when the natural function and composition of the community across its range is depleted due to a range of threats and pressures (DCCEEW, 2022). All listed Threatened Ecological Communities (TECs) are Matters of National Environmental Significance (MNES) under the EPBC Act.

Only TECs that exist in relation to aquatic/estuarine habitats were included in the assessment. A review of the PMST indicated one relevant TEC listed under the EPBC Act was predicted to occur within the study locality:

- Subtropical and temperate coastal saltmarsh.

The likelihood of each TEC to occur within the impact areas was conducted through assessment against the likelihood of occurrence criteria (Table 3-1). A full list of the likelihood of occurrence can be found in Appendix A. Two other TECs (Coastal Flats Swamp Mahogany Forest and Swamp Oak Floodplain Forest were also mapped adjacent to the Vineyard Creek / Parramatta River Impact Area and crossing, however, these are considered terrestrial and did not overlap directly with the Project impact area. Potential project impacts to these TECS have been considered as part of the Biodiversity Development Assessment Report (Arcadis, 2025).

4.1.10 Protected and Sensitive Lands

Areas of Conservation Significance were assessed due to their biodiversity values and sensitivity to potential impacts. The Areas of Conservation Significance assessed in relation to the Project include Nature Reserves, State Parks, Aquatic Reserves, and Biodiversity Values (see Figure 4-5 and Figure 4-4).

Within the study locality, Newington Nature Reserve is the sole nature reserve. It is located just upstream of the discharge site at John Whitton Bridge but on the southern bank of the Parramatta River. Although it contains known populations of threatened communities of flora and fauna it does not directly overlap with any impact assessment areas. No State Parks or Aquatic Reserves were present in the study locality.

The Biodiversity Values Map identifies land with high biodiversity values that are sensitive to impacts from potential development. In the study locality, mapped areas are included as they satisfy one or more of the following criteria: biodiverse riparian land, coastal wetlands identified under the Coastal Management Act, or presence of threatened species or communities with potential for serious and irreversible impacts.

No State Parks or Aquatic Reserves were present in the study locality or impact areas.

4.1.11 Key Fish Habitat (KFH)

The NSW DPI Fisheries Spatial Data Portal defines all waterways of the lower Parramatta River, including Duck River and Vineyard Creek as KFH (NSW DPI, 2024a). Most estuarine habitats present in the estuary are classified as KFH – Type 2 (moderately sensitive KFH), The main channel of the Parramatta River estuary is classified as ‘Poor’ Freshwater Fish Community, while Duck River up to the M4 bridge is considered ‘Fair’.

Figure 4-4 Aquatic biodiversity values and habitats at the Meadowbank impact assessment area (near John Whitton Bridge)

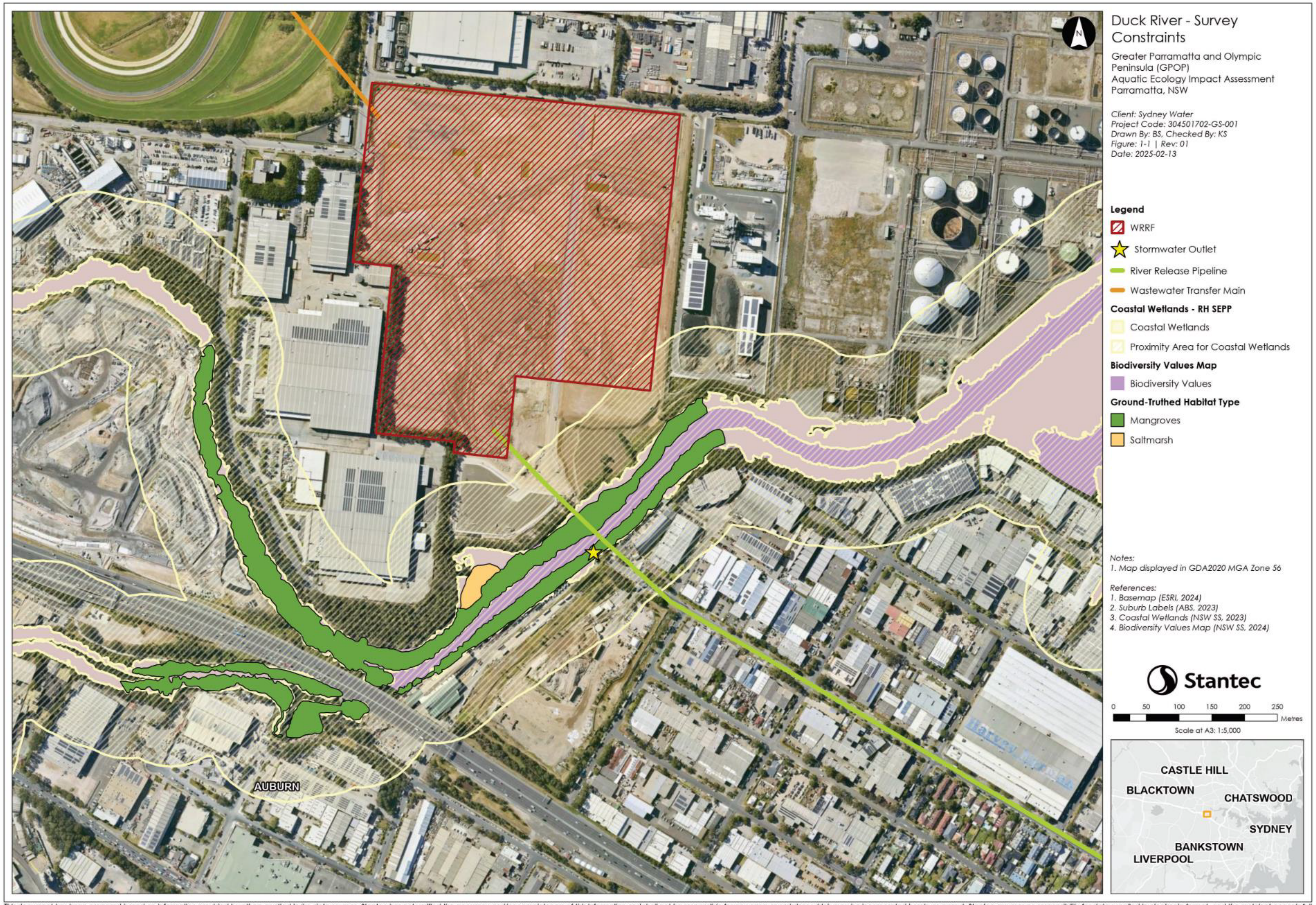


Figure 4-5 Aquatic biodiversity values and habitats within the impact assessment areas - Duck River

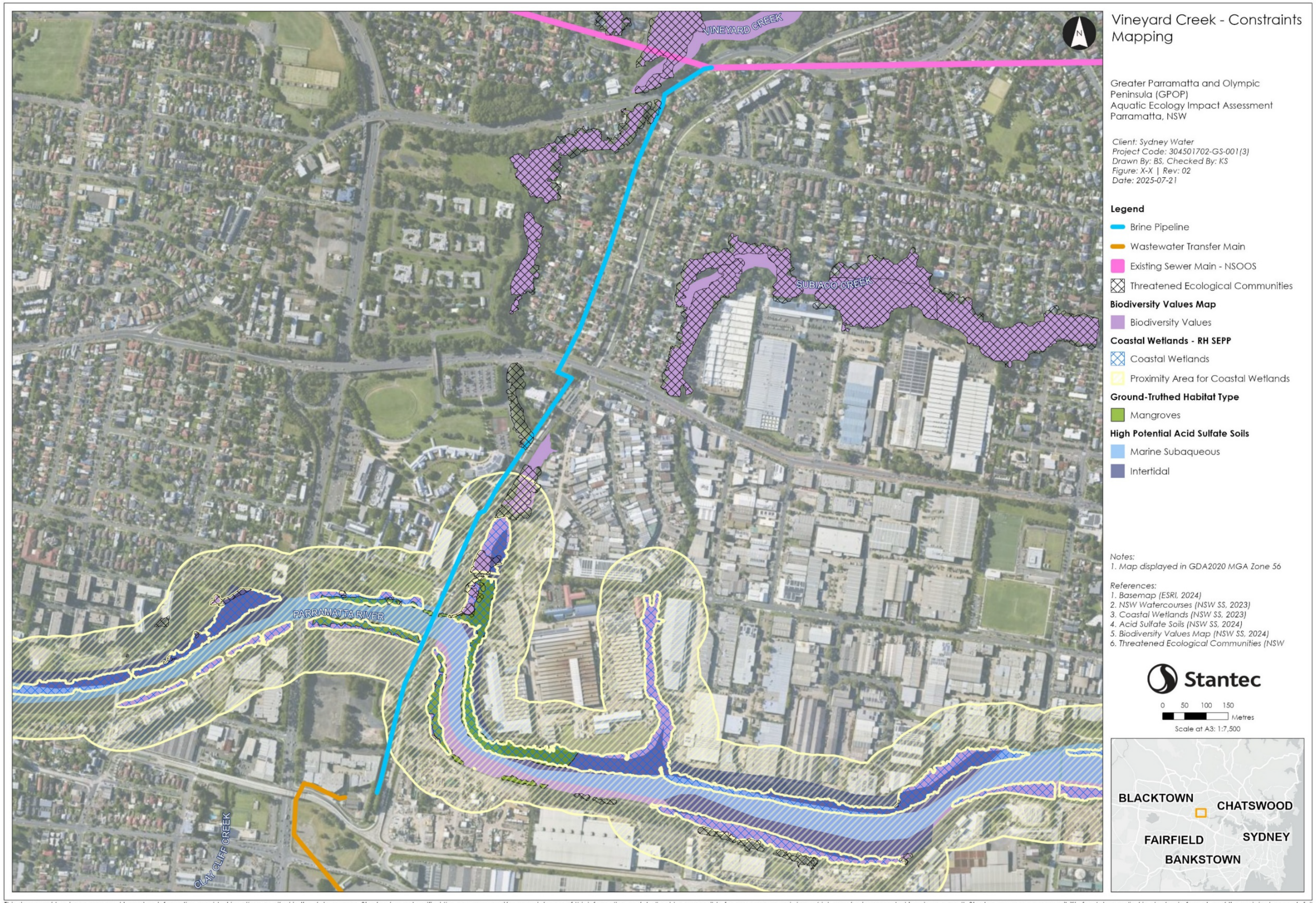


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Figure 4-6 Aquatic biodiversity values and habitats - Vineyard Creek

4.2 Field Inspections

4.2.1 John Whitton Bridge Release Study Site

The release site at John Whitton Bridge was inspected on foot and with an ROV on 31 January 2025. This was done around mid-high tide (high tide 10:26 am and low tide 5:02 pm). The area surveyed extended from Meadowbank Park sporting fields, east to the public wharf at Ryde Wharf Reserve (Figure 4-7). Key landmarks included the John Whitton Bridge, at the approximate midpoint of the survey area, Meadowbank ferry wharf and Meadowbank dog beach.

4.2.1.1 Intertidal Habitats

The majority of the intertidal shoreline within the study area was characterised by a continuous sandstone boulder seawall which backs onto the Ryde River Walk pathway (Figure 4-7 a). Other habitats present shoreward of the sandstone boulder seawall included mangrove stands, beach habitat and a low relief rock platform (approx.80 m in length). Other artificial structures (vertical seawalls, wharves and piles) were also present under the bridge and east of the bridge (Figure 4-7a-f).

The sandstone boulder seawall and other artificial surfaces were predominantly encrusted with barnacles, filamentous green algae and oysters; both Sydney rock oysters (*Saccostrea glomerata*) and Pacific oysters (*Magallana gigas*). Occasional gastropod molluscs including black nerite (*Nerita atramentosa*), striped mouth conniwink (*Bembicium nanum*) and the isopod wharf louse (*Ligia exotica*) were also recorded (Figure 4-7 b, c, d). These species are commonly found intertidally across Sydney Harbour, although the diversity of this assemblage would be considered relatively poor.

The area of natural low-relief rock self was covered with some filamentous green algae only, but no encrusting or mobile invertebrates were recorded on that habitat. Wash caused by passing fast ferries was observed, often producing enough energy to cause a breaking wave along seawalls. This may be a factor limiting the settlement and establishment of intertidal marine organisms on these structures and the natural rock shelf.

A relatively large and continuous stand of grey mangrove (*Avicennia marina*) occurred west of the John Whitton Bridge, varying in width from approximately 90 m from edge to shore or seawall to a few metres. Wider stands of mangroves contained sub-habitats, such as mangrove pneumatophores, shallow tidal channels and sandy banks occupied by salt-tolerant plant species such as Warrigal greens (*Tetragonia tetragonioides*) and largeleaf pennywort (*Hydrocotyle bonariensis*). Littering and the growth of exotic grasses and weeds was also evident (Figure 4-8 a-d).

An RCE score of 31, indicated moderate riparian health with the limiting factors being the seawall limiting width of mangrove foliage. The fish habitat sensitivity score was moderately sensitive (Type 2) and the fish habitat Class 2 (moderate key fish habitat) as the site is a permanently flowing estuarine waterway.

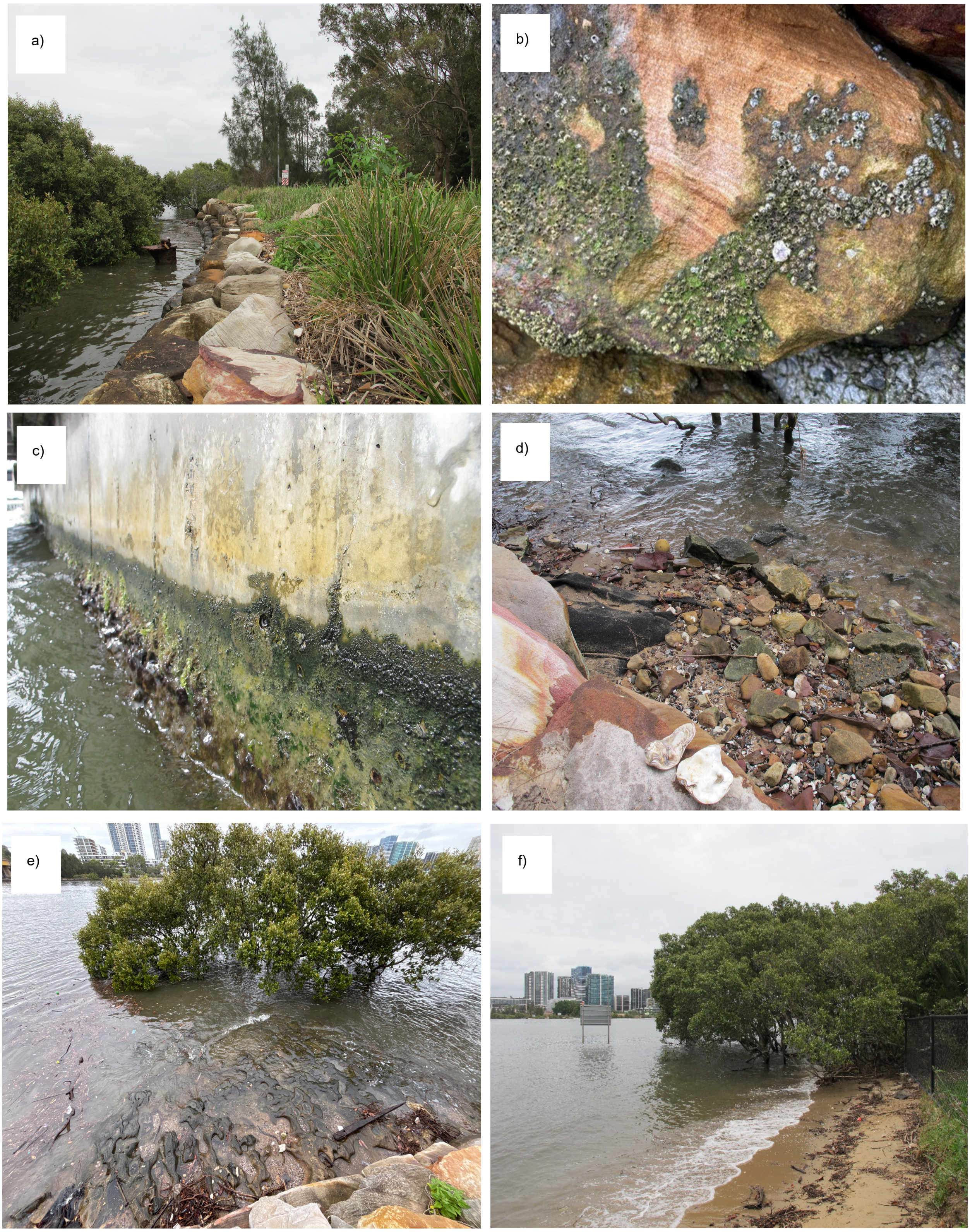

Figure 4-7 Habitats in the vicinity of John Whitton Bridge (proposed release site): a) Sandstone boulder seawall; b) intertidal invertebrates on boulder seawall; c) vertical seawall; d) Sydney rock oysters (Saccostrea glomerata) and gastropod (Patelloida mimula) on vertical seawall; e) intertidal rock platform; f) beach habitat

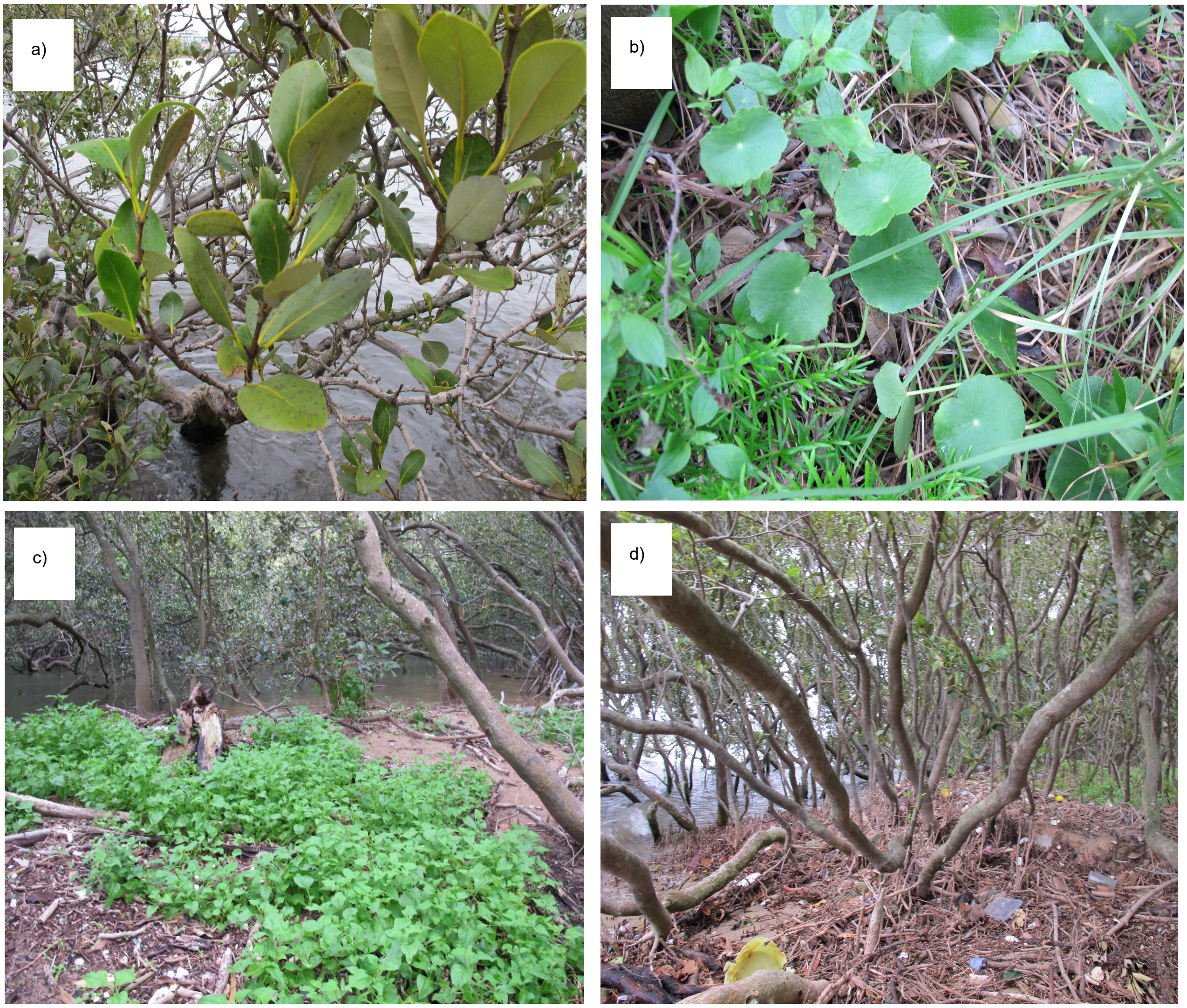

Figure 4-8 Grey mangroves (Avicennia marina) and mangrove sub-habitats within the survey area. a) grey mangroves, b) Hydrocotyle and exotic grasses c) Warrigal greens d) litter and plastic waste.

4.2.1.2 Subtidal Habitats

A remotely operated vehicle (ROV) was deployed subtidally adjacent to the John Whitton Bridge release area and along artificial seawall habitat. Visibility was very poor due to current and fine sediments, however, some general observations were made. The subtidal habitat consisted of very fine bioturbated sandy silt sediment which when disturbed created highly turbid conditions and also appeared to contain organic detritus which remained in suspension once mobilised. The many surface burrows indicated the presence of crabs and other infaunal invertebrates within these surface sediments. The subtidal hard substrata including seawalls was colonised by a similar assemblage as observed on the intertidal hard surfaces, i.e. consisting predominantly of oysters, barnacles and limpets but with encrusting sponges, encrusting algae and larger barnacle species, although these could not be identified due to the very turbid conditions.

4.2.2 Wentworth Point

Construction of the release pipeline will not directly impact on Wentworth Point (as this will be underbored via Hill Road), however, it does contain sensitive ecological habitats that could indirectly be influenced by any Project related changes to water quality originating from the release point at Meadowbank (near John Whitton Bridge). The potential for this to occur, based on the hydrodynamics and water quality impact assessment (Sydney Water, 2025a), is discussed in Section 5.2.3.

The shoreline of Wentworth Point consisted of artificial seawalls and rocky revetments, with mangroves interspersed. Some intertidal invertebrates were noted including oysters (likely Sydney rock oysters, but possibly Pacific oyster), common gastropods, limpets and barnacles.

Areas of both mangrove and saltmarsh habitat occur on Wentworth Point. Small patches of mangroves lined the foreshore, east of the Sydney Olympic Park ferry wharf and south into Homebush Bay. There is also approximately 0.33 ha of saltmarsh on the north-east point of the Wentworth Point foreshore. Species comprising the saltmarsh assemblage as identified through field investigation included: seablite (*Sueda australis*), samphire (*Sarcocornia quinqueflora*), New Zealand spinach (*Tetragonia tetragonioides*), saltwater couch (*Sporobolus virgincus*), saltmarsh rush (*Juncus kraussi*), and swampweed (*Selliera radicans*) (Figure 4-9).

Subtidal habitats were not surveyed as part of the site inspection but are likely to be similar to that described at John Whitton Bridge.

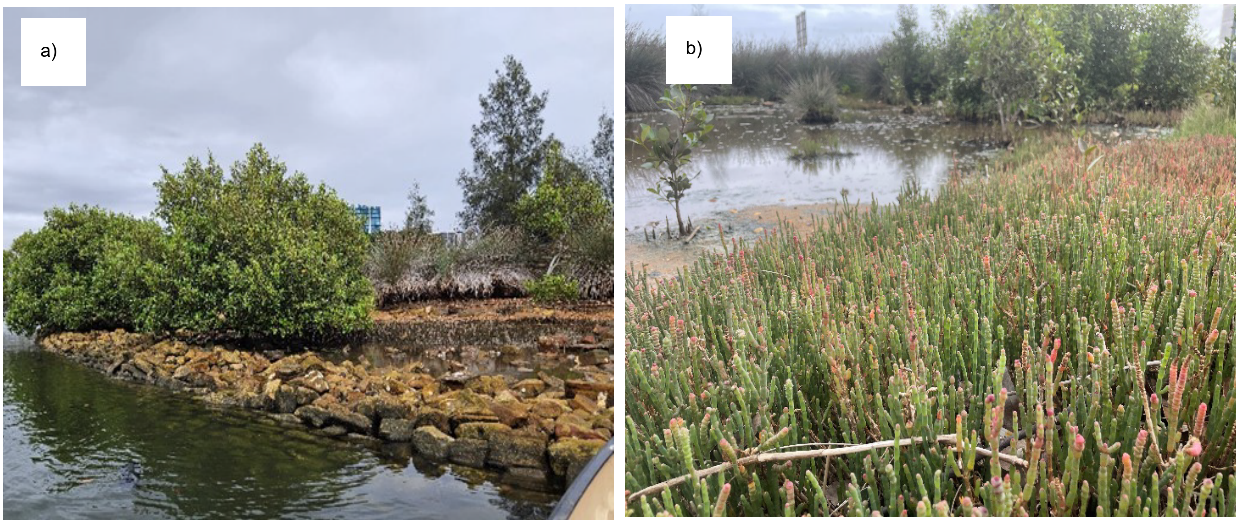

Figure 4-9 Representative foreshore habitat at Wentworth Point: a) Grey mangroves (Avicennia marina) and intertidal seawall b) Saltmarsh plants including (Sarcocornia quinqueflora)

4.2.3 Duck River

Duck River was accessed by canoe and surveyed on foot in January 2025. The survey area included a ~400 m stretch of Duck River and its banks in the southern part of the river either side of where the pipeline river crossing would be underbored across the River.

The habitat within the survey area was characterised by a 20 m wide channel and banks characterised by grey mangroves (Avicennia marina) both mature stands and saplings in the intertidal zone. The mangrove stand on the south-eastern banks was narrower (approx. 15 m) and was bordered by mostly exotic terrestrial plant species with a seawall separating the surrounding industrial lots from the river. The mangrove stand on the opposite north-western bank was wider (approx. 30 m) and transitioned into riparian and/or terrestrial plant species including Casuarina stands in the absence of a seawall or other structures. The mangrove stands in the survey area were dense and entirely intertidal, with pneumatophores and banks exposed at low tide (up to 0.5 m of bank exposed at low tide). An area of saltmarsh is indicated to occur in an area of the northern bank upstream of the crossing site as indicated from DPI mapping (see Figure 4-5). However, upon inspection this would not be considered a ‘true’ saltmarsh habitat as it was characterised by common native riparian vegetation such as Typha sp. and Juncus sp. (types of rushes), rather than typical saltmarsh species. Saltmarsh habitat is present along other parts of the river further downstream where species such as seablite (*Sueda australis*), samphire (*Sarcocornia quinqueflora*), New Zealand spinach (*Tetragonia tetragonioides*), saltwater couch (*Sporobolus virginicus*), saltmarsh rush (*Juncus kraussi*), and swampweed (*Selliera radicans*) species have previously been recorded by Stantec (in March 2024).

The study area was assigned an overall RCE score of 38, which is indicative of relatively good riparian health with the limiting factors being the external seawalls and infrastructure confining the width of the vegetation corridor. The fish habitat sensitivity score was moderately sensitive (Type 2) and the fish habitat classification Class 2 ‘moderate’ key fish habitat as it was a permanently flowing estuarine waterway providing habitat to fish species. Only two species of fish were observed – smooth toadfish (*Tetractenos glaber*) and sea mullet (*Mugil cephalus*), both of which were adults.

A feature of the study site was the existing stormwater drain located on the southern bank of Duck River. This would be used as a stormwater discharge point for the site and nearby sites. Representative photos of the Duck River survey area are shown in Figure 4-10.

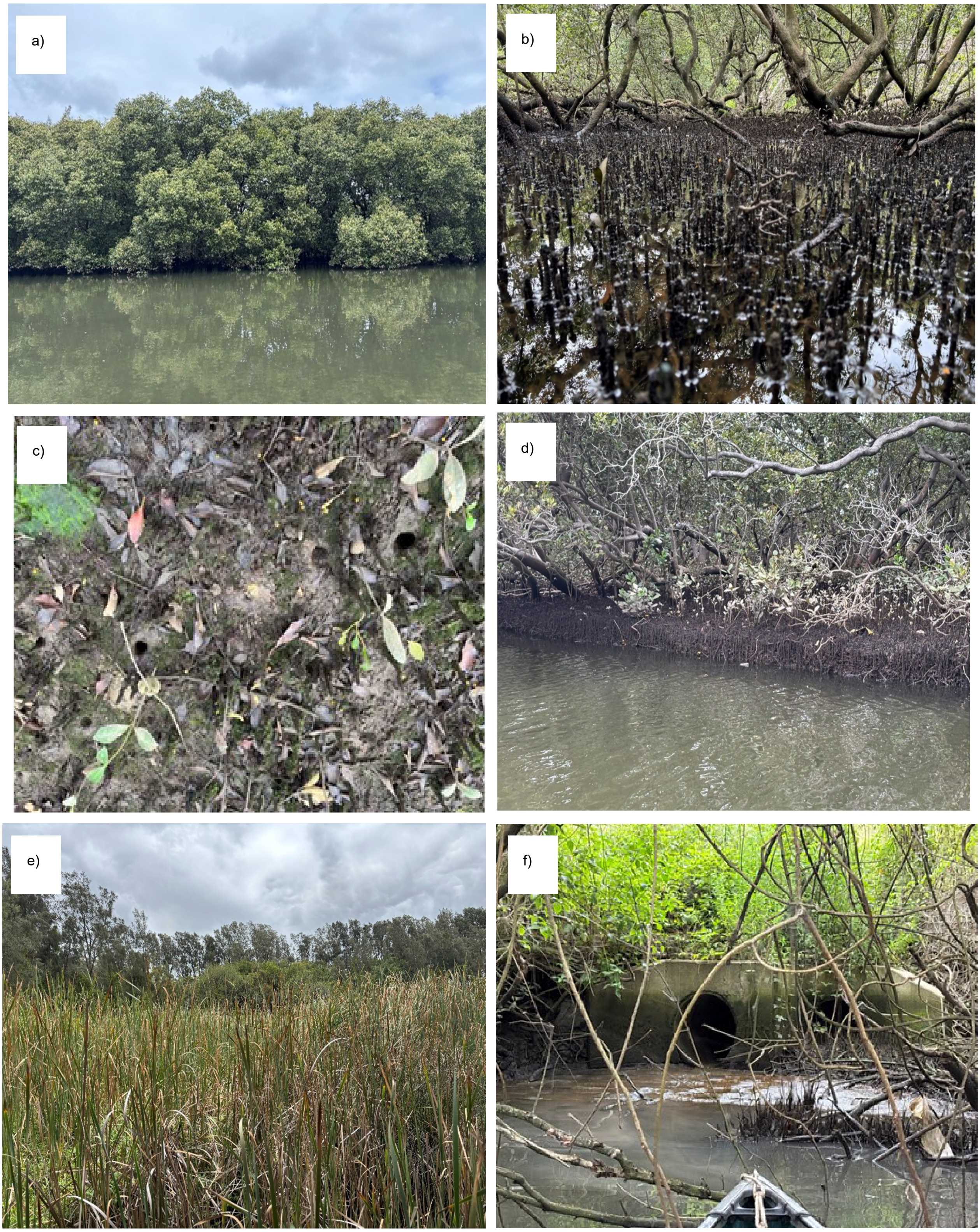

Figure 4-10 Representative photos of the Duck River survey area (January 2025); a-d) grey mangroves (Avicennia marina); e) native rushes, Typha and Juncus spp. Casuarina in background: f) existing storm water outlet on Duck River.

4.2.4 Vineyard Creek

The Vineyard Creek survey area was inspected on foot in March 2024 as part of a preliminary review and site inspection. The extent of the survey area included an approximate 750 m section of the creek and associated riparian areas. The southern boundary of this study site was located approximately 450 m upstream from the confluence with the Parramatta River.

There are no mangrove, saltmarsh or mudflats mapped within the Vineyard Creek survey area and none were recorded during the site inspection, however, coastal wetlands and coastal wetland buffer areas do occur further downstream and overlap with some proposed construction compounds.

The riparian vegetation within the Vineyard Creek survey area was predominately Plant Community Type (PCT) 3262- Sydney Turpentine Ironbark Forest, spanning approximately 2.18 ha across the survey area. This PCT is defined as a tall sclerophyll open forest dominated by turpentine (*Syncarpia glomulifera*) and a variety of gums predominantly found in isolated patches on shale or sheltered shale-sandstone soils in northern Sydney. The riparian habitat changes along the stretch of Vineyard Creek with the better-quality riparian habitat observed in the northern extent of the survey area. The southern half on the western side of the creek is open tall sclerophyll forest, with the eastern side characterised by a mixture of planted native and exotic species (Figure 4-11). For the most part, the Vineyard Creek survey area had good riparian health with an RCE score of 33. The fish habitat sensitivity was recorded as Type 3 (minimally sensitive fish habitat) and the waterway classification as Class 3 fish habitat, providing some areas for breeding and feeding of aquatic fauna. On assessment of the site during the site investigation, the site had slow flows and the species of fish observed was the pest freshwater fish species, mosquitofish (*Gambusia holbrooki*).

Figure 4-11 Vineyard Creek: a) mouth of Vineyard Creek mature and seedling mangroves near confluence; b – c) upstream Vineyard Creek riparian habitat and d) modified revetment wall upstream

5 Assessment of Impacts

A detailed Project Description is outlined in Section 2. Section 2.3 also identifies the construction and operational activities and phases of the Project that have potential to impact both directly and / or indirectly on the aquatic and riparian receiving environment throughout the Impact Assessment Area. The specific Project activities, impact pathways and receptors potentially affected are identified and discussed in the following sections.

5.1 Construction Related Impacts

5.1.1 Direct Habitat Loss / Disturbance

Several activities have potential to result in direct loss / disturbance of aquatic or riparian habitat (including KFH) if implementation is not appropriately managed including:

- open trenching of pipeline alignments (from HDD pit at Meadowbank Park to the release point at John Whitton Bridge)
- excavation of riverbank for release pipeline connection and placement of diffuser heads into the Parramatta River (Meadowbank, near John Whitton Bridge)
- placement of a concrete mattress, pipeline and release diffuser on the riverbed
- temporary construction of a coffer dam to connect the underground end of the pipelines to the sections of pipe on the riverbed

Other activities may also require excavation such as the digging of pipeline launch and retrieval pits for HDD and re-lining of existing pipelines. These pits would not, however, be located in areas that would directly result in loss or disturbance to aquatic or riparian land and will mostly be located within designated construction compounds. Similarly, construction compounds would only be located on areas that have already been cleared (e.g. fields) or on existing hardstand areas (e.g. car parks) to prevent direct loss or disturbance of sensitive habitat.

The section of open trenched pipeline from the HDD pit at Meadowbank Park to the proposed barometric loop will transverse waterways (Charity Creek and one unnamed creek). These creeks were not inspected as part of the ABIA field surveys, however, aerial imagery (Nearmap January 2025), indicates these waterways are highly modified, concrete lined, drainage channels at the point where they would be transected by the river release pipeline. The mouth of both channels culminates in a culvert structure overpassed by the public walkway before draining into a large stand of mangroves west of the release point. Their upstream extents are limited to around 500 m where they meet Constitution Road West. These channels are not mapped as KFH and based on imagery alone would be considered Class 3 waterways (i.e. have minimal potential for fish habitat). It is only because of their connection with wetlands or other Class 1-3 fish habitat (i.e. Parramatta River) that they would be considered Class 3 habitat. It should still, however, be ensured that any construction works in the vicinity of these waterways do not temporarily obstruct fish passage.

As described in Section 2.3, construction at the Meadowbank release site (near John Whitton Bridge) will involve works within the Parramatta River which is a KFH. Activities will involve open trenching of the river release pipeline and alignment for the set of high-density polyethylene (HDPE) pipeline group which will be laid over a concrete mattress that will sit directly onto the riverbed. A small section of riverbank immediately west of John Whitton Bridge and the existing car park area will need to be excavated to allow for open pipeline trenching and placement of the diffuser heads onto the riverbed (Figure 2-2). This section of riverbank consists of an artificial sandstone seawall characterised by an assemblage of intertidal invertebrates that are commonly found on both natural and artificial intertidal hard surfaces throughout the Parramatta River and Sydney Harbour. However, results of the site inspection indicated this assemblage was relatively poor in species diversity compared to other representative habitats within the estuary. The loss of this relatively small section of artificial seawall would not therefore represent any notable loss of important or unique intertidal habitat. Once completed, the site will be rehabilitated and landscaped. It is expected that a similar artificial seawall and scour protection would be constructed which would provide similar artificial habitat for colonisation of intertidal invertebrates. This could be further enhanced by the use of more complex sandstone block arrangements and riparian planting to improve habitat heterogeneity and encourage a more diverse invertebrate assemblage and riparian habitat.

Placement of the pipeline set, concrete mattress and coffer dam construction will result in the direct loss of riverbed including an area approximately 17 m in width and extending out to the third pier of the bridge. It is noted that this direct loss is not in coastal wetland area and there will be no marine vegetation disturbance. The underlying sediment that would be impacted consists primarily of silt with small proportions of sand and clay. These sediments will likely be characterised by a typical (if relatively depauperate), assemblage of infaunal invertebrates commonly associated with fine sediments elsewhere in the Parramatta River and Sydney Harbour. These habitats are characterised by high numbers of disturbance tolerant polychaete and oligochaete worms, other wormlike taxa (such as nematodes) and potentially some taxa of mollusc and crustacean. Given the elevated concentrations of several metals and dioxins recorded in the surficial sediments in the vicinity of the proposed release area, it would be expected that the existing infaunal assemblage is impaired in terms of diversity and health. The loss of this soft sediment habitat would not, therefore represent any loss of important habitat or food source for fish or other aquatic fauna dependent on infaunal invertebrates (or microbiota) further up the food chain. Construction of the coffer dam may also result in changes to flow velocities and hydrodynamics around the structure, potentially increasing scouring and sediment disturbance outside of the coffer dam.

Preparation, placement and connection of the concrete mattress pipeline and diffusers (including coffer dam construction) and any rehabilitation could take up to six months, however, the majority of work within the waterway will likely be completed over several weekends (Friday am to Monday am). Riverbank and instream works are not anticipated to result in any obstruction to fish passage up or downstream of the Parramatta River at any time during construction of the release structures as works will only take place within a small section of the river at any one time. Furthermore, the release structure will only span across half of the river channel.

5.1.2 Indirect Impacts to Aquatic Habitats

Construction activities that could indirectly affect aquatic habitats (including KFH) and biota include those requiring excavation and earthworks and the use of heavy plant and machinery. This potentially includes the following activities:

- establishment of construction compounds and other ancillary infrastructure
- excavation of pipeline launch and retrieval pits for HDD where these occur upstream of any watercourses

- open trenching of pipeline alignments (from HDD pit at Meadowbank Park to the release point near John Whitton Bridge)
- placement of a concrete mattress, pipeline and release diffuser on the riverbed.

The main impact pathway associated with these activities by which aquatic habitats and biota could be affected is through the exposure and mobilisation of soils and sediments.

Predominantly land based activities that require excavation such as the establishment of construction compounds; the upgrade of the Camellia-Rosehill WRRF and open pipeline trenching / pits, have potential to disturb and expose soils. Following rain or surface run-off, exposed soils can be mobilised and transported downstream into adjacent drainage lines and creeks, potentially entering into larger waterways including Parramatta River, Duck River, Vineyard Creek (all KFH) and areas of wetlands within Sydney Olympic Park. This may lead to impaired water quality, particularly temporary increases in turbidity and deposition of sediments within watercourses. As discussed in Section 4.1.3 elevated turbidity can significantly reduce biodiversity by decreasing light penetration, hindering plant growth, and impacting animal habitats and feeding behaviours. This can also increase nutrient loads, cause changes in pH, decrease DO and lead to smothering of instream habitats and sessile biota.

These risks can, however, be managed through standard sediment and erosion control measures e.g. as per guidance outlined in Managing Urban Stormwater, Soils and Construction Volume 1, 4th Edition (Landcom, 2004). This may include requirements to install sedimentation basins in locations where watercourses are located directly adjacent to, or downstream of any earthworks. A Soil and Water Management Plan (SWMP) may also be developed as part of the Project Construction Management Plan (CEMP) which would include plans to divert surface runoff away from disturbed soil and stockpiles, installation of sediment and erosion controls prior to construction and measures to prepare for and deal with heavy rainfall conditions when predicted.

Instream construction works also have potential to disturb and mobilise fine muddy sediments by placement of the concrete mattress / pipeline set onto the riverbed. This activity is unlikely to mobilise large volumes of sediments but will cause a short-term increase in turbidity and suspended sediment loads. The impact of this will be dependent on the tidal reach and volume of freshwater input at the time of construction but is likely to be within the level of natural variation (in terms of turbidity and suspended sediments). Sediment-laden water will mostly be diluted and flushed downstream with any localised deposition e.g. affecting mangroves or saltmarsh within the area of impact, would be unlikely to cause any detectable effects. Sediment curtains may be deployed to further minimise any risks of turbidity and sedimentation affecting areas outside the pipeline and diffuser footprint. Construction of a coffer dam at the riverbank pipeline connection point will mitigate any risks of sediment mobilisation from disturbance of the sandstone seawall and seabed at that location.

5.1.3 Mobilisation of Contaminants

Construction phase activities that could result in the mobilisation of contaminants into watercourses include:

- land-based activities requiring excavation and exposure of potentially contaminated soils and ASS
- temporary construction of an in-stream coffer dam in Parramatta River leading to exposure of ASS and other contaminants
- disturbance of the riverbed from placement of the concrete mattress leading to mobilisation of contaminants

- potential for spills and contamination from fuels, lubricants and drilling fluids from heavy plant, machinery and work barges.

The potential for contamination from groundwater inflow during excavations and / or risk of aquifer contamination from soils surrounding excavations is discussed in the Ground Water Impact Assessment report (Jacobs, 2025).

Land-based excavation activities have potential to mobilise exposed soils, potentially impacting on water quality and downstream aquatic habitats. In addition to the indirect risks identified in Section 5.1.2, these soils also have potential to contain legacy contaminants. The risk of these contaminants becoming mobilised on land and subsequently entering water courses can be effectively managed through appropriate erosion and sedimentation controls (as identified in Section 5.1.2) and development of a Construction Contamination Management Plan (CCMP) to be incorporated into the CEMP. As identified in Section 4.1.4.5 there are several locations within the impact assessment area that also have a high probability of containing ASS. Areas to be excavated on land with known ASS should be carefully identified according to mapping and managed in accordance with the Acid Sulfate Soils Management Advisory Committee: Acid Sulfate Soils Assessment Guidelines (ASSMAC, 1998) and an Acid Sulfate Soils Management Plan (ASSMP). This should specifically include measures to prevent ASS from oxidising and entering watercourses and / or outlining measures to treat and appropriately dispose of any ASS before it can be oxidized and become a contamination risk.

Exposure of ASS and other legacy contaminants is also likely within the in-stream coffer dam that will be constructed around the sandstone seawall at the river pipeline connection point. Although these sediments will be contained within the coffer dam, the risk of acid formation is high as sediment will be exposed to air. Site specific controls within the Project ASSMP will therefore be required to ensure these sediments and water coming in contact with the sediments (potentially containing sulphuric acid), does not enter the river. Options for further testing and subsequent treatment, removal or remediation of sediments prior to the coffer dam being removed therefore need to be outlined in the ASSMP. Similarly, as identified in Section 4.1.4. disturbed sediments within the coffer dam are likely to contain legacy contaminants (such as elevated concentrations of zinc, copper, lead and arsenic as well as dioxins). Although site specific sediment quality testing has not been undertaken in the direct footprint of the coffer dam, it can be assumed that any disturbed or excavated sediments will likely contain such contaminants. Disturbed sediments within the coffer dam will therefore require appropriate management, remediation and / or disposal as part of the CCMP and in accordance with NSW Environment Protection Authority (EPA) Waste Classification Guidelines.

The construction method has been designed to minimise sediment disturbance and mobilisation. This includes the type of barges (spud) to avoid the need for normal anchoring if possible

It is assumed that some sediment disturbance will occur when the concrete mattress is positioned on the riverbed. The concrete mattress will first be laid directly on top of riverbed, which the pipelines will then be placed on top of. The aim of this is to minimise any potential sediment disturbance. A second concrete mattress will then be placed over the top of the pipeline set to secure it in place and minimise erosion during operation to create a protective layer. This process has potential to disturb and mobilise sediments containing metals (zinc, copper, lead and arsenic) and dioxins, all of which were identified in sediment quality testing to occur in surficial sediments within the impact area (see Section 4.1.4). If mobilised into the water column these contaminants may become temporarily bioavailable and be taken up by aquatic biota with potentially toxic effects as described in Sections 4.1.4.2 and 4.1.4.4. Sediment containment measures such as silt curtains (or turbidity barriers) should therefore be considered as detailed design progresses, if possible, to minimise the transport and deposition of potentially contaminated sediments outside of the pipeline construction footprint. The type of silt curtain and anchoring method should aim to prevent further disturbance of the riverbed and will depend on the current velocity and tidal movements. This method is likely to contain a large proportion of any contaminants potentially mobilised during the pipeline laying process. Scheduling pipeline construction works and deployment of sediment containment devices outside of high velocity flow events and large tidal movements will further help contain potentially contaminated sediments.

The use of heavy plant and equipment on land and work barges / cranes during water-based construction activity introduces the risk of direct and indirect contamination via hydrocarbon fuels, lubricants, oils, drilling fluids and other chemicals via spills or leaks. Releases of these types of products can affect estuarine biota via several pathways including direct toxicity, smothering and physical fouling and / or indirect long-term or chronic impacts on behaviour or physiology. Several standard controls would, however, be in place that will likely be effective in either minimising the likelihood of potential spills and leaks occurring and /or ensuing appropriated preparedness in the unlikely event of an incident occurring. This includes the use of reputable contractors (i.e. with demonstrated regular maintenance and testing of plant, equipment and work barges / cranes), ensuring that re-fuelling and maintenance activities take place in compounds or designated areas away from waterways and drainage lines and that spill kits appropriate to the scale and nature of activities being undertaken are available on land and on work barges. An incident management plan should be developed that includes procedures and processes to respond to spills.

5.1.4 Geomorphic and Groundwater Impacts

Drawdown of groundwater due to dewatering of excavations (i.e. shafts and trenches) is the main pathway via which waterways and groundwater dependent ecosystems (GDE's) such as mangroves and saltmarsh could be affected during the construction phase. As these habitats rely on a stable subsurface water supply to maintain soil moisture, salinity balance, and vegetation health, changes to groundwater supply could have implications for the long-term health and condition of these habitats.

However, according to Jacobs (2025), estimated drawdown does not extend to any areas mapped as either potential GDE's or High Ecological Value Aquatic Ecosystems (HEVAE). The magnitude and extent of drawdown from Project excavations is anticipated to be limited and temporary, with no impacts to GDEs or HEVAEs anticipated from excavation dewatering. Furthermore, the estimated drawdown extent induced by construction dewatering at Project shafts and trenches does not extend to any identified waterways (Jacobs, 2025).

5.1.5 Vessel Movements and Operation

Excavation of the riverbank (including construction of a coffer dam) and instream works to place the pipeline set and concrete mattress into the Parramatta River will require the use of work barges and construction vessels. These water-based construction activities will result in a temporary increase in vessel and barge movements particularly in the initial stages of pipeline laying, placement and connection. Potential impact pathways that could affect the aquatic environment include:

- Direct disturbance to the riverbed from anchoring or scouring from propeller thrust and wash
- Underwater noise
- Introduction or spread of marine pests.

These potential impacts are further discussed below.

Direct disturbance to the riverbed from anchoring or scouring from propeller thrust and wash

The level of direct disturbance to the riverbed will be dependent on several factors including: number of vessels, vessel draft and engine thrust/power of the work vessels being contracted. Particularly at low tide, vessel wash and propeller thrust could stir up bottom sediments resulting in mobilisation of contaminants (see Section 5.1.3) or displacement of benthic and epibenthic flora and fauna. Anchoring of construction barges may also displace epifauna and infauna and potentially sensitive mangroves or macroalgae if barges are anchored too closely to the shore.

The local sessile biota and adjacent mangroves will, however, be adapted to a frequent level of disturbance from constant vessel wash from marine traffic within this section of river. This includes constant ferry traffic from both the Sydney Olympic Park Ferry Terminal and the adjacent Meadowbank Ferry Terminal. These risks are therefore considered to be minimal and can be controlled through the provision of designated anchoring zones and also ‘no go’ zones around mangroves. These should be specified as part of the CEMP. The contracted work barges should be shallow draft and minimise the use of high-powered thrusters where this is feasible to further reduce the risk of sediment disturbance. Jack-up ‘spud’ barges would also be used where possible to minimise riverbed disturbance from anchoring and anchor dragging.

Underwater noise

Water based construction activities are not anticipated to produce intense, high impact sounds (such as those associated with pile driving) but will likely produce low to mid-frequency sound that propagates through the water column such as engine vibration and sediment excavation (e.g. Reine et al. 2014). Intense high-impact sounds will be produced during excavation of the riverbank for the release pipeline connection, but this will be contained within a dry coffer dam, so sound will not propagate directly through the water column. The underwater noise produced would not be expected to exceed the ambient levels of engine noise already experienced in the lower Parramatta River from marine traffic. The vessels operating within the waterside construction footprint will also be either stationary barges or operating at very slow speeds, hence the sound intensity would be relatively low. Given the short and temporary nature of the water-based construction activities, this is not expected to have any significant or long-term impacts on aquatic animals that are known to occur in this part of the river (and which would be sensitive to underwater noise because of their auditory physiology i.e. fish with swim bladders and potentially some invertebrates). At worst, any impacts on such species in the vicinity of construction work would be temporary behavioural changes only, such as avoidance of the area and temporary displacement.

Introduction or spread of marine pests

Under the Biosecurity Act 2015, biosecurity is a shared responsibility between government, industry, and communities. Aquatic construction projects and maintenance works have the potential to introduce and / or spread marine pests and diseases into the lower Parramatta River via work vessels, barges or equipment which can provide an attachment surface for live animals or fragments and act as vectors. As identified in Section 4.1.7. several types of marine pests occur across NSW estuaries including some that are already present in Sydney Harbour. The green alga Caulerpa is a particular risk as it already occurs in parts of Sydney Harbour and could be spread to the lower Parramatta Estuary.

Standard mitigation controls can effectively minimise the risks of vegetative fragments and live pests being introduced or spread into the lower Parramatta River. This includes understanding what the last port or estuary was that work barges have come from (and the known species associated with those locations in regard to potential risks) as well as thorough cleaning and wash down prior to accessing and departing the Project area and following Australian ballast water management standards (for larger vessels).

5.1.6 Impacts on Recreational Fishing Amenity

Fishing is a popular recreational activity in the lower Parramatta River, in particular at ferry wharves e.g. Sydney Olympic Park Ferry Wharf and potentially the Meadowbank Ferry Wharf as well as some rock ledges e.g. at Wentworth Point and John Whitton Reserve. Fishing is forbidden near the John Whitton Bridge/Sydney Olympic Park, but some fishing still occurs there, and it is also discouraged due to high levels of dioxins in fish tissue (see Section 4.1.4). Construction works, vessel traffic and general disturbance to the area may reduce the quality of the recreational fishing experience or limit accessibility in the immediate area, although such impacts are likely to be comparable to those currently caused by commercial ferry and public vessel movements.

Given the short-term and temporary nature of the water-based works (likely to be over two or three weekend periods), this is not considered to cause any substantial disruption to recreational fishing amenity. The high mobility of targeted species and associated ability to avoid disturbances, means they will temporarily seek out alternative habitat. Appropriate on-site signage and communication of the Project works and timeframes would be recommended to ensure that local recreational fishers are kept informed and have a mechanism in place to report any issues if encountered.

5.1.7 Impacts on Threatened and Protected Species, Populations and Communities

Six species of waterbirds and shorebirds were considered to have a ‘high’ likelihood of occurrence within the impact areas due to recent records within or in the vicinity of the impact areas. Nine species (also waterbirds and shorebirds) were considered to have a ‘moderate’ likelihood of occurrence in the impact areas due to presence of potentially suitable habitat and records of occurrence in the vicinity (see Section 4.1.8). Several of these waterbird species (or those associated with aquatic habitat) have also been identified in the BDAR (Arcadis, 2025).

Despite their being recent records and potentially suitable habitat within the impact areas for foraging, resting and roosting (such as soft sediments foreshores, mangroves, open water and creeks), none of these locations would be considered highly important, unique or in supporting resident populations of threatened avifauna. Many individuals would be transient visitors or opportunistically foraging only. Impact areas are therefore not considered to provide unique or important habitat for these species. In the event that a threatened species of waterbird or shorebird did occur within the relatively small impact areas at the time of construction, the likely scenario would be that the individual is temporarily deterred by the noise and disturbance and seeks alternative similar habitat nearby. As such, no assessments of significance were undertaken for these species as part of the ABIA. Due to potential for land-based disturbance, assessments of significance for some of these species have been undertaken as part of the BDAR (Arcadis, 2025).

No species of threatened or protected species of fish, marine mammals or reptiles were identified as being likely to occur within or in the vicinity of the impact assessment area. If any of these species’ groups were to occur, it would be considered a rare or transitory event only.

A review of the PMST indicated one relevant TEC (subtropical and temperate coastal saltmarsh) which is listed under the EPBC Act as predicted to occur within the study locality. In the Sydney Basin this TEC is known to be associated with a number of saline tolerant and succulent vegetation formations and classes including samphire (*Sarcocornia quinqueflora*), seablite (*Sporobulous virginicus),* saltmarsh rush (*Juncus kraussi)* and reeds (*Phragmites australis*). The presence of saltmarsh was confirmed during field investigations at the Duck River and Wentworth Point survey areas. Small patches of saltmarsh were also mapped approximately 200 m west of where the river release pipeline crosses the Parramatta River. These areas of saltmarsh would not, however, be directly located within any of the Project impact areas.

Providing that appropriate mitigation and management controls are implemented to limit risks associated with habitat loss / disturbance and contamination of water quality, then no significant impacts to threatened species, populations, aquatic TEC's (saltmarsh), or critical habitat would be expected during the construction phase. Measures to minimise the levels of artificial lighting at night and standard airborne noise management safeguards (during daylight working hours), would further mitigate potential disturbance to sensitive avifauna potentially present in the vicinity of construction works. That considered, no significant impacts are anticipated such that referrals under the EPBC Act, BC and/or FM Act are considered necessary for any aquatic species reviewed in this assessment.

5.1.8 Impacts to Protected and Sensitive Lands

As indicated in Section 4.1.10 there are no National Parks, Nature Reserves, State Conservation Areas, Critical Habitats, Marine Parks or Aquatic Reserves (as declared under the NPW Act or Marine Estate Management Act) that would be directly affected by Project activities.

High biodiversity value land and KFH does, however, overlap with the Project impact areas in three locations. These areas are mainly associated with mapped mangrove assemblages which are protected under the FM Act and considered sensitive habitats under the Marine Estate Management Strategies. These areas are also designated SEPP coastal wetlands.

These include the section of proposed brine pipeline that extends from Victoria Road (near Vineyard Creek) adjacent to the railway line and Railway Street south to the Parramatta River rail crossing which transects the designated SEPP Coastal Wetland buffer but would not directly impact on any SEPP Coastal Wetland. It is expected that an existing pipeline alignment and overbridge crossings would be repurposed to minimise the need for additional disturbance along this section of the pipeline alignment (refer to Figure 4-6).

The river release pipeline would also transect an area of SEPP coastal wetland and SEPP coastal wetland buffer that fringes either side of Duck River, however, it is understood that this section of pipeline would be underbored and therefore not directly affect any designated SEPP wetland.

The section of river release pipeline that extends through Meadowbank to the release point near John Whitton Bridge will also largely avoid the designated SEPP wetland and associated buffer area. The location where the open trenching would reach the riverbank is also not part of a designated SEPP or buffer area but would result in the disturbance of a channel/bed of a river / estuary and land within 40 m of the highest bank (as defined by the Water Management Act 2000).

In summary, any sections of pipeline that transect SEPP coastal wetlands, SEPP coastal wetland buffers / mangroves or high biodiversity value land will generally be underbored and will therefore not directly disturb sensitive habitats. The only exception to this is the open trenching required at the foreshore of the river release pipeline and coffer dam near John Whitton Bridge.

5.1.9 Key Threatening Processes (KTPs)

Key Threatening Processes (KTPs) are listed under the BC Act, FM Act and the EPBC Act. A threatening process is generally defined as a key threatening process if it threatens or may threaten the survival, abundance or evolutionary development of a native species, population or ecological community or could cause species, populations or ecological communities that are not threatened to become threatened.

KTPs with the potential to be caused or exacerbated by the Project include:

1. Degradation of native riparian vegetation along New South Wales water courses (FM Act)
2. Removal of large woody debris from New South Wales rivers and streams (FM Act)
3. Introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales (FM Act)
4. Novel biota and their impact on biodiversity (EPBC Act)

KTPs 1 and 2 would be mitigated via the controls outlined to address direct and indirect habitat loss and to ensure that water quality is maintained. In addition, it should be ensured that any large, wooded debris encountered during construction of the coffer dam or water-based construction is managed according to DPIRD (fisheries) best practice (see Section 5.3). KTPs 3 and 4 would also be effectively managed via the controls outlined to manage IMPs (Section 5.3). In conclusion, Project construction is not expected to exacerbate or cause any listed KTPs as relevant to aquatic biodiversity.

5.2 Operational Impacts

5.2.1 Alteration of Existing Habitat

Once in operation, the pathways via which existing aquatic habitat may be permanently altered include:

- Physical presence of new infrastructure (pipeline set, concrete mattress, diffusers) and associated scour protection
- Changes to hydrodynamic flows around the physical structures – indirectly leading to scouring or sediment deposition.

The construction and placement of the release pipeline, concrete mattress and diffuser on the riverbed at John Whitton Bridge will replace previously fine soft sediment with a hard complex structure. This will create a novel attachment surface suited to a different assemblage of aquatic biota. Rather than burrowing (infaunal) organisms such as polychaete worms, crustaceans (amphipods, isopods and crabs), molluscs and other wormlike animals, it will provide a surface more suited to encrusting sessile biota similar to that found on nearby artificial surfaces (e.g. seawalls, wharves and pilings). This could include for example, oysters, barnacles and encrusting algae. Over time macroalgae and larger mobile invertebrates may establish depending on whether the conditions are suitable. In many instances pipelines and other artificial structures increase habitat complexity, which attracts small fish and invertebrates, sometimes acting as a 'reef-like' feature. Existing currents may, however, preclude the settlement and establishment of new biota and it is possible there would be a small net loss of habitat within the footprint of the concrete mattress and diffuser structure.

The pipeline and diffuser structure is not expected to present any physical barrier to fish passage as it will extend out to the third bridge pier from the shore of John Whitton Bridge and will not extend vertically. Results of computational flow dynamic (CFD) modelling (based on the relative change in river flows with the diffuser operating at 63 ML/d, 0.73 m^3/s) indicate the most pronounced changes (during slack tide (50 percentile) flow conditions) would be up to 10 percent change, representing a 1.0 m^3/s increase in velocity at 100 m and 200 m downstream of the diffuser. This would be negligible relative to the magnitude of flows that are currently generated across the tidal cycle and in frequent rain events. Dominant mid-channel velocities upstream of the river release will reduce by up to 5 percent, while velocities downstream are predicted to increase by a similar percentage. This represents a decrease in upstream velocities from approximately 0.125 m/s to 0.120 m/s and increase in downstream mid-channel median velocity from 0.125 m/s to 0.130 m/s (0.005 m/s change in each case) (Aurecon, 2025).

Within the near field mixing zone (extending 135 m upstream and 185 m downstream of the diffuser nozzles) the greatest modelled nearbed velocity would be 0.152 m/s (95 percentile flood and ebb conditions). Higher velocities are expected within 50 m of the diffuser. Considering that most adult fish would be able to navigate velocities in excess of 0.3 m/s (Cramp et al. 2021) it is not expected that the diffuser could present a ‘flow’ barrier to fish movement over or around the structure.

5.2.2 Mobilisation of Contaminants

As identified in Section 4.1.4, surface sediments in the vicinity of the release pipeline and riverbed diffuser are likely to contain elevated levels of legacy contaminants including metals (zinc, copper, lead and arsenic) and dioxins. CFD modelling was therefore used to assess how changes in flow velocity could affect scouring, sediment mobilisation and transport around the diffuser (Aurecon, 2025) and the subsequent toxicity risk to aquatic biodiversity within the impact assessment area.

Results indicated that it would be unlikely that the river release of 63 ML/d or 70 ML/d would contribute to any detectable increase in the sediment transport regime of the river outside of the near field mixing zone immediately up and downstream of the nozzles (Aurecon, 2025). Highly localised effects on sessile aquatic biota could therefore be expected, but these effects are unlikely to be any more pronounced than the impacts on sedentary biota (and particularly infaunal biota), already associated with this area. As a precaution, it is recommended that Sydney Water continues to monitor contaminant levels and bioaccumulation risk in the initial operational phase of the Project as part of the existing monitoring program and that adaptive management actions are undertaken as required.

5.2.3 Changes to Water Quality

The Camellia-Rosehill WRRF is expected to operate at a constant rate and produce a constant stream of advanced treated water continuously over a 24-hour period. Interruptions to flow from the WRRF would typically only occur during unusual scenarios, for example, when the RO system was offline for unplanned maintenance. Release volumes and flow rates under these operational scenarios are indicated in Table 5-1 below.

Table 5-1 WRRF operational scenarios (Source: Sydney Water 2025a)

Release type	Flow (ML/d)	Flow (m^3/s)	Release volume (ML/y)	Operations
Reverse osmosis (RO) Advanced treated water	63	0.73	~ 22,743 (99% of annual volume)	**Normal operation**: Continuous river release, 24 hours per day, except when RO plant is offline.
Membrane bioreactor (MBR) Tertiary treated water	70	0.81	~280 (1% of annual volume)	**Offline events**: Constant discharge occurring during RO-offline events. Notionally has been represented as two 48-hour offline events per year, conservatively assumed to occur during consecutive dry months.

The impacts to water quality as a result of WRRF operation have been modelled and assessed by Sydney Water following the development, calibration and validation of a Water Quality Response Model (WQRM). The WQRM simulates the hydrodynamics and an extended suite of water quality processes within the receiving waters of the river. It was based on a comparison of background scenarios and future conditions representative of a 2056 time horizon and takes into account changes in population growth, wet weather inflows and effects of climate change. With respect to water quality, the main suite of parameters calibrated and assessed within the model included salinity, temperature, dissolved oxygen, suspended sediment, nutrients (including inorganic and organic fractions), primary productivity and pathogens.

The modelling has assumed the adoption of a treatment and release strategy specifically developed to reduce impacts on the Parramatta River, with consideration of the sensitivities and characteristics of the waterway. The adoption of the treatment and release strategy forms a key mitigation measure for the avoidance of environmental harm from the WRRF releases.

A toxicity and mixing zone analysis was also undertaken to predict impacts from the operation of the WRRF and assessed these against Project specific waterway objectives sourced from existing guidelines.

The methodology, assumptions, scenarios and detailed results of the WQRM and toxicity and mixing zone analysis are outlined in the Greater Parramatta and Olympic Peninsula Water Cycle Management - Hydrodynamics and Water Quality Impact Assessment (Sydney Water, 2025a).

The results of this assessment in terms of impacts to aquatic biodiversity from changes to the physico-chemical properties of the release water and the predicted levels of residual toxicants (as based on the results of the Hydrodynamics and Water Quality Impact Assessment) are discussed in the following sections.

5.2.3.1 Physico-Chemical Parameters

To understand the potential changes in key water quality parameters resulting from operation of the WRRF, different operational scenarios were compared against baseline conditions (circa 2024/25) and corresponding background conditions (circa 2056) as well as against the relevant waterway objectives (see Sydney Water, 2025b). The analysis allowed for an understanding of the cumulative impacts from future conditions (with and without the predicted influence of climate change) as well as residual impacts from just the WRRF releases.

To assist in interpretation of impacts to sensitive aquatic environments within the impact assessment area (such as mangroves, saltmarsh, intertidal and foreshore areas), modelled values for each parameter were reported at a set of representative locations (indicated in Figure 5-1) as well as at 100 m downstream from the diffusers. These included:

- Meadowbank Park, west of John Whitton Bridge (AQ2 – AQ4 sites adjacent to mangroves)
- Anderson Park, east of John Whitton Bridge (AQ5 adjacent to mangroves)
- Wentworth Point (AQ1 saltmarsh habitat)
- Morrisons Bay (AQ6 intertidal reef)

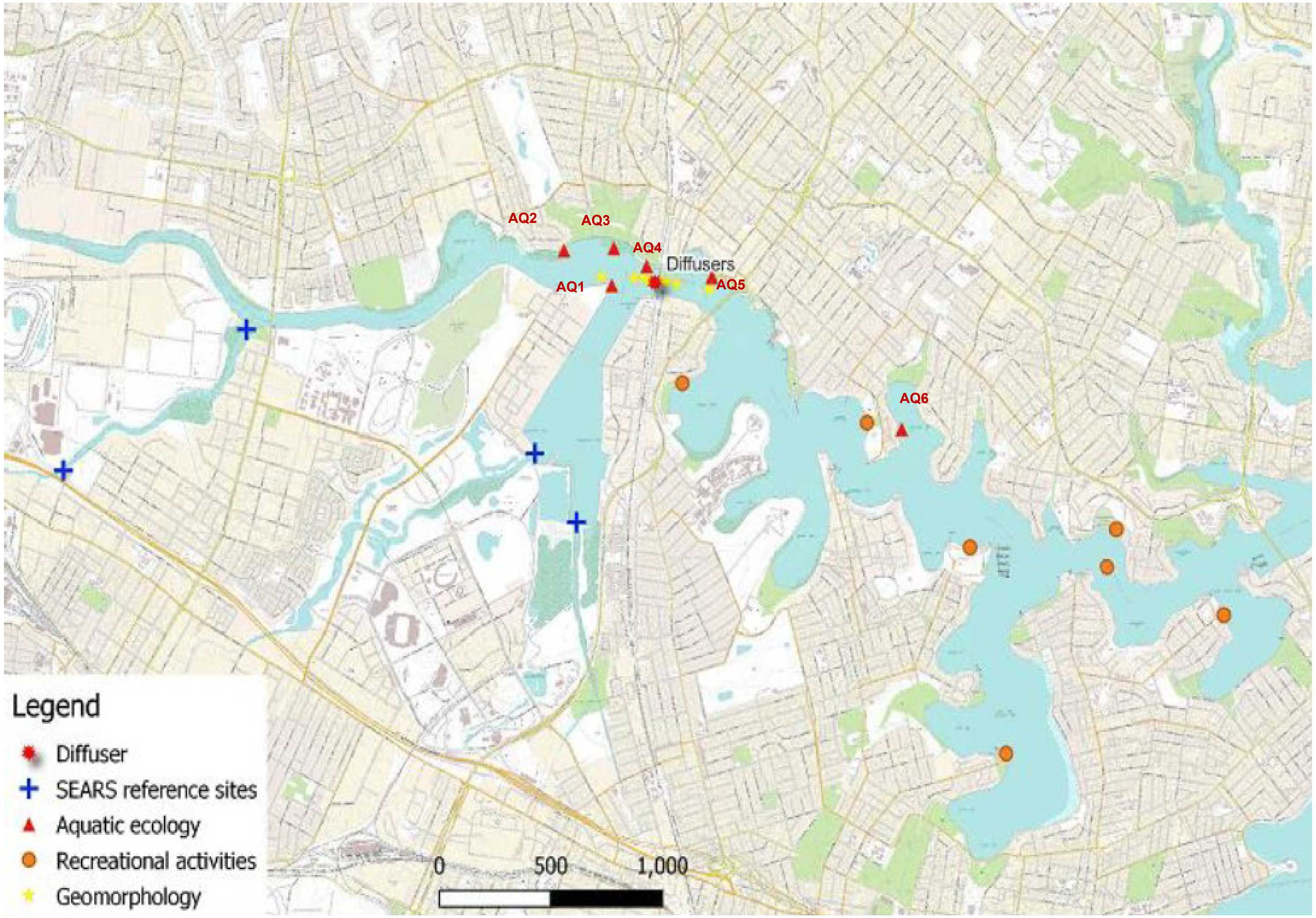

Figure 5-1 Aquatic biodiversity sites of interest

General Findings

The release of RO treated water was demonstrated in the WQRM to generally result in improvements in water quality in the immediate vicinity of the releases as well as further afield in the estuary. The modelling also demonstrated the potential for significant mixing and dilution within 30 m of the diffuser ports, prior to a transition to more ambient advection and dispersion processes.

With the exception of the more extreme and transient low tide, slack-water conditions, the proposed reference design is predicted to generate initial dilutions that exceed the minimum criteria stated in the Australian Guidelines for Effluent Management (NWQMS 1997) and reductions in the sewer overflows are predicted due to the operation of the Camellia-Rosehill WRRF. These reductions relate to both the volumes and contaminant loads released to the river.

Offline events have potential to negatively impact on water quality in the river due to temporary, elevated concentrations of nutrients and chlorophyll a during and subsequent to their cessation. Normal operation is also predicted to result in lower salinities and slight increases in surface water temperatures.

These results and their implications on aquatic biodiversity are further discussed below.

Total Suspended Solids

At all sites modelled (including aquatic biodiversity sites) results indicate a slight reduction in TSS from ambient conditions as a result of the WRRF operation with predicted annual median concentrations generally varying by less than 0.5 mg/L. This is therefore not considered to have any negative impact (more likely a positive impact) on sensitive aquatic receptors in the receiving environment.

Total Nitrogen and Phosphorus

Reductions in loads of total nitrogen and phosphorous of up to 14 percent were estimated under the average annual rainfall conditions. Similar results were presented for the higher rainfall year, reducing to between 5 percent and 10 percent under the lower rainfall conditions. Annual median concentrations at the aquatic ecology sites for an average rainfall year verify the predicted influence of the WRRF in reducing total nitrogen and total phosphorous levels in the estuary through low nutrient-content river releases as well as through mitigation of the wet weather overflows. For the average year, reductions in annual medians are predicted in the order of 0.02 to 0.04 mg/L (for nitrogen) and 0.005 mg/L (for phosphorus) depending on whether climate change is simulated. These reductions have potential for positive impacts on aquatic biodiversity by reducing the risk of excessive algal growth and associated effects from reduced DO.

Ammonia and Oxidised Nitrogen

While total nitrogen and phosphorus would be reduced in an average rainfall year, annual median ammonia and oxidized nitrogen concentrations are predicted to increase (albeit marginally) as a result of WRRF operation (including at all aquatic biodiversity sites). These increases are conservative and expected to be in the order of 0.001 mg/L (ammonia) up to 0.003 mg/L (oxidised nitrogen). The extent of these increases would also be co-dependent on factors such as temperature and pH (not specifically modelled). Due to the uncertainty in the modelling of these fractions it has been recommended that these parameters are monitored to evaluate any potential increases in the ambient waters.

Chlorophyll-a

Overall reductions in chlorophyll a were predicted across all the rainfall years simulated, thereby indicating a potential decrease in algal biomass within the estuary. The exception to this was during offline events when higher nutrient loads are introduced from the tertiary treated water. While relatively limited in magnitude (~0.5 µg/L), elevated levels may persist up to two months following these events (when modelled under conservative/worst case scenarios). If combined with other contributing factors such as elevated temperatures and increased nutrients, the risk of algal blooms could be exacerbated. Although these are likely to be rare events, water quality monitoring would assist in understanding the overall ambient conditions at the time of the release and associated risks and to guide appropriate mitigation or management actions if needed.

DO

Small improvements in annual median DO concentrations were predicted at the aquatic ecology sites as a result of the WRRF operation and up to 0.1 to 0.2 mg/L in the lower estuary in general. Although DO levels within the Parramatta River have generally been within the WQO range for protection of aquatic systems (80 – 110 percent saturation) e.g. Montoya (2015), small increases may have a positive impact on a wide range of native aquatic invertebrates, fish and macroalgae particularly in areas such as Silverwater and Duck River where concentrations of DO have been historically impaired.

Salinity

Modelling indicated a reduction in salinity within the estuary and at all aquatic biodiversity sites due to the influence of the low saline river releases during normal WRRF operation. In an extreme (lower rainfall) year, reductions of between 2.3 and 2.8 PSU are predicted at the sites in the vicinity of Meadowbank and Wentworth Point (AQ1 to AQ5), while a reduction of up to ~1.7 PSU is predicted at the more distant site in Morrisons Bay (AQ6). With respect to short term variations, the modelling indicates that maximum changes in salinity are generally in the order of 3 to 4 PSU at the sites closer to the river releases but with potential for up to 5 or 6 PSU under extended dry periods. At site AQ2 near mangroves at Meadowbank Park, the annual median change in salinity from background to operational (with climate change factored in) would be 26.8 PSU reduced to 25.2 PSU. These changes would be well within the tolerances of aquatic flora and fauna within the receiving environment and impact assessment area. For example, the grey mangrove (*Avicennia marina*) has shown optimal growth in a wide range of salinities from 5 – 35 PSU (e.g. Kodikara et al. 2017, Saenger 2002) and the saltmarsh plant *Sarcocornia quinqueflora* tolerates salinity from ~5 to >60 PSU (Ball and Pidsley, 1995; Adam 1990), and Saintilan, 2009). Many species of estuarine fish, invertebrates and macroalgae also have wide salinity tolerances, however, optimal growth or specific life stages may occur within a more limited range and depend on a combination of factors especially temperature. With that considered, long-term changes that persist in the order of 5 to 6 PSU could result in localised shifts in assemblage composition towards species better adapted for optimal growth under reduced salinities.

Salinity should therefore be monitored and reviewed regularly as part of the proposed ambient water quality monitoring program.

Temperature

Impacts on temperature were predicted to be relatively small. The greatest changes would be evident during the lower rainfall scenario but would still only be in the order of 0.1°C or less including consideration of climate change conditions. Peak, short term changes were generally in the order of

±0.5°C at aquatic biodiversity sites closer to the river releases (AQ1-5) and lower at the Morrisons Bay site (AQ6). As might be expected, more pronounced differences in temperature were predicted during the coolest and warmest months. Given the large seasonal range in surface temperature experienced in the lower estuary, these changes alone would be unlikely to have detectable effects on estuarine species composition, such that shifts in species ranges would occur. However, in combination with other factors such as reduced salinity and small nutrient inputs, conditions could become more favourable to a smaller group of tolerant species further reducing the local aquatic biodiversity. Non-native or pest species, including those already established within the lower harbour (e.g. *Caulerpa*) may also be encouraged to grow and potentially increase their range.

It is therefore recommended that surface temperature be monitored and reviewed as part of ambient water quality monitoring and that where feasible, any difference between the river releases and the receiving waters (particularly where releases are warmer than those in the river) are minimised.

Biological Indicators

Operation of the WRRF is predicted to have no contribution to enterococci load at all modelled locations including the aquatic biodiversity sites. If anything, reductions in enterococci of up to 10,000 cfu/100mL in wet weather were predicted at some sites in the lower estuary, due to reduction in frequency and volumes of overflows downstream of the treatment plant (as a result of the WRRF). The dilution effect of releasing advanced treated water, a net reduction in flows in NSOOS as well as non-project related source control works would also help mitigate the input of waterborne bacteria. These improvements would help reduce risks associated with the spread of pathogenic viruses in general that could affect fish and other aquatic organisms.

5.2.3.2 Residual Toxicants

As identified in the desktop review (Section 4.1.3), RO treatment of wastewater is highly effective at reducing the concentrations of contaminants such as trace metals and other organics and pharmaceuticals. Some residual compounds can, however, remain, depending on the quality of the incoming water and the efficiency of the RO system. These are only likely to present a risk to biodiversity if present in sufficiently high enough concentrations. Toxicity and mixing zone analysis was therefore carried out to understand the necessary dilution factors required to meet dilution requirements as determined by assumed maximum treated water concentrations, available background ambient concentration data and the relevant ANZG (2018) toxicant DGVs. Results are summarised as follows:

For RO treated water:

- Due to the relatively high background concentrations for aluminium and copper, the dilution requirements fall below zero
- With respect to total chlorine and cadmium, dilution factors of ~1.5 are required.

The dilution profiles predicted from the near field modelling indicate that these dilution requirements would be achieved in the immediate vicinity of the diffuser ports, even under the most conservative (slack tidal) conditions, the dilution requirements are predicted to be exceeded within the first metre of the diffuser ports.

For the tertiary treated water:

- For aluminium, copper, mercury and zinc, it is noted that median levels from the baseline monitoring indicate the toxicity DGVs are exceeded in background waters and no dilution is therefore required.
- For nitrate, total chlorine, cadmium, cobalt, iron and manganese, dilution requirements range up to a maximum factor of ~four.

Similar to the RO treated water analysis, dilution profiles predicted from the near field modelling indicate that the dilution requirements for tertiary treated water are achieved in close proximity (i.e. within a few metres) of the diffuser ports, even under the most conservative (slack tidal) conditions.

For aluminium, copper, mercury and zinc, background concentrations already exceed the toxicity DGVs, while treated water is predicted to contain higher than background concentrations. Overall, however, it is expected that improvements in water quality from the continuous release of RO treated water will potentially reduce the concentrations of these contaminants to below the relevant guideline values (Sydney Water, 2025a).

Provided that the recommended dilution factors are achieved at least within 2 m of the diffuser ports, impacts on aquatic biodiversity in the nearfield receiving environment from residual toxicants tested for are expected to be negligible.

5.2.4 Key Threatening Processes (KTPs)

Long term operation of the Project has the potential to exacerbate or cause the following KTPs:

1. Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams (FM Act)
2. Alteration to natural flow regimes (BC Act)

As discussed in Section 5.2.1 significant alteration of existing habitat either from the installation and operation of the pipeline and diffuser and / or changes in the flow regime are not considered to exacerbate or facilitate either of these KTPs.

5.3 Cumulative Impacts

Cumulative impacts have the potential to occur when impacts from a development overlap or interact with those of other developments (past, current and future), potentially resulting in a larger overall impact (positive or negative) on the environment or local communities.

The extent to which other current or future development or activity could interact with the construction and/or operation of the Project would depend on the location, scale, and/or timing of construction or operation. A screening assessment was undertaken by Sydney Water to identify projects that may contribute to potential cumulative impacts. Based on this screening, developments identified to have potential for cumulative impacts on aquatic biodiversity are identified in Table 5-2 below.

Table 5-2 Current and future developments potentially contributing to cumulative impacts

Project ID / Name	Status	Construction / operational timeframe	Relevance	Potential impacts to aquatic biodiversity
WSU Indigenous Centre of Excellence	Under assessment /response to submissions	Commence in Q1 2025 and completed and operational by 2026	Operational impacts expected to overlap with construction/operation of GPOP	• Removal of non-native trees • No impacts expected to threatened species or ecological communities • not expected to have adverse water quality impacts due to design incorporating WSUD including a constructed wetland
Meadowbank Bridge Remediation (John Whitton Bridge)	EIA in preparation	unknown	Overlaps with Project	• TBC
Duck River Nature Trail	Approved / stage 1 determined	Stage 1: Construction to begin March 2025. Operational in September 2025 Stage 2: Construction to begin in late 2025. Operational in mid 2026 Stage 3: Construction to begin in 2026. Operational in 2028	Overlaps with the Project	• Short-term construction noise impacts • No biodiversity impacts expected in Stage 1 • Potential for construction to affect waterways (Duck River) • Potential biodiversity issues associated with stages 2 and 3 TBC

Although the Projects listed do overlap both temporally and potentially spatially with the Project, based on the available information, the scale and nature of the impacts anticipated would not be expected to significantly impact upon aquatic biodiversity provided that standard controls to manage waterside construction works are observed (e.g. sediment containment and erosion controls).

6 Mitigation and Management

A summary of proposed measures to avoid, minimise, mitigate or manage potential impacts identified during the construction and operation of the Project are summarised in Table 6-1 below. Offsetting under the Policy and Guidelines for Fish Habitat Conservation and Management (NSW DPI, 2013) is not required given the project would not have significant impacts to aquatic biodiversity. There are also no direct or indirect impacts on SEPP coastal wetlands and no removal or disturbance of marine vegetation. These mitigation and management controls would be implemented either as part of a Project CEMP or as part of specific management and monitoring plans.

Table 6-1. Proposed mitigation and management controls

Construction Phase		
Potential Impact	**Mitigation and Management Controls**	**ID**
Direct Habitat Loss / Disturbance (including KFH)	• Rehabilitate disturbed banks and seawalls with appropriate landscaping and habitat features (e.g. complex sandstone, riparian planting). Consider further habitat enhancement by the use of complex sandstone block arrangements and riparian planting to improve habitat heterogeneity and fish habitat as per 'A Guide to Improving the Environmental Value of Seawalls and Seawall-lined Foreshores in Estuaries' (OEH 2012).	AE01
	• Prepare and implement a Soil and Water Management Plan (SWMP) as part of the CEMP. This should include plans to: o divert surface runoff away from disturbed soil and stockpiles. o install sediment and erosion controls prior to construction and measures to prepare for and deal with heavy rainfall conditions when predicted. o Keep materials, plant, equipment and stockpiles outside of tidal zone.	SW01
	• Install erosion and sediment controls in accordance with *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).	SW02
	• Ensure that contractors are aware of mapped TEC, mangroves and sensitive foreshore habitat and that it is not directly or indirectly disturbed during construction activities.	AE02
Indirect Impacts to Aquatic Habitats (including KFH)	• Consider deploying sediment retention devices (such as silt curtains) for in-stream works.	AE03
	• Prepare and implement a Soil and Water Management Plan (SWMP) as part of the CEMP. This should include plans to: o divert surface runoff away from disturbed soil and stockpiles. o install sediment and erosion controls prior to construction and measures to prepare for and deal with heavy rainfall conditions when predicted. o Keep materials, plant, equipment and stockpiles outside of tidal zone.	SW01
	• Ensure that contractors are aware of mapped TEC, mangroves and sensitive foreshore habitat and that it is not directly or indirectly disturbed during construction activities.	AE02
	• Install erosion and sediment controls in accordance with *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).	SW02

Construction Phase		
Potential Impact	**Mitigation and Management Controls**	**ID**
Mobilisation of Contaminants	• Consider deploying sediment retention devices (such as silt curtains) for in-stream works.	AE03
	• Manage acid sulfate soils in accordance with the Acid Sulfate Soils Management Advisory Committee: Acid Sulfate Soils Assessment Guidelines (ASSMAC, 1998). Prepare an Acid Sulfate Soils Management Plan (ASSMP).	SW03
	• Prepare a Waste and Resource Recovery Plan (WRRP) to appropriately manage and classify any excavated materials including soils, construction/demolition wastes and associated stockpiles.	WR01
	• Keep functioning spill kit on site for clean-up of accidental chemical/fuel spills and/or aquatic spill kit on site for clean-up of accidental chemical/fuel spills in mapped key fish habitat. Keep the spill kits stocked and located for easy access.	SW04
	• 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.	SW05
	• Maintain equipment in good working order to minimise the risk of leaks of failures.	SW06
	• Regular visual water quality checks (for hydrocarbon spills, turbid plumes and other water quality issues) should be carried out when working near any waterways.	SW07
Vessel Movements and Operation	• Vessel and marine pest management measures would be captured in the CEMP e.g. as part of a vessel management sub-plan and include the following: o Provision of designated anchoring zones and also ‘no go’ zones around mangroves. o Contracted work barges should be shallow draft and minimise the use of high-powered thrusters where this is feasible to reduce the risk of sediment disturbance. o All work vessels, barges and equipment used in water should be cleaned and inspected prior to arriving and departing from site. o Ballast water should be managed in accordance with the Australian Ballast Water Management Requirements o Undertake vessel risk assessments and invasive species inspections for all vessels as part of routine biofouling management practice. o If any marine pests are encountered during water-based construction activities, the area must be isolated and DPIRD Fisheries notified promptly.	AE04
Recreational Fishing Amenity	• Provide advance notice to community and recreational users of construction timing including: o Install clear temporary signage at affected foreshore areas.	AE05

Construction Phase		
Potential Impact	**Mitigation and Management Controls**	**ID**
	○ Maintain safe access where practicable. ○ Limit in-water works to short, defined periods where feasible.	
Threatened and Protected Species	• All controls listed to minimise direct and indirect habitat disturbance.	n/a
	• Direct artificial light away from sensitive receivers where possible (i.e. potential waterbird and shorebird habitat).	AE06
	• Incorporate standard daytime hours noise management safeguards into the CEMP.	N01
	• Ensure that contractors are aware of mapped TEC, mangroves and sensitive foreshore habitat and that it is not directly or indirectly disturbed during construction activities.	AE02
Protected and Sensitive Lands	• Any sections of pipeline that transect SEPP coastal wetlands, SEPP coastal wetland buffers / mangroves or high biodiversity value land will generally require underboring. The only exception to this is the open trenching required at the river release pipeline near John Whitton Bridge Foreshore (and subtidal pipeline placement).	n/a
	• Ensure that contractors are aware of mapped TEC, mangroves and sensitive foreshore habitat and that it is not directly or indirectly disturbed during construction activities.	AE02
	• All controls listed to minimise direct and indirect habitat disturbance.	n/a
	• Vessel and marine pest management measures would be captured in the CEMP e.g. as part of a vessel management sub-plan.	AE04
Key Threatening Processes	• All controls listed to minimise direct and indirect habitat disturbance.	n/a
	• Observe DPIRD (Fisheries) best practice management for instream large, wooded debris: ○ Lopping (trimming) should be considered as a first option. ○ Instream realignment should be considered as the next option ○ If realignment is unfeasible, relocation within the river channel is preferable to removal ○ Removal should be considered as a last resort.	AE07

Operational Phase		
Potential Impact	**Mitigation and Management Controls**	**ID**
Mobilisation of Contaminants	• It is recommended that Sydney Water continues to monitor contaminant levels and bioaccumulation risk in the initial operational phase of the Project as part of the existing monitoring program and that adaptive management actions are applied in response to monitoring results as required.	SW08
Changes to Water Quality	• **RO treated water**: Treated water should be monitored in the final release stream in line with the requirements of the EPL. The location, type and frequency of the monitoring program would be developed in consultation with the EPA.	SW09
	• **Ambient monitoring**: Monitoring in the Parramatta River should continue to allow for evaluation of impacts on the receiving waterway relative to background conditions. Analysis should include a suite of parameters considered appropriate to the release stream and the receiving environment including inorganic nutrient fractions (ammonia and oxidised nitrogen), chlorophyll a, salinity, temperature and other potential analytes of concern. •	SW10
	• **Offline events**: All precautions are taken to reduce the frequency of these incidents, particularly during extended low rainfall periods when flushing in the river is limited. •	SW11
	• All monitoring is to follow Sydney Water's standard sampling and laboratory procedures and also align with the Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (EPA 2022). •	SW12
	• Apply adaptive management in response to monitoring results as required.	SW13

7 Conclusions

This ABIA has identified a range of potential construction and operational impacts associated with the Project, including direct disturbance to aquatic and riparian habitats (including KFH), temporary mobilisation of sediments and contaminants, changes to water quality, and localised disturbance from vessel movements. While some works, such as open trenching, riverbank excavation and placement of pipelines and diffusers, will result in the permanent loss or alteration of existing habitats. These modified areas are small of generally low ecological value or will occur in already disturbed environments. Potential indirect impacts to waterways and aquatic biodiversity, including increased turbidity, mobilisation of contaminants, and risks associated with acid sulfate soils, can be effectively managed through standard construction safeguards (such as sediment containment), site-specific management plans, and targeted monitoring. There will be no impacts to SEPP coastal wetlands and no impacts to marine vegetation.

During operation, the presence of new infrastructure on the riverbed will alter the existing soft sediment habitat but is expected to increase habitat complexity and may provide surfaces for colonisation by sessile organisms. Modelling indicates that changes to hydrodynamics and water quality parameters will be negligible or close to background levels, with some parameters showing overall improvement relative to existing conditions (including in consideration of climate change and other cumulative catchment effects). Residual risks from contaminants and nutrient enrichment are considered low and will be managed through ongoing monitoring and adaptive management.

Based on the modelling undertaken, operation of the WRRF is expected to provide many improvements in the water quality of the Parramatta River. These improvements generally consist of lower concentrations of nutrients, pathogens and algal biomass, as well as higher levels of dissolved oxygen. These improvements in water quality are expected within the immediate vicinity of the release location as well as the broader estuary with potential associated improvements in aquatic health, KFH and biodiversity.

The implementation of an ambient water quality monitoring program (to be developed by Sydney Water in consultation with the EPA) provides an additional safeguard against potential for elevated levels of nutrients, small reductions in salinity and slight increases in surface water temperatures. The residual risk of contaminant mobilisation can also be monitored and addressed.

Providing that all mitigation and management plans are implemented and that appropriate water quality monitoring (and adaptive management) is undertaken, no significant or long-term impacts to KFH, threatened species, ecological communities, sensitive or protected lands are anticipated, and the Project is not expected to exacerbate any listed KTPs. Offsetting of impacts to aquatic biodiversity are not required in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management (NSW DPI, 2013). Sydney Water has consulted with NSW DPIRD (Fisheries) on the project. Along with rehabilitation of the seawall to introduce habitat heterogeneity and new habitat generation via the concrete mattress, Sydney Water will additionally install Living Sea Wall boulders along the disturbed sea wall and immediately adjacent sea wall banks.

Potential cumulative impacts with other local projects are considered minor, provided that established controls are applied. Based on available information, the Project is not expected to result in significant adverse impacts on aquatic biodiversity or sensitive environmental values of the Parramatta River and its tributaries.

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Appendices

Appendix A Likelihood of Occurrence Assessment

Section 2

Table A.1 Likelihood of occurrence analysis for all migratory and threatened species, and threatened ecological communities recorded within the study locality

Scientific Name	Common Name	BC Act / FM Act* / NPW Act	EPBC Act	Habitat requirements	Number of record (source)	Likelihood of occurrence
Birds						
Anthochaera phrygia	Regent Honeyeater	CE	CE	Temperate woodlands and open forests of the inland slopes of south-east Australia. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters usually nest in horizontal branches or forks in tall mature Eucalypts and Sheoaks.	(PMST-K) 2 (BioNet)	Low. Unlikely that the species inhabits the impact area, if it did, it would likely be a transient visitor.
Aphelocephala leucopsis	Southern Whiteface	V	V	Southern whitefaces occur across most of mainland Australia south of the tropics, from the north eastern edge of the Western Australian wheatbelt, east to the Great Dividing Range. Southern whitefaces live in a wide range of open woodlands and shrublands where there is an understorey of grasses or shrubs, or both. These areas are usually in habitats dominated by acacias or eucalypts on ranges, foothills and lowlands, and plains.	(PMST-M)	None. No suitable habitat within the impact areas.
Ardenna grisea	Sooty Shearwater	-	M, Ma	The Sooty Shearwater forages in the open ocean. They breed mainly on subtropical and sub-Antarctic islands, as well as on the mainland of New Zealand. Birds nest in burrows or rock crevices on coastal slopes, ridges and cliff tops, in herbfields, tussock grassland or forest. Areas with waterlogged or shallow soils and/or dense vegetation are avoided.	(PMST-L)	Low. It is unlikely that the species inhabits the impact area, if it did, it would likely be a transient visitor.

Botaurus poiciloptilus	Australasian Bittern	E	E	Occurs from south-east QLD to south-east SA, TAS and the south-west of WA. Occurs in terrestrial freshwater wetlands and, rarely, estuarine habitats.	(PMST-K) 5 (BioNet)	Low. Prefers specific habitat not in the impact areas.
Calidris acuminata	Sharp-tailed Sandpiper	P	M	In Australasia, the Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. They forage at the edge of the water of wetlands or intertidal mudflats, either on bare wet mud or sand, or in shallow water. They also forage among inundated vegetation of saltmarsh, grass or sedges	(PMST-K) ALA	High Suitable habitat could be present within the impact areas. Many records of this bird in the broader area
Calidris canutus	Red Knot	P	V	In Australasia the Red Knot mainly inhabit intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours; sometimes on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms or coral reefs. They are occasionally seen on terrestrial saline wetlands near the coast, such as lakes, lagoons, pools and pans, and recorded on sewage ponds and saltworks, but rarely use freshwater swamps. They rarely use inland lakes or swamps	(PMST-K)	Moderate. Suitable habitat could be present within the impact areas.
Calidris ferruginea	Curlew Sandpiper	E	CE, M, Ma	The breeding range of the Curlew Sandpiper is mainly restricted to the Arctic of northern Siberia, including Yamal Peninsula east to Kolyuchiskaya Gulf, Chokotka Peninsula, and also New Siberian Island. Curlew Sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms.	(PMST-K) 169 (BioNet)	Moderate. Suitable habitat could be present within the impact areas.
Calidris tenuirostris	Great Knot	V	E	In Australasia, the species typically prefers sheltered coastal habitats, with large intertidal mudflats or sandflats. This includes	(PMST-K)	Moderate.

				inlets, bays, harbours, estuaries and lagoons. They are occasionally found on exposed reefs or rock platforms, shorelines with mangrove vegetation, ponds in saltworks, at swamps near the coast, saltlakes and non-tidal lagoons. The Great Knot rarely occurs on inland lakes and swamps	1 (BioNet)	Suitable habitat within the impact areas.
Callocephalon fimbriatum	Gang-gang Cockatoo	V	E	In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. Also occur in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest. In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box ironbark assemblages, or in dry forest in coastal areas. It requires tree hollows in which to breed.	(PMST-K)	None. No suitable habitat within the impact areas.
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	V	The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central QLD coast to East Gippsland in VIC, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. An isolated population exists on Kangaroo Island, SA. Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak (Allocasuarina littoralis) and Forest Sheoak (A. torulosa) are important foods. Inland populations feed on a wide range of sheoaks, including Drooping Sheoak, Allocasuarina diminuta and A. gymnathera. Belah (Casuarina cristata) is also utilised and may be a critical food source for some populations. In the Riverina, birds are associated with hills and rocky rises supporting Drooping Sheoak, but also recorded in open woodlands dominated by Belah.	(PMST-K)	Low. Favoured tree species present though preferred distribution is not within the impact areas.
Charadrius leschenaultii	Greater Sand Plover	V	V, M, Ma	The species is rare on the east coast, usually found singly while it is common on the west coast. In NSW, the species has been recorded between the northern rivers and the Illawarra, with most records coming from the Clarence and Richmond estuaries. Almost entirely restricted to coastal areas in NSW, occurring mainly on sheltered sandy, shelly or muddy beaches or estuaries	(PMST-L)	Low. Preferred habitat is not present within the impact areas.

				with large intertidal mudflats or sandbanks. Roosts during high tide on sandy beaches and rocky shores; begin foraging activity on wet ground at low tide, usually away from the edge of the water; individuals may forage and roost with other waders.		
Charadrius mongolus	Lesser Sand Plover	V	E, M, Ma	Lesser Sand Plovers are a common summer migrant to Australia, widespread from the southeast Gulf of Carpentaria, north to the Torres Strait and along the entire east coast. The habitat of the Lesser Sand Plover is usually coastal, on the beaches of sheltered bays, in harbours and estuaries with large intertidal sand flats or mudflats. They are occasionally sighted on sandy ocean beaches; coral reefs, wave-cut rock platforms and rocky outcrops and sometimes in short saltmarsh or mangroves.	(PMST-K)	Low It is unlikely that the species or community inhabits the impact area, if it did, it would likely be a transient visitor.
Climacteris picumnus victoriae	Brown Treecreeper (south-eastern)	V	V	Endemic to eastern Australia and occurs in eucalypt forests and woodlands of inland plains and slopes of the Great Dividing Range. It is less commonly found on coastal plains and ranges. Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (Eucalyptus camaldulensis) Forest bordering wetlands with an open understorey of Acacias, saltbush, lignum, Cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.	(PMST-K)	None. No suitable habitat within the impact areas.
Dasyornis brachypterus	Eastern Bristlebird	E	E	The distribution of the Eastern Bristlebird has contracted to three disjunct areas of south-eastern Australia. There are three main populations: Northern - southern QLD/northern NSW, Central - Barren Ground Nature Reserve, Budderoo Nature Reserve, Woronora Plateau, Jervis Bay National Park, Booderee National	(PMST-M)	None No suitable habitat within the impact areas.

				Park and Beecroft Peninsula and Southern - Nadgee Nature Reserve and Croajingalong National Park in the vicinity of the NSW/VIC border. Habitat for central and southern populations is characterised by dense, low vegetation including heath and open woodland with a heathy understorey. In northern NSW the habitat occurs in open forest with dense tussocky grass understorey and sparse mid-storey near rainforest ecotone; all of these vegetation types are fire prone.		
Diomedea antipodensis	Antipodean Albatross	V	V, M, Ma	The Antipodean Albatross is endemic to New Zealand, however forages widely in open water in the south-west Pacific Ocean, Southern Ocean and the Tasman Sea, notably off the coast of NSW. It breeds on the New Zealand islands of Antipodes Island, Campbell Island, Pitt Island and the Auckland Islands. This subspecies nests in open patchy vegetation, such as among tussock grassland or shrubs on ridges, slopes and plateaus. On Antipodes Island, they nest in relatively uniform densities, but avoid areas of tall vegetation on steep coastal slopes, or amongst the tall ferns on poorly drained parts of the peaks near the island's centre.	(PMST-L)	Low. Has potential to fly through the impact areas and forage (although generally forages in open water) however, this species has a wide-ranging habitat and is highly mobile.
Diomedea antipodensis gibsoni	Gibson's Albatross	V	V, M, Ma	In Australian territory, Gibson's Albatross has been recorded foraging between Coffs Harbour, NSW, and Wilson's Promontory, VIC. Gibson's Albatrosses are rarely observed in the Pacific Ocean or Indian Ocean. The only Australian record of this species is from a recapture off Wollongong, NSW, in September 1997. Gibson's Albatross breeds on Adams Island and Auckland Island, New Zealand. There are no breeding colonies of Gibson's Albatross in Australian territory. This albatross visits Australian waters while foraging and during the non-breeding season.	(PMST-L)	Low. Has potential to fly through the impact areas and forage (although generally forages in open water) however, this species has a wide-ranging habitat and is highly mobile.

Diomedea epomophora	Southern Royal Albatross	-	V, M, Ma	During the non-breeding season, the Southern Royal Albatross has a wide and possibly circumpolar distribution, ranging north to about 35°S. The Southern Royal Albatross is moderately common throughout the year in offshore waters of southern Australia, mostly off southeastern NSW, VIC and TAS. Off SA, they are mostly seen May to September. It breeds on Campbell, Adams, Enderby and Auckland Islands, south of New Zealand. nests on flat or gently sloping ground on slopes, ridges, gullies and plateaux of large islands, and on the summits of islets. Depressions, gullies, lee slopes and vegetation provide shelter for its nests, but exposed sites are also needed nearby so that the Southern Royal Albatross can take off and land. Its nests are placed among vegetation that is sparse enough for easy access.	(PMST-L)	Low. Has potential to fly through the impact areas and forage (although generally forages in open water) however, this species has a wide-ranging habitat and is highly mobile.
Diomedea exulans	Wandering Albatross	E	V, M, Ma	The Wandering Albatross breeds on Macquarie Island. Macquarie Island lies in the southwest Pacific Ocean, about half-way between New Zealand and Antarctica. A single breeding pair has also been recorded on Heard Island. The Territory of Heard Island and McDonald Islands are an Australian external territory and volcanic group of barren Antarctic islands, about two-thirds of the way from Madagascar to Antarctica. It feeds in Australian portions of the Southern Ocean. On breeding islands, the Wandering Albatross nests on coastal or inland ridges, slopes, plateaux and plains, often on marshy ground. Nests of the Wandering Albatross are sited on moss terraces, in dense tussocks, and often in loose aggregations on the west (windward) side of islands. It prefers open or patchy vegetation (tussocks, ferns or shrubs), and it requires nesting areas that are near exposed ridges or hillocks so that it can take off.	(PMST-L)	Low. Has potential to fly through the study area and forage (although generally forages in open water) however, this species has a wide-ranging habitat and is highly mobile.
Diomedea sanfordi	Northern Royal Albatross	-	E, Ma	The Northern Royal Albatross ranges widely over the Southern Ocean, with individuals seen in Australian waters off south-eastern Australia. It breeds on Chatham Island and Taiaroa Head on the South Island of New Zealand. Its habitat includes subantarctic, subtropical, and occasionally Antarctic waters. The Northern Royal Albatross nests on flat or gently sloping ground,	(PMST-M)	Low. Has potential to fly through the impact areas and forage (although generally

				on slopes, ridges, gullies and plateaux of large islands, and on the summits of islets.		forages in open water) however, this species has a wide-ranging habitat and is highly mobile.
Epthianura albifrons	White-fronted Chat	V	-	In NSW, it occurs mostly in the southern half of the state, in damp open habitats along the coast, and near waterways in the western part of the state. Along the coastline, it is found predominantly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas.	184 (BioNet)	High Suitable habitat within the impact areas and many records in the vicinity. Several records in the vicinity of impact areas.
Erythrotriorchis radiatus	Red Goshawk	E	E	The species is very rare in NSW, extending south to about 30°S, with most records north of this, in the Clarence River Catchment, and a few around the lower Richmond and Tweed Rivers. Formerly, it was at least occasionally reported as far south as Port Stephens. Red Goshawks inhabit open woodland and forest, preferring a mosaic of vegetation types, a large population of birds as a source of food, and permanent water, and are often found in riparian habitats along or near watercourses or wetlands. In NSW, preferred habitats include mixed subtropical rainforest, Melaleuca swamp forest and riparian Eucalyptus forest of coastal rivers.	(PMST-M)	Low. Species habitat present within impact areas, albeit species sightings are rare within NSW.
Falco hypoleucos	Grey Falcon	V	V	The species frequents timbered lowland plains, particularly acacia shrublands that are crossed by tree-lined water courses. The species has been observed hunting in treeless areas and frequents tussock grassland and open woodland, especially in winter.	(PMST-L) BC Act: V	Low. No suitable habitat within impact areas.

Gallinago hardwickii	Latham's Snipe, Japanese Snipe	-	V, M, Ma	Latham's Snipe is a non-breeding visitor to south-eastern Australia, and is a passage migrant through northern Australia (i.e. it travels through northern Australia to reach non-breeding areas located further south). They usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies). They can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity.	(PMST-K) ALA	High Suitable habitat is within the vicinity of the impact areas, Large number of records in the broader vicinity.
Grantiella picta	Painted Honeyeater	V	V	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, VIC and southern QLD. During the winter it is more likely to be found in the north of its distribution. Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus Amyema.	(PMST-K)	None. No suitable habitat within the impact areas.
Haematopus longirostris	Australian Pied Oystercatcher	E	-	The species is distributed around the entire Australian coastline, although it is most common in coastal Tasmania and parts of Victoria, such as Corner Inlet. In NSW the species is thinly scattered along the entire coast, with fewer than 200 breeding pairs estimated to occur in the State. The species favours intertidal flats of inlets and bays, open beaches and sandbanks.	1 (BioNet) ALA	High Suitable habitat is within the vicinity of the impact areas. Several records in the vicinity of the impact area.
Haliaeetus leucogaster	White-bellied Sea Eagle	V	-	The White-bellied Sea-eagle is distributed around the Australian coastline, including Tasmania, and well inland along rivers and wetlands of the Murray Darling Basin. In New South Wales it is widespread along the east coast, and along all major inland rivers and waterways. Preferred habitats are characterised by the presence of large areas of open water.	313 (BioNet) ALA	High Suitable habitat is within the vicinity of the impact areas, they may transit through impact

						areas. Large number of records in the broader vicinity.
Hirundapus caudacutus	White-throated Needletail	-	V, M, Ma	White-throated Needletails often occur in large numbers over eastern and northern Australia. White-throated Needletails are aerial birds and for a time it was commonly believed that they did not land while in Australia. It has now been observed that birds will roost in trees, and radio-tracking has since confirmed that this is a regular activity.	(PMST-K)	None. Almost exclusively aerial, no suitable habitat in impact areas.
Ixobrychus flavicollis	Black Bittern	V	-	In NSW, records of the species are scattered along the east coast, with individuals rarely being recorded south of Sydney or inland. Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves.	4 (BioNet)	Moderate Suitable habitat could be present within the impact areas.
Lathamus discolor	Swift Parrot	E	CE, Ma	On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany (Eucalyptus robusta), Spotted Gum (Corymbia maculata), Red Bloodwood (C. gummifera), Red Ironbark (E. sideroxylon), and White Box (E. albens).	(PMST-K) 13 (BioNet)	None. No suitable habitat in the impact areas.
Limosa lapponica baueri	Nunivak Bar-tailed Godwit, Alaskan Bar-tailed Godwit	-	E	The Bar-tailed Godwit is a migratory wader which undertakes the largest non-stop flight of any bird. The trans-Pacific route from its breeding grounds in the Arctic to its non-breeding grounds in the southern hemisphere covers over 11,000 kilometre. Birds arrive in NSW between August and October and then leave between February and April, with a small number of individuals overwintering. The subspecies is most frequently recorded along major coastal river estuaries and sheltered embayments, particularly the Tweed, Richmond, Clarence, Macleay, Hastings,	(PMST-K) ALA Records	High ALA records within impact areas and the vicinity

				Hunter and Shoalhaven river estuaries, Port Stephens and Botany Bay. It is a rare visitor to wetlands away from the coast with scattered records as far west as along the Darling River and the Riverina. It is found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. Less frequently it occurs in salt lakes and brackish wetlands, sandy ocean beaches and rock platforms. It often occurs around beds of seagrass, and sometimes in nearby saltmarsh or the outer margins of mangrove areas. It forages at low to mid tide in shallow water or along the water's edge on sandy substrates on intertidal flats, banks and beaches or on soft mud substrates.		
Limicola falcinellus	Broad-billed Sandpiper	V	-	In NSW, the main site for the species is the Hunter River estuary, with birds occasionally reaching the Shoalhaven estuary. There are few records for inland NSW. They favour sheltered parts of the coast such as estuarine sandflats and mudflats, harbours, embayments, lagoons, saltmarshes and reefs as feeding and roosting habitat. Occasionally, individuals may be recorded in sewage farms or within shallow freshwater lagoons.	1 (BioNet)	Low. It is unlikely that the species or community inhabits the impact area, if it did, it would likely be a transient visitor.
Limosa limosa	Black-tailed Godwit	V	E	The Black-tailed Godwit has a primarily coastal habitat environment. The species is commonly found in sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats, or spits and banks of mud, sand or shell-grit; occasionally recorded on rocky coasts or coral islets. The use of habitat often depends on the stage of the tide. It is also found in shallow and sparsely vegetated, near-coastal, wetlands; such as saltmarsh, saltflats, river pools, swamps, lagoons and floodplains. There are a few inland records, around shallow, freshwater and saline	(PMST-K)	Moderate. Some foraging habitat present in the impact areas.

				lakes, swamps, dams and bore-overflows. They also use lagoons in sewage farms and saltworks		
Macronectes giganteus	Southern Giant Petrel	E	E, M, Ma	The Southern Giant Petrel has a circumpolar pelagic range from Antarctica to approximately 20° S and is a common visitor off the coast of NSW. Over summer, the species nests in small colonies amongst open vegetation on Antarctic and subantarctic islands, including Macquarie and Heard Islands and in Australian Antarctic territory.	(PMST-M)	Low. Has potential to fly through the impact areas and forage (although generally forages in open water) however, this species has a wide-ranging habitat and is highly mobile.
Macronectes halli	Northern Giant Petrel	V	V, M, Ma	The Northern Giant-Petrel has a circumpolar pelagic distribution, usually between 40-64ºS in open oceans. Their range extends into subtropical waters (to 28ºS) in winter and early spring, and they are a common visitor in NSW waters, predominantly along the south-east coast during winter and autumn. Breeding in Australian territory is limited to Macquarie Island and occurs during spring and summer. Adults usually remain near the breeding colonies throughout the year (though some do travel widely) while immature birds make long and poorly known circumpolar and trans-oceanic movements. Hence most birds recorded in NSW coastal waters are immature birds. Northern Giant-Petrels seldom breed in colonies but rather as dispersed pairs, often amidst tussocks in dense vegetation and areas of broken terrain.	(PMST-L)	Low. Has potential to fly through the impact areas and forage (although generally forages in open water) however, this species has a wide-ranging habitat and is highly mobile.
Melanodryas cucullata cucullata	South-eastern Hooded Robin, Hooded Robin	V	E	The Hooded Robin is widespread, found across Australia, except for the driest deserts and the wetter coastal areas - northern and eastern coastal Queensland and Tasmania. However, it is common in few places, and rarely found on the coast. Prefers lightly wooded country, usually open Eucalypt woodland, Acacia	(PMST-L)	None. No suitable habitat in the impact areas.

	(south-eastern)			scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature Eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.		
Neophema chrysostoma	Blue-winged Parrot	V	V, Ma	The Blue-winged Parrot inhabits a range of habitats from coastal, sub-coastal and inland areas, right through to semi-arid zones. Throughout their range they favour grasslands and grassy woodlands. They are often found near wetlands both near the coast and in semi-arid zones.	(PMST-L)	None. No suitable habitat in the impact areas.
Numenius madagascariensis	Eastern Curlew	-	CE, M, Ma	Within Australia, the Eastern Curlew has a primarily coastal distribution. The species is found in all states, particularly the north, east, and south-east regions including TAS. The Eastern Curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass.	(PMST-K) ALA	Moderate Some foraging habitat present in the impact areas.
Pachyptila turtur subantarctica	Fairy Prion (southern)	-	V	The southern subspecies (subantarctica) of the Fairy Prion was first recorded on Macquarie Island in 1956, with breeding confirmed in 1978. Breeding has also been recorded on two offshore rock stacks at Macquarie Island, one near Langdon Point, the other near Davis Point. A second sub-population was found on Bishop and Clerk Islands in 1993. The species as a whole has been recorded breeding on subantarctic and cool temperate islands. The southern subspecies of the Fairy Prion is a marine bird, found mostly in temperate and subantarctic seas. The species' oceanic distribution is poorly known. The Fairy Prion sometimes forages over continental shelves and the continental slope, but it can come close inshore in rough weather. It may also feed in deep coastal waters. Off Wollongong, NSW, 79% of Fairy Prions were seen in waters over the continental slope while 21% were counted over neritic water (water more than 200 m deep). Data from the south-eastern Australian Seabird Atlas confirm this pattern, with 83% (of 24 505 individuals) seen over the	(PMST-K)	Low. Has potential to fly through the impact areas and forage (although generally forages in open water) however, this species has a wide-ranging habitat and is highly mobile.

				continental slope, 9% over continental shelf and only 8% over open ocean. The southern Fairy Prion is found flying over the ocean where sea surface temperatures are 8.6° to 20.2 °C.		
Pandion cristatus	Eastern Osprey	V	-	Eastern Ospreys are found right around the Australian coast line, except for Victoria and Tasmania. They are common around the northern coast, especially on rocky shorelines, islands and reefs. The species is uncommon to rare or absent from closely settled parts of south-eastern Australia. There are a handful of records from inland areas.	5 (BioNet) ALA	Moderate Prefers specific habitat not in the impact areas, but records in the vicinity. Coul be transient visitor.
Pycnoptilus floccosus	Pilotbird	-	V	The pilotbird is found from the Wollemi National Park and Blue Mountains National Park in NSW through to the Dandenong Ranges, near Melbourne in VIC. Its natural habitat is temperate wet sclerophyll forests and occasionally temperate rainforest, where there is dense undergrowth with abundant debris.	(PMST-M)	None. No suitable habitat within the impact areas.
Rostratula australis	Australian Painted Snipe	E	E, Ma	Most records are from the south east, particularly the Murray Darling Basin, with scattered records across northern Australia and historical records from around the Perth region in WA. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	(PMST-L)	Low. Prefers specific habitat not in the impact areas.
Stagonopleura guttata	Diamond Firetail	V	V	The Diamond Firetail is endemic to south-eastern Australia, ranging from Carnarvon Ranges in Queensland to the Eyre Peninsula and Kangaroo Island in South Australia. Habitat: Diamond Firetails are found in open grassy woodland, heath and farmland or grassland with scattered trees	(PMST-L)	None. Species habitat is not present within the impact areas.
Sternula albifrons	Little Tern	E	-	Migrating from eastern Asia, the Little Tern is found on the north, east and south-east Australian coasts, from Shark Bay in Western Australia to the Gulf of St Vincent in South Australia. In NSW, it arrives from September to November, occurring mainly	2 (BioNet)	Low.

				north of Sydney, with smaller numbers found south to Victoria. It breeds in spring and summer along the entire east coast from Tasmania to northern Queensland, and is seen until May, with only occasional birds seen in winter months.		Prefers specific habitat not in the impact areas.
Sternula nereis nereis	Australian Fairy Tern	-	V	Within Australia, the Fairy Tern occurs along the coasts of VIC, TAS, SA and WA; occurring as far north as the Dampier Archipelago near Karratha. The subspecies has been known from NSW (NSW) in the past, but it is unknown if it persists there. The Fairy Tern (Australian) nests on sheltered sandy beaches, spits and banks above the high tide line and below vegetation. The subspecies has been found in embayments of a variety of habitats including offshore, estuarine or lacustrine (lake) islands, wetlands and mainland coastline. The bird roosts on beaches at night.	(PMST-L)	Low. Has potential to fly through the impact areas and forage (although not preferred foraging habitat) however, this species has a wide-ranging habitat and is highly mobile.
Stictonetta naevosa	Freckled Duck	V	-	The Freckled Duck is found primarily in south-eastern and south-western Australia, occurring as a vagrant elsewhere. It breeds in large temporary swamps created by floods in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers, and other rivers within the Riverina. The duck is forced to disperse during extensive inland droughts when wetlands in the Murray River basin provide important habitat. The species may also occur as far as coastal NSW and Victoria during such times.	1 (BioNet)	Low. Prefers specific habitat not in the impact areas.
Thalassarche bulleri	Buller's Albatross	-	V, M, Ma	Buller's Albatross breed in New Zealand (Snares, Solander and Chatham Islands), but are regular visitors to Australian waters. They are frequently seen off the coast from Coffs Harbour, south to TAS and west to Eyre Peninsula. In Australia, Buller's Albatross are seen over inshore, offshore and pelagic waters. They appear to congregate over currents where water	(PMST-M)	Low. Has potential to fly through the impact areas and forage (although generally forages in open water) however,

				temperature exceeds 16 °C. Feeds mostly on squid, fish, krill and tunicates via surface seizing.		this species has a wide-ranging habitat and is highly mobile.
Thalassarche bulleri platei	Northern Buller's Albatross	-	V, M, Ma	The Pacific Albatross is a non-breeding visitor to Australian waters. Foraging birds are mostly limited to the Pacific Ocean and the Tasman Sea, although birds do reach the east coast of the Australian mainland. Occurrence within the Australian Fishing Zone is likely, however, the threat from longline injury is considered low. The Pacific Albatross is a marine, pelagic species. It occurs in subtropical and subantarctic waters of the South Pacific Ocean. Habitat preferences are poorly known. In New Zealand, the species has been observed in association with fishing boats close inshore and over waters of 180–360 m depth although it is not so strongly associated with fishing grounds as are other albatrosses.	(PMST-M)	Low. Has potential to fly through the impact areas and forage (although generally forages in open water) however, this species has a wide-ranging habitat and is highly mobile.
Thalassarche cauta	Shy Albatross	E	E, M, Ma	This pelagic or ocean-going species inhabits subantarctic and subtropical marine waters, spending the majority of its time at sea. Occasionally the species occurs in continental shelf waters, in bays and harbours. Known breeding locations include Albatross Island off Tasmania, Auckland Island, Bounty Island and The Snares, off New Zealand.	(PMST-L)	Low. Has potential to fly through the impact areas and forage (although generally forages in open water) however, this species has a wide-ranging habitat and is highly mobile.
Thalassarche eremita	Chatham Albatross	-	E, M, Ma	Breeding for the Chatham Albatross is restricted to Pyramid Rock, Chatham Islands, off the coast of New Zealand. The principal foraging range for this species is in coastal waters off eastern and southern New Zealand, and TAS. The Chatham Albatross is a marine species. It occurs in subantarctic and	(PMST-M)	Low. Has potential to fly through the impact areas and forage

				subtropical waters reaching the tropics in the cool Humboldt Current off South America. It has been noted in shelf-waters around breeding islands, over continental shelves during the non-breeding season, and occurs inshore and offshore. It enters harbours and bays and is scarce in pelagic waters. The Chatham Albatross preference for sea-surface temperatures is poorly known. In Chilean waters it has been observed over waters of 11.5 to 15°C. The species nests on level or gently sloping ledges, summits, slopes and caves of rocky islets and stacks. It is usually in broken terrain with little soil and vegetation."		(although generally forages in open water) however, this species has a wide-ranging habitat and is highly mobile.
Thalassarche impavida	Campbell Albatross	-	V, M, Ma	The Campbell Albatross is a non-breeding visitor to Australian waters. Non-breeding birds are most commonly seen foraging over the oceanic continental slopes off TAS, VIC and NSW. They breed only on sub-Antarctic Campbell Island (New Zealand), south of New Zealand. After breeding, birds move north and may enter Australia's temperate shelf waters.	(PMST-M)	Low. Has potential to fly through the impact areas and forage (although generally forages in open water) however, this species has a wide-ranging habitat and is highly mobile.
Thalassarche melanophris	Black-browed Albatross	V	V, M, Ma	The Black-browed Albatross has a circumpolar range over the southern oceans, and are seen off the southern Australian coast mainly during winter. This species migrates to waters off the continental shelf from approximately May to November and is regularly recorded off the NSW coast during this period. The species has also been recorded in Botany Bay National Park. Inhabits Antarctic, subantarctic, subtropical marine and coastal waters over upwellings and boundaries of currents. Can tolerate	(PMST-L)	Low. Has potential to fly through the impact areas and forage (although generally forages in open water) however, this species has a wide-ranging

				water temperatures between 0 ºC and 24 ºC. Spends most of its time at sea, breeding on small isolated islands.		habitat and is highly mobile.
Thalassarche salvini	Salvin's Albatross	-	V, M, Ma	Salvin's Albatross breeds on Bounty, Snares and Chatham Islands, south of New Zealand, as well as on Crozet Island in the Indian Ocean. The species forages over most of the southern Pacific Ocean, where it is particularly common in the Humboldt Current, off South America. There are small numbers in the Indian Ocean and sometimes in the South Atlantic Ocean. During the non-breeding season, the species occurs over continental shelves around continents. It occurs both inshore and offshore and enters harbours and bays. Salvin's Albatross is scarce in pelagic waters.	(PMST-L)	Low. Has potential to fly through the impact areas and forage (although generally forages in open water) however, this species has a wide-ranging habitat and is highly mobile.
Thalassarche steadi	White-capped Albatross	-	V, M, Ma	Breeding colonies occur on islands south of New Zealand. The White-capped Albatross is a marine species and occurs in subantarctic and subtropical waters. The White-capped Albatross is probably common off the coast of south-east Australia throughout the year.	(PMST-K)	Low. Has potential to fly through the impact areas and forage (although generally forages in open water) however, this species has a wide-ranging habitat and is highly mobile.
Tringa nebularia	Common Greenshank	-	E, M, Ma	The common greenshank occurs in all types of wetlands and has the widest distribution of any shorebird in Australia. In NSW the species has been recorded in most coastal regions. It is widespread west of the Great Dividing Range, especially between the Lachlan and Murray Rivers and the Darling River drainage basin, including the Macquarie Marshes, and north-west regions. The common greenshank forages at the edge of wetlands, in soft	(PMST-K)	Moderate Species may forage in impact areas, records in the broader vicinity.

				mud on mudflats, in channels, or within shallows around the edge of waterbodies. These locations are often situated near or among mangroves or other sparse, emergent or fringing vegetation such as sedges or saltmarsh		
Xenus cinereus	Terek Sandpiper	V	-	A rare migrant to the eastern and southern Australian coasts, being most common in northern Australia, and extending its distribution south to the NSW coast in the east. The two main sites for the species in NSW are the Richmond River estuary and the Hunter River estuary. The latter has been identified as nationally and internationally important for the species.	1 (BioNet)	Low. Species habitat is not present within the impact areas.
Fish and Syngnathids						
Epinephelus daemelii	Black Rockcod	V	V	In Australia, the distribution of Black Rockcod ranges from southern QLD through NSW to northern VIC. However, records from QLD and VIC are rare, and the NSW coastline forms the species' main range, both in Australia and internationally. Adults are usually found in caves, gutters and beneath bommies on rocky reefs from nearshore areas to at least 50 metres depth. Small juveniles are often recorded in coastal rock pools while larger juveniles are found around rocky shores in estuaries. The use of estuaries may be an important part of the ecology of juvenile Black Rockcod in NSW waters. The Black Rockcod is territorial and often have a high site fidelity.	(PMST-L)	Low. Black Rockcod is usually found in areas much closer to the entrance of NSW estuaries.
Macquaria australasica	Macquarie Perch	E	E	The Murray-Darling form of the Macquarie Perch is still known to exist in waterways of VIC, NSW and the ACT. The eastern form is confined to the Hawkesbury-Nepean and Shoalhaven river systems including a number of Sydney's water supply reservoirs. The Macquarie Perch is a riverine, schooling species. It prefers clear water and deep, rocky holes with lots of cover. As well as aquatic vegetation, additional cover may comprise of large boulders, debris and overhanging banks.	(PMST-M)	Low. May occur in the impact areas, however preferred habitat is the upstream reaches of rivers.
Sharks and Rays						

Sphyrna lewini	Scalloped hammerhead	E	CD	The Scalloped Hammerhead Shark is a coastal pelagic species with a circumglobal distribution in warm temperate and tropical coastal areas between 45°N and 34°S. They are known to form large migratory schools and in Australia tend to move south during the warmer months.	(PMST-L)	Low. Not considered an estuarine species
Lamna nasus	Porbeagle shark		M, Ma	The Porbeagle primarily inhabits oceanic waters and areas around the edge of the continental shelf. They occasionally move into coastal waters, but these movements are temporary (Campana & Joyce 2002; Francis et al. 2002).	(PMST-M)	Low Not considered an estuarine species. Suitable habitat not present in impact areas.
Mobula alfredi	Reef manta ray		M	Often associated with inshore coral and rocky reefs in tropical and subtropical waters as well as around offshore reefs and seamounts. Individuals undertake seasonal migrations and aggregate at certain sites.	(PMST-M)	None Not considered an estuarine species. Suitable habitat not present in impact areas.
Mobula birostris	Giant manta ray		M	Occasionally found in temperate seas from south-western Western Australia, around the tropical north of the country and south to the southern coast of New South Wales. Usually found offshore, often around oceanic islands, sometimes coastal, and most common in tropical waters.	(PMST-M)	None Not considered an estuarine species. Suitable habitat not present in impact areas.
Reptiles						
Caretta caretta	Loggerhead Turtle	E	E, M, Ma	Loggerhead Turtles are found in tropical and temperate waters off the Australian coast. In NSW they are seen as far south as Jervis Bay and have been recorded nesting on the NSW north coast and feeding around Sydney. Loggerhead Turtles are ocean-dwellers, foraging in deeper water for fish, jellyfish and bottom-	(PMST-K) 3 (BioNet)	Low. May rarely swim through the impact areas albeit not

				dwelling animals. The female comes ashore to lay her eggs in a hole dug on the beach in tropical regions during the warmer months.		considered core range.
Chelonia mydas	Green Turtle	V	V, M, Ma	Green turtles occur in seaweed-rich coral reefs and coastal seagrass pastures in tropical and subtropical areas of Australia. Usually ocean-dwelling but also occurs in coastal waters on the north or central coast with some straying south of the central coast. Green Turtles spend their first five to ten years drifting on ocean currents. During this pelagic (ocean-going) phase, they are often found in association with driftlines and rafts of Sargassum (a floating marine plant that is also carried by currents). Once Green Turtles reach 30 to 40 cm curved carapace length, they settle in shallow benthic foraging habitats such as tropical tidal and sub-tidal coral and rocky reef habitat or inshore seagrass beds. The shallow foraging habitat of adults contains seagrass beds or algae mats on which Green Turtles mainly feed. In Australia there are seven separate genetic management units for the green turtle, and three of these occur in QLD. The entire Great Barrier Reef area is an important feeding area for turtles which nest locally, as well as for those which nest in other regions and countries.	(PMST-K)	Low. May rarely swim through the impact areas albeit not considered core range.
Dermochelys coriacea	Leatherback Turtle	E	E, M, Ma	The Leatherback Turtle has the widest distribution of any marine turtle, occurring in tropical, temperate and sub-polar waters from the North Sea and Gulf of Alaska in the Northern Hemisphere, to Chile and New Zealand in the Southern Hemisphere. Leatherback turtles occur in tropical and temperate waters of Australia. Large numbers of leatherback turtles feed off the southern QLD and NSW coasts and off WA's coast, south of Geraldton, but they are less abundant in the tropical waters of northern Australia. Most sightings are along the more heavily populated eastern seaboard of Australia where large adults are found year round in larger bays, estuaries and rivers. The frequency of sightings suggests that the species actively seeks	(PMST-K)	Low. May rarely swim through the impact areas albeit not considered core range.

				out temperate feeding grounds, rather than simply straying to the south.		
Eretmochelys imbricata	Hawksbill Turtle	-	V, M, Ma	Major nesting of Hawksbill Turtles in Australia occurs at Varanus Island and Rosemary Island in WA, and in the northern Great Barrier Reef and Torres Strait, QLD. hawksbill turtles spend their first five to ten years drifting on ocean currents. Hawksbill Turtles spend their first five to ten years drifting on ocean currents. During this pelagic phase, they are often found in association with rafts of Sargassum sp. (floating marine algae that is also carried by currents). Once hawksbill turtles reach 30 to 40 cm curved carapace length, they settle and forage in tropical tidal and sub-tidal coral and rocky reef habitat. They primarily feed on sponges and algae. They have also been found, though less frequently, within seagrass habitats of coastal waters, as well as the deeper habitats of trawl fisheries. Hawksbill turtles have been seen in temperate regions as far south as northern NSW.	(PMST-K)	Low. May rarely swim through the impact areas albeit not considered core range.
Natator depressus	Flatback Turtle	-	V, M, Ma	The Flatback Turtle is only found in the tropical waters of northern Australia, Papua New Guinea and Irian Jaya and is one of only two species of sea turtle without a global distribution. Post-hatchling and juvenile flatback turtles do not have the wide dispersal phase in the oceanic environment like other sea turtles. Adults inhabit soft bottom habitat over the continental shelf of northern Australia, extending into Papua New Guinea and Irian Jaya although the extent of their range is not fully known. Hatchling to subadult flatback turtles lack a pelagic life stage and reside in the Australian continental shelf. Flatback turtles require sandy beaches to nest. Sand temperatures between 25 °C and 33 °C are needed for successful incubation. Beaches free from light pollution are required to prevent disorientation, disturbance, and to allow nesting females to come ashore.	(PMST-K)	Low. May swim through the impact areas albeit not considered core range. The species is considered to be a vagrant in NSW waters.
Threatened Ecological Communities (TECs)						

Subtropical and Temperate Saltmarsh	-	V	Subtropical and Temperate Coastal Saltmarsh is found in coastal areas from southern Queensland, New South Wales, Victoria, Tasmania, South Australia and southern Western Australia, associated with soft substrate estuaries and embayments in low energy coastal areas. Saltmarshes support a range of flora and fauna species and their species composition varies with geographic region and environmental conditions. To be included in the TEC listed under the EPBC Act, saltmarsh must be located within the latitudinal boundaries (south of Mackay in QLD and Shark Bay in WA), occur on the coastal margin, have tidal connection, occur on sandy or muddy substrate, consist of characteristic saltmarsh species, and have less than 50% cover of large trees (e.g., Melaleuca and Casuarina) or seagrass. Excluded saltmarsh includes isolated patches of less than 0.1 ha area, patches with greater than 50% weeds or patches not connected to tides.	(PMST-L)	Moderate Isolated patches of < 1 ha with greater than 50% weeds occur within the impact areas along Duck Creek.

* Distribution and habitat requirement information adapted from:

Australian Government DCCEEW https://www.environment.gov.au/biodiversity/threatened/species.

NSW DPE-EES http://www.environment.nsw.gov.au/threatenedSpeciesApp/. and

NSW DPI (Fisheries) listed threatened species, populations and ecological communities https://www.dpi.nsw.gov.au/fishing/species-protection/what-current.

+ Data source includes

The NSW DPI (Fisheries) Threatened species lists https://www.dpi.nsw.gov.au/fishing/species-protection/what-current.

Number of records from the NSW DPE-EES Wildlife Atlas record data (Accessed December 2022, data retrieved for the years 2002-2022) http://www.bionet.nsw.gov.au/. and

Australian Government DCCEEW PMST http://www.environment.gov.au/epbc/protected-matters-search-tool.

Key:

EP = endangered population

CE = critically endangered

E = endangered

V = vulnerable

M = migratory (EPBC Act only)

Ma = marine (EPBC Act only)

CD = conservation dependant

P = Protected (National Parks and Wildlife Act 1974)

*(Bionet) = Species unidentified. Assumed sighting.

Stantec is a global leader in sustainable engineering, architecture, and environmental consulting. The diverse perspectives of our partners and interested parties drive us to think beyond what's previously been done on critical issues like climate change, digital transformation, and future-proofing our cities and infrastructure. We innovate at the intersection of community, creativity, and client relationships to advance communities everywhere, so that together we can redefine what's possible.

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