Health Impact Assessment: Greater Parramatta and Olympic Peninsula Project (GPOP) Water Cycle Management

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EnRiskS

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Limitations

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Glossary of terms and abbreviations

Term	Definition
AAQ	Ambient air quality
ABS	Australian Bureau of Statistics
Acute exposure	Contact with a substance that occurs once or for only a short time (up to 14 days)
Absorption	The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs
Adverse health effect	A change in body function or cell structure that might lead to disease or health problems
Aerodynamic diameter	Airborne particles have irregular shapes, their aerodynamic behaviour is expressed in terms of the diameter of an idealised spherical particle
Background level	An average or expected amount of a substance or material in a specific environment, or typical amounts of substances that occur naturally in an environment
Chronic exposure	Contact with a substance or stressor that occurs over a long time (more than one year) [compare with acute exposure and intermediate duration exposure]
Commonwealth DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment, and Water (including previous organisational names such as Department of Environment and Heritage (DEH)
dBA	Decibels (A-weighted)
Detection limit	The lowest concentration of a substance that can reliably be distinguished from a zero concentration
Dose	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An 'exposure dose' is how much of a substance is encountered in the environment. An 'absorbed dose' is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
EIS	Environmental Impact Statement
EPHC	Environment Protection and Heritage Council
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Also includes contact with a stressor such as noise or vibration. Exposure may be short term [acute exposure], of intermediate duration, or long term [chronic exposure].
Exposure assessment	The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.
Exposure pathway	The route a substance takes from its source (where it began) to its endpoint (where it ends), and how people can come into contact with (or get exposed) to it. An exposure pathway has five parts: a source of contamination (such as chemical substance leakage into the subsurface); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Term	Definition
Guideline value	Guideline value is a concentration in soil, sediment, water, biota or air (established by relevant regulatory authorities such as the NSW Department of Environment and Conservation (DEC) or institutions such as the National Health and Medical Research Council (NHMRC), Australia and New Zealand Environment and Conservation Council (ANZECC) and World Health Organisation (WHO)), that is used to identify conditions below which no adverse effects, nuisance or indirect health effects are expected. The derivation of a guideline value utilises relevant studies on animals or humans and relevant factors to account for inter and intra-species variations and uncertainty factors. Separate guidelines may be identified for protection of human health and the environment. Dependent on the source, guidelines would have different names, such as investigation level, trigger value and ambient guideline.
GPOP WCM	Greater Parramatta and Olympic Peninsula Water Cycle Management
HHRA	Human health risk assessment
HI	Hazard Index
ICNG	Interim Construction Noise Guideline
I-INCE	International Institute of Noise Control Engineering
Inhalation	The act of breathing.
Intermediate exposure	Contact with a substance that occurs for more than 14 days and less than a year [compared with acute exposure and chronic exposure]
LGA	Local Government Area
Metabolism	The conversion or breakdown of a substance from one form to another by a living organism
Morbidity	This is the condition of being ill, diseased or unhealthy. This can include acute illness (which has a sudden onset and may improve or worsen over a short period of time) as well as chronic illness (which can present and progress slowly over a long period of time).
Mortality	This is the condition of being dead. It may be presented as the number of deaths in a population over time, either in general or due to a specific cause.
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NSOOS	Northern Suburbs Ocean Outfall Sewer
NSW	New South Wales
NSW DCCEEW	NSW Department of Climate Change, Energy, the Environment, and Water (including previous organisational names such as Department of Planning and Environment, Department of Planning, Industry and Environment, Office of Environment and Heritage, Department of Environment and Conservation, Department of Environment, Climate Change and Water)
NSW DPHI	NSW Department of Planning, Housing and Infrastructure (including previous organisational names such as Department of Planning and Environment)
NSW EPA	NSW Environment Protection Authority (including previous organisational names such as NSW Department of Environment and Conservation, NSW Department of Environment and Climate Change and NSW Department of Environment, Climate Change and Water)
PM	Particulate matter
$PM_{2.5}$	Particulate matter of aerodynamic diameter 2.5 micrometres (µm) and less
PM_{10}	Particulate matter of aerodynamic diameter 10 micrometres (µm) and less
Point of exposure	The place where someone can come into contact with a substance present in the environment [see exposure pathway]
Population	A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age)
RBL	Rating Background Level

Term	Definition
Receptor	An assessed location for potential air, noise or blasting impacts. Typically, receptors are residences, however, can include commercial and industrial premises, places of worship, schools, etc. Also known as receivers.
Receptor population	People who could come into contact with hazardous substances [see exposure pathway]
Risk	The probability that something would cause injury or harm
Route of exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].
SEARs	Secretary's Environmental Assessment Requirements.
Toxicity	The degree of danger posed by a substance to human, animal or plant life.
Toxicity data	Characterisation or quantitative value estimated (by recognised authorities) for each individual chemical substance for relevant exposure pathway (inhalation, oral or dermal), with special emphasis on dose-response characteristics. The data are based on based on available toxicity studies relevant to humans and/or animals and relevant safety factors.
Toxicological profile	An assessment that examines, summarises, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.
Toxicology	Study of the harmful effects of substances on humans or animals
TSP	Total suspended particulates
UK	United Kingdom
US	United States of America
USEPA	United States Environmental Protection Agency
WHO	World Health Organisation
WRRF	Water resource recovery facility
$\mu g/m^3$	Micrograms per cubic metre
µm	Micrometre or micron

Executive summary

Introduction

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by Sydney Water to prepare a Health Impact Assessment (HIA) for the "Greater Parramatta and Olympic Peninsula Water Cycle Management" Project (GPOP WCM).

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 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.

An environmental impact statement (EIS) is being prepared for this project and this HIA addresses the potential risks and benefits to human health posed by this project.

Assessment approaches

The potential for this project to result in changes to:

- water quality in Duck River or Parramatta River
- air quality
- noise and vibration
- soil and groundwater contamination
- hazardous chemicals storage/transport
- bushfire risk
- subsidence
- traffic and transport

that might be sufficient to impact on community health for the off-site area have been assessed in this HIA. The assessments have been undertaken in accordance with national and state guidance relevant to each matter and has used information from the range of technical assessments undertaken as part of this EIS.

Results

Based on the assessment undertaken in relation to this facility, the potential for changes to community health that could arise has been found as follows:

- Water quality

With consideration of the water quality guidance adopted, the design of the proposed new facility and the assessment of potential changes in water quality arising due to this proposed facility, there will be no changes in water quality that could impact on community health in Parramatta River or Duck River where the facility and pipelines are designed to meet the specifications identified.

- Air quality

With consideration of the air quality guidance adopted and the assessment of potential changes in air quality arising due to this proposed facility, there will be no changes in air quality that could impact on community health in the area around the proposed facility where the facility is designed to meet the specifications identified.

- Noise

With consideration of the noise limits adopted and the assessment of potential changes in noise levels for the project, where the project is designed to meet the noise specifications identified (i.e. predicted levels), and where the identified noise mitigation measures are implemented, there will be no changes in noise sufficient to cause changes in community health for the off-site community.

- Other matters (soil contamination, transport, dangerous goods/chemical hazards, subsidence, bushfire)

Based on the evaluations provided and ensuring that government regulations about storage and transport of hazardous chemicals are followed, there are no changes in handling/storage of dangerous goods, soil contamination or transport/traffic related to the project that would be sufficient to cause changes in community health for the off-site community. The project is located in an area which is not subject to subsidence, bushfire or flooding so these matters did not require detailed assessment.

Section 1. Introduction

1.1 Background

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The main elements of the project include:

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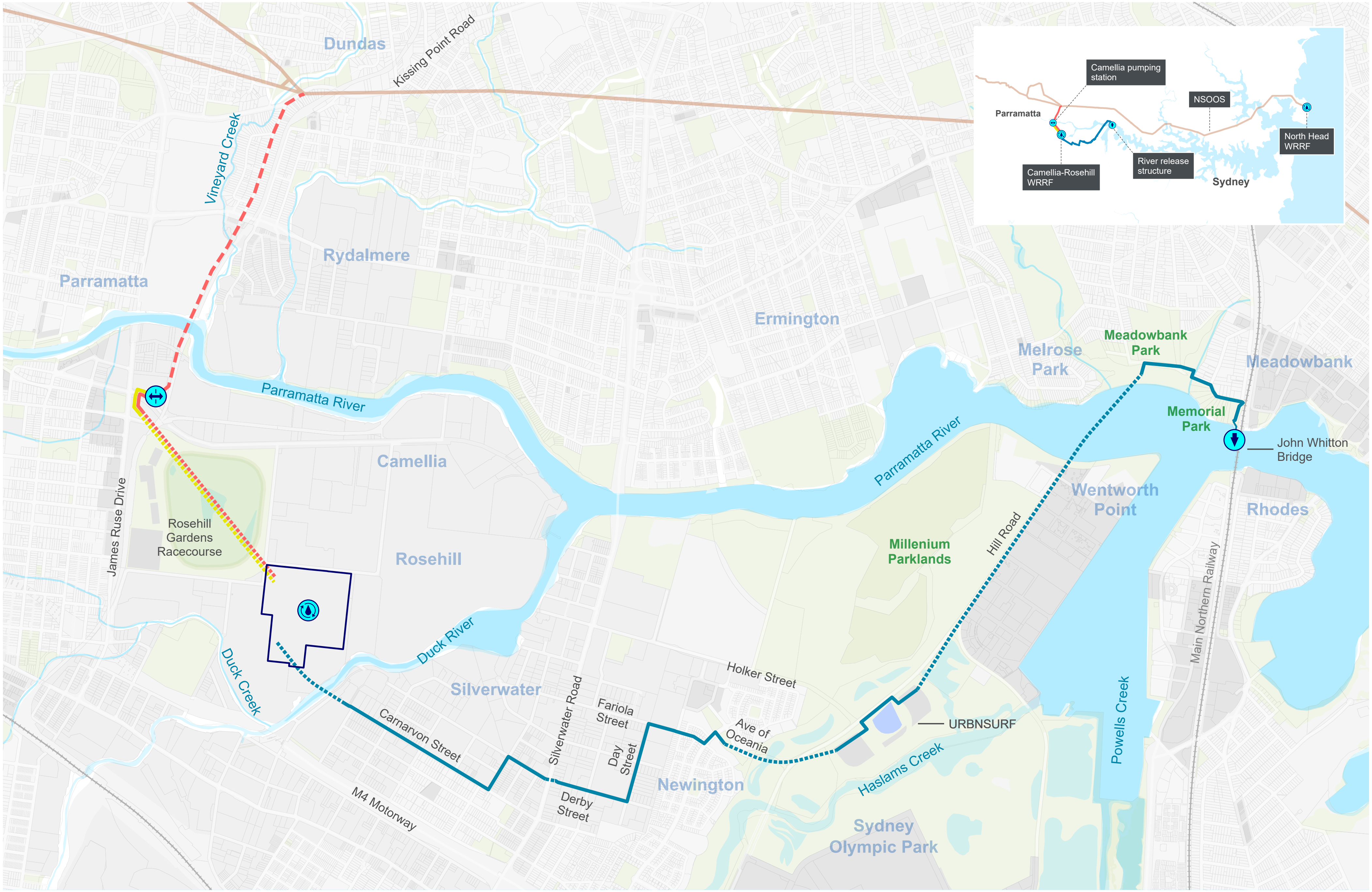
- a new river release pipeline to transfer advanced treated water from the WRRF to a release structure in Parramatta River at Meadowbank.

The location of the main elements of the project is provided in **Figure 1.1**. Further details of each component of the project are provided in **Section 4**.

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.



Camellia-Rosehill WRRF
Camellia pumping station
River release structure

Proposed pipelines
Brine pipeline
Transfer pipeline
River release pipeline

Pipeline construction method
Open trench
Trenchless
Relining

Northern Suburbs Ocean Outfall Sewer (NSOOS)
Railway

Figure 1-1 Project overview

0 500 1000 1500 m

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2025
Scale: 1:27,500 @ A4
GDA2020 MGA Zone 56

1.2 Purpose of this report

This purpose of this report is to provide an assessment of the potential for impacts to community health associated with the project as an input to the EIS that will be assessed and determined by the NSW Department of Planning, Housing and Infrastructure (DPHI).

This Health Impact Assessment report has been prepared to address relevant Secretary's Environmental Assessment Requirements (SEARs) which were issued on 24 September 2024. The relevant SEARs for this report are included in **Table 1.1**. This assessment has addressed these requirements using information from reports detailing other assessments required by the SEARs.

Table 1.1: Secretary's environmental assessment requirements (SEARs)

Secretary's environmental assessment requirements	Section where addressed
Specific SEARs – Health and safety	
8(1). The health impacts of the project, in accordance with the current guidelines.	Addressed in this entire report – purpose of this paper
8(2) The assessment must:	
(a) describe the current known health status of the affected population	Addressed in Section 3 using ABS census data and NSW HealthStats
(b) assess health risks associated with exposure to environmental hazards	Addressed in Sections 5 (water quality), 6 (air quality), 7 (noise and vibration), 8 (soil contamination), 9 (safety and other aspects), 10 (transport and traffic). Further discussion will be provided in the main EIS report.
(c) assess the effect of the project on other relevant determinants of health such as the level of physical activity and access to social infrastructure	
(d) assess opportunities for health improvement	
(e) assess the distribution of the health risks and benefits	
(f) discuss how, in the broader social and economic context of the project, the project will minimise negative health impacts while maximising the health benefits.	
(g) assess the impact of project discharge(s) to Parramatta River on making the Parramatta River swimmable by 2025, and the potential health impacts to recreational uses of Parramatta River.	Addressed in Section 5
8(3). The likely risks of the project to public safety, paying particular attention to pedestrian safety, subsidence risks, bushfire risks and the handling and use of dangerous goods.	Addressed in Section 9 – safety and other aspects – use of dangerous goods
General SEARS	
3(1) The level of assessment of likely impacts must be proportionate to the significance of, or degree of impact on, the issue, within the context of the project location and the surrounding environment. The level of assessment must be commensurate to the degree of impact and sufficient to ensure that the Department and other government agencies are able to understand and assess impacts.	Addressed in this entire report – purpose of this paper
3(2) For each key issue (such as Health), the EIS must include a detailed summary of the results of the assessment of the potential impacts of the project undertaken in detailed studies, including:	Addressed in this entire report – purpose of this paper
(a) the condition of the existing environment	Addressed in Sections 5 (water quality), 6 (air quality), 7 (noise and vibration), 8 (soil contamination), 10 (transport and traffic). Section 9 covers safety and other aspects for which the condition of the existing environment may not be particularly relevant.
(b) a summary of the key findings of the detailed technical studies in the appendices of the EIS, using suitable cross-referencing to reduce repetition between the two parts of the EIS	Addressed in Sections 5 (water quality), 6 (air quality), 7 (noise and vibration), 8 (soil contamination) and 9 (safety and other aspects).

Secretary's environmental assessment requirements	Section where addressed
(c) description of the scale and nature of the predicted impacts, including any cumulative impacts, and whether these impacts will comply with the relevant statutory requirements, standards or performance measures and goals and criteria set out in relevant guidelines and policies	Addressed in Sections 5 (water quality), 6 (air quality), 7 (noise and vibration), 8 (soil contamination), 9 (safety and other aspects). It is noted that: • scale and nature of predicted impacts are outlined in the technical paper relevant for each specific key technical issue. • The HIA then summarises that information to show that risks to community health in the off-site community are negligible to low. During construction this may require mitigation measures (as is the case for any large construction project) while, during operation, all relevant controls (including statutory requirements) should be incorporated into the overall design of the facility.
(d) demonstrated ability to avoid, mitigate or offset the impacts of the project having regards to - − mitigation measures incorporated into the design of the project (e.g., changes to the project area, project layout and design, key uses and activities carried out on site, timing) − other mitigation measures that will be implemented − any negotiated agreements or offsets proposed to address residual impacts of the project following mitigation	Addressed in Sections 5 (water quality), 6 (air quality), 7.6.2 and 7.6.4 (noise and vibration), 8 (soil contamination), 9 (safety and other aspects) and 10 (transport and traffic).
(e) detailed reasons justifying any predicted exceedances of relevant standards or performance measures	Addressed in Sections 5, 6, 7, 8, 9 and 10 Such issues are only relevant in a HIA if discussed in relevant key technical paper and if they have potential to impact on human health. If no such exceedances are discussed in other papers, then no relevant discussion can be included in the HIA. Overall, the HIA has not identified any issues that may impact on community health due to this project.
(f) identification of key uncertainties associated with the assessment and what action will be taken to address these uncertainties	Addressed in Sections 5 (water quality), 6 (air quality), 7 (noise and vibration), 8 (soil contamination), 9 (safety and other aspects), 10 (transport and traffic)
(g) highlight any key linkages between the assessment of different key issues or likely cumulative impacts of the project.	Addressed in Sections 5 (water quality), 6 (air quality), 7 (noise and vibration), 8 (soil contamination), 9 (safety and other aspects), 10 (transport and traffic). The potential for cumulative impacts for this project is most relevant for water quality. This is discussed in Section 5.

1.3 Legislative and policy context

When developing assessments required for the planning applications, it is important to consider the relevant legislation and state and local policies that apply to the project.

Table 1.2 provides a list of the relevant guidance considered in preparing technical assessments that have informed this assessment of potential health impacts.

Table 1.2: Legislation and policy context

Legislation/Policy	Description and objectives	Relevance
Environmental Planning and Assessment Act 1979 (EP&A Act).	The EP&A Act, the Environmental Planning and Assessment Regulation 2000 (NSW) and associated environmental planning instruments (including State Environmental Planning Policies (SEPPs) and Local Environmental Plans (LEPs)) provide the framework for the assessment of the environmental impact of development proposals in NSW.	The project has been declared as State Significant Infrastructure (SSI) and the Secretary of the Department of Planning, Housing and Infrastructure (DPHI) has issued project specific environmental assessment requirements (SEARs).
Protection of the Environment Operations Act 1997 (NSW) (POEO Act).	The POEO Act is the key piece of environment protection legislation administered by the EPA. The objects of this Act are as follows: ■ to protect, restore and enhance the quality of the environment in New South Wales, having regard to the need to maintain ecologically sustainable development ■ to provide increased opportunities for public involvement and participation in environment protection ■ to ensure that the community has access to relevant and meaningful information about pollution ■ to reduce risks to human health and prevent the degradation of the environment by the use of mechanisms that promote the following— ○ pollution prevention and cleaner production ○ the reduction to harmless levels of the discharge of substances likely to cause harm to the environment ○ the elimination of harmful wastes ○ the reduction in the use of materials and the re-use, recovery or recycling of materials ○ the making of progressive environmental improvements, including the reduction of pollution at source ○ the monitoring and reporting of environmental quality on a regular basis ■ to rationalise, simplify and strengthen the regulatory framework for environment protection ■ to improve the efficiency of administration of the environment protection legislation	Development of the project will produce spoil and waste as part of construction. An environment protection licence (EPL) for a plant of this site will be required from NSW EPA. In this case, a variation to the EPL for the North Head WRRF is proposed.

Legislation/Policy	Description and objectives	Relevance
	▪ to assist in the achievement of the objectives of the *Waste Avoidance and Resource Recovery Act 2001*.	
Protection of the Environment Operations (General) Regulation 2009.	Key parts of The Protection of the Environment Operations (General) Regulation 2009 include: ▪ Provides for the administration of environment protection licences. ▪ Establishes the method of calculating licence fees, including load based licence fees, and environmental protection notice fees. ▪ Prescribes certain matters for the purposes of the definition of water pollution. ▪ Gives effect to and requires compliance with the National Environment Protection (National Pollutant Inventory) Measure made under the National Environment Protection Council Act 1994 (Cth). ▪ Prescribes requirements in respect of pollution incident response management plans. ▪ Prescribes certain offences as penalty notice offences and prescribes penalty notice amounts.	The project will include consideration of many of the matters covered in this regulation
Protection of the Environment Operations (Waste) Regulation 2014.	The Waste Regulation allows the NSW EPA to protect human health and the environment and provides a platform for a modern and fair waste industry. It includes strict thresholds for environment protection licences and outlines the waste levy system.	The project will include consideration of the matters covered in this regulation
Protection of the Environment Operations (Clean Air) Regulation 2022.	This regulation details NSW EPA requirements for domestic solid fuel heaters, burning (hazard reduction etc), emissions from motor vehicles etc, emissions from industry (i.e. activities and plant), control measures to be applied to storage of volatile liquids like fuels and matters related to cruise ship fuels. Information about what guidance to use when modelling emissions from industry is also provided.	The project will include consideration of the matters covered in this regulation particularly those related to emissions from industry.
Contaminated Land Management Act 1997 (NSW) (CLM Act).	The general object of this Act is to establish a process for investigating and (where appropriate) remediating land that the EPA considers to be contaminated significantly enough to require regulation. Particular objects of this Act are: ▪ to set out accountabilities for managing contamination if the EPA considers the contamination is significant enough to require regulation	Development of any such project may involve disturbing contaminated soils and ground water. Consideration of this aspect will be included in this project.

Legislation/Policy	Description and objectives	Relevance
	■ to set out the role of the EPA in the assessment of contamination and the supervision of the investigation and management of contaminated sites, and ■ to provide for the accreditation of site auditors of contaminated land to ensure appropriate standards of auditing in the management of contaminated land, and ■ to ensure that contaminated land is managed with regard to the principles of ecologically sustainable development.	
State Environmental Planning Policy (Resilience and Hazards) (2021) (NSW Government 2021)	In 2021, the SEPP (Resilience and Hazards) was published replacing State Environmental Planning Policy No. 55. The policy provides a Statewide planning approach to the remediation of contaminated land. The Policy aims to promote the remediation of contaminated land for the purpose of reducing the risk of harm to human health or any other aspect of the environment whenever planning decisions are being made about a site. It does this by: ■ specifying when consent is required, and when it is not required, for remediation work ■ specifying certain considerations that are relevant in rezoning land and in determining development applications in general and development applications for consent to carry out a remediation work in particular ■ requiring that remediation work meet certain standards and notification requirements.	This SEPP builds on the requirements of the CLM Act focusing on addressing contamination when land is to be developed/redeveloped. The project will include consideration of the matters covered in this SEPP.
	In 2021, the SEPP (Resilience and Hazards) was published State Environment Planning Policy No. 33 which specified requirements for the management of potentially hazardous developments.	The project will include consideration of the matters covered in this SEPP.
Dangerous Goods (Road and Rail Transport) Act 2008	The NSW EPA regulates the transport of dangerous goods in NSW. Dangerous goods are substances and objects that pose acute risks to people, property and the environment due to their chemical or physical characteristics. ■ When transporting dangerous goods, training is required as well as a licence for both the driver and the vehicle. ■ If you are transporting waste, a waste transporter's licence may be needed. ■ All licence holders are listed in the dangerous goods public register.	The project will include consideration of the matters covered in this Act in regard to storage and transport of chemicals used in water treatment and, if required, movement and transport of contaminated soils and spoil during construction.

Legislation/Policy	Description and objectives	Relevance
	This legislation controls the transport of all dangerous goods except: ▪ Class 1 (explosives), regulated under the Explosives Act 2003 and administered by Safework NSW. ▪ Class 7 (radioactive substances), regulated under the Radiation Control Act 1990 and administered by NSW EPA. ▪ Dangerous goods are classified under the Australian Dangerous Goods Code (ADG Code) and the United Nations Manual of Tests and Criteria (UN Manual).	
NSW Planning 2011, Hazardous and Offensive Development Application Guidelines Applying SEPP 33 (NSW Planning 2011b)	Guidance detailing the framework for applying SEPP 33.	The project will include consideration of the matters covered in this guidance.
NSW Planning and Infrastructure 2011, Assessment Guideline Multi-level Risk Assessment (NSW Planning and Infrastructure 2011)	Guidance detailing specific parts of the assessment process for potentially hazardous industry.	The project will include consideration of the matters covered in this guidance.
NSW Planning 2011b, Risk Criteria for Land Use Safety Planning, Hazardous Industry Planning Advisory Paper No 4 (NSW Planning 2011c)		The project will include consideration of the matters covered in this guidance.
NSW Planning 2011, Hazardous Industry Planning Advisory Paper No 6, Hazard Analysis (NSW Planning 2011a)		The project will include consideration of the matters covered in this guidance.
Work Health and Safety (WHS) Regulation 2017 (NSW).	The WHS Regulation 2017 (NSW) provides a framework to protect the health, safety and welfare of all workers and others in relation to NSW workplaces and work activities. Regulations set out specific requirements for particular hazards and risks, such as noise, machinery, and manual handling.	The project will include construction of critical infrastructure and management of soils and contamination, where required, as part of the works. Protection of health and safety through

Legislation/Policy	Description and objectives	Relevance
		safety in design (SID) via engineering concept design and management of contamination risks have been considered.
Waste Avoidance and Resource Recovery Act, 2001	Promotes waste avoidance and resource recovery to achieve a continual reduction in waste generation by providing for the development of a state-wide Waste Strategy. Introduces a scheme to promote extended producer responsibility for the lifecycle of a product. It establishes the following waste management hierarchy: ▪ Avoidance – minimise the potential for waste generation by avoiding unnecessary consumption of resources ▪ Recovery – reuse, reprocess or recycle waste products to minimise the amount of waste requiring disposal ▪ Disposal – as a last resort, dispose of resources that cannot be recovered.	The waste hierarchy is the governing philosophy that drives the management methodology for the project's waste.
NSW EPA – Waste Classification Guidelines, 2014 (Part 1 Classifying Waste)	Part 1 of the guidelines, covers the classification of wastes into groups that pose similar risks to the environment and human health. These classifications are: ▪ special waste ▪ liquid waste ▪ hazardous waste ▪ restricted solid waste ▪ general solid waste (putrescible) ▪ general solid waste (non-putrescible)	These guidelines were used to classify all defined and identified wastes into the relevant environment and human health risk categories.
NSW EPA – Waste Strategies	The NSW EPA has a number of strategies in relation to waste management and recycling in NSW including: ▪ National Waste Policy Action Plan: NSW Government Implementation Plan 2025 ▪ NSW Waste and Sustainable Materials Strategy 2041 – Stage 1 Plan 2021-2027 ▪ NSW EPA Waste Delivery Plan (2021) ▪ NSW Plastics Action Plan	Relevant parts of these strategies will be incorporated in this project.
NSW EPA – Asbestos Waste Strategy, 2019-2021	Proposes innovative measures to reduce illegal dumping and unsafe disposal and promotes lawful and appropriate disposal of asbestos waste. A key principle is the strive to making asbestos waste disposal cheaper by working with local government and industry to provide cheaper ways for householders and licensed contractors to lawfully dispose of asbestos waste under certain circumstances.	Parts of this project are being constructed close to an area where manufacturing of building products containing asbestos occurred. Appropriate procedures and compliance with

Legislation/Policy	Description and objectives	Relevance
	Issues around managing asbestos waste are also outlined in: ▪ NSW Waste and Sustainable Materials Strategy 2041 – Stage 1 Plan 2021-2027	these strategies will be included in the project where appropriate.
NSW Noise Policy for Industry (NPfI) (2017), Environment Protection Authority (NSW EPA)	The NPfI provides guidelines for the assessment of noise impacts from the operation of an industrial development onto nearby receivers. The NPfI has superseded the NSW Industrial Noise Policy [2] referred to in the SEARs.	The project will include consideration of the matters covered in this guidance.
NSW Interim Construction Noise Guideline (ICNG), NSW EPA 2009	The ICNG provides guidelines for the assessment and management of construction noise. The ICNG provides a range of work practices to minimise construction noise impacts	The project will include consideration of the matters covered in this guidance.
NSW Assessing Vibration – a technical guideline (AVTG), NSW EPA 2006 (based on BS 6472)	Used for assessing potential vibration disturbance to human occupants of buildings and building contents	The project will include consideration of the matters covered in this guidance.
Parramatta River Masterplan (2018)	This masterplan laid out the pathway to make Parramatta River swimmable again by 2025.	A number of swim sites and water play areas are now open and have been considered in this project.

1.4 Available project-specific information

This HIA has been undertaken on the basis of relevant project specific information which is available in the following reports:

- Sydney Water (2025a) Greater Parramatta and Olympic Peninsula Water Cycle Management – Hydrodynamics and Water Quality Impact Assessment UPDATED DRAFT provided to enRiskS on 11 November 2025, Report is UNDATED
- Sydney Water (2025b) Greater Parramatta and Olympic Peninsula Water Cycle Management – Sediment size and chemistry for cores retrieved from the John Whitton Bridge potential release site. Dated June 2025
- Aurecon (2025) Greater Parramatta and Olympic Peninsula Water Cycle Management – Surface Water and Geomorphology Assessment – WORKING DRAFT. Dated 1 September 2025
- Jacobs (2025a) River Release Outfall CFD Modelling Technical Memorandum, Greater Parramatta and Olympic Peninsula (GPOP) Project. Dated 28 July 2025 (Jacobs 2025).
- WSP (2025), Air Quality Impact Assessment, Greater Parramatta and Olympic Peninsula Water Resource Recovery Facility. Dated June 2025.
- AECOM (2025), Greater Parramatta and Olympic Peninsula Water Cycle Management Project, Noise and Vibration Impact Assessment. Dated 27 June 2025.
- GHD (2025a), Soil and Contaminated Land Impact Assessment, Greater Parramatta, Olympic Peninsula Water Cycle Management. Dated 15 September 2025.
- GHD (2025b). Desk Top Study – Camellia Pumping Station to NSOOS Greater Parramatta, Olympic Peninsula Water Cycle Management. DRAFT. Dated 30 September 2025.
- GHD (2025c), Greater Parramatta and Olympic Peninsula Water Cycle Management Preliminary Hazard Analysis Report. Dated 5 June 2025.
- Stantec (2025a), Greater Parramatta and Olympic Peninsula (GPOP), Water Cycle Management, Traffic and Transport Impact Assessment. Dated 10 October 2025.
- Stantec (2025b), Aquatic Biodiversity Impact Assessment, Greater Parramatta and Olympic Peninsula (GPOP), Water Cycle Management.
- EMM (2025) Greater Parramatta, Olympic Peninsula Water Cycle Project (GPOP), Social Impact Assessment (SIA). Dated November 2025.
- Jacobs (2025b). Detailed Site Investigation – Camellia WRRF. Dated 21 January 2025.
- Jacobs (2025c). Detailed Site Investigation – River Release Pipeline Alignment. Dated 17 April 2025.
- Jacobs (2025d). Detailed Site Investigation – Brine and Influent Pipeline Alignment. Dated 16 June 2025.
- Jacobs (2025e) Flood Assessment Report, Greater Parramatta and Olympic Peninsula Water Cycle Management Project. Dated 2 October 2025.
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Section 2. Assessment methodology

2.1 Health impact assessment

There is a definite link between human health and development. As society has developed over time health and life expectancy has improved. For example, life expectancy in Australia around 1900 was 50 years but around 2000 it had increased to around 80. Such improvements occur due to improved access to food, housing, work and health care as well as improved infrastructure, regulatory requirements for use of chemicals, heavy equipment and workplace operations, management of industry and vehicle emissions to achieve cleaner air and management of discharges to water and catchment management to achieve cleaner water. Such improvements often arise out of specific individual developments as well as local, regional and state based planning. There are so many aspects of how we live that can impact on health and wellbeing as shown in **Figure 2.1** (enHealth 2017).

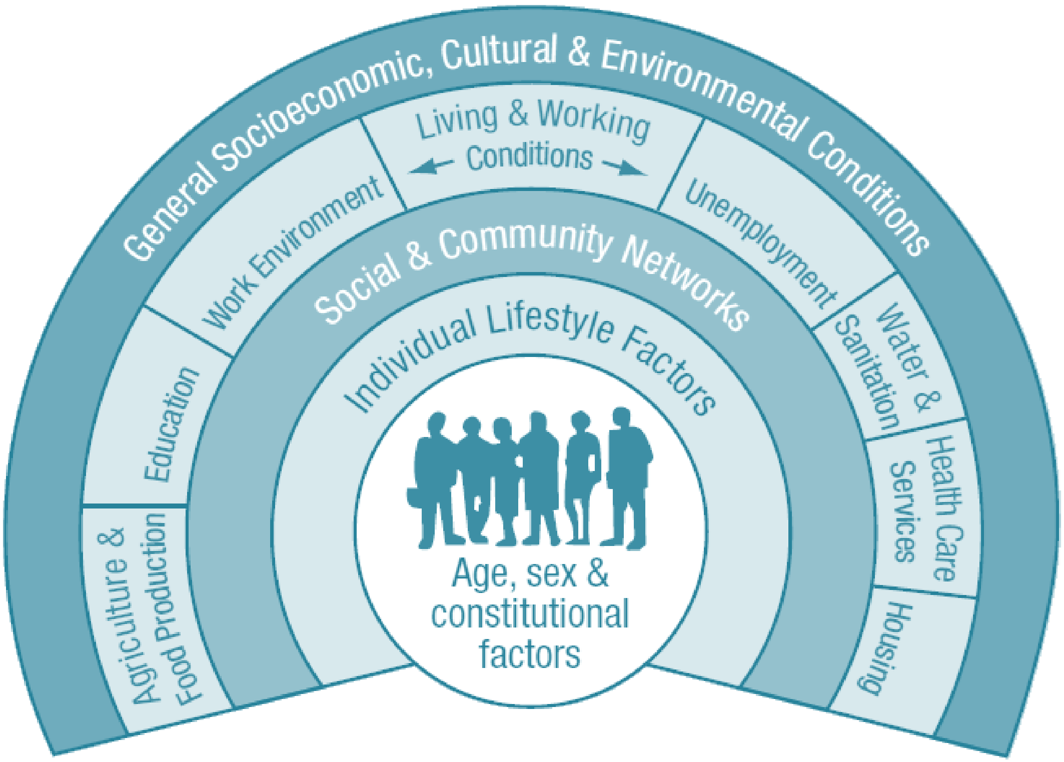


Figure 2.1: Wider determinants of health, as presented by Harris et al (2007)

The link between health and a particular type of development can be positive when a new development provides jobs or improves the way an area works or provides new infrastructure that wasn't there before. The link can also be negative should a development take away existing jobs or take away infrastructure that was important to the local area (or makes it harder to access such infrastructure) or not make the best use of available technology (enHealth 2017).

A health impact assessment (HIA) is designed to look at the positive and negative impacts on health that might arise for a particular development. Such an assessment can then be used to improve the development, where possible, by either maximising the positive impacts or decreasing the negative ones or both.

While there are processes for undertaking a risk assessment (or assessment of potential for negative impacts) in a quantitative fashion for some aspects of a development (e.g. evaluation of emissions to air or water or changes in noise), it is much more difficult to evaluate the potential positive impacts from a development as they often only become clear after the development is constructed. This means the potential for positive impacts is usually undertaken in a qualitative way (i.e. a narrative discussion) (enHealth 2017).

2.2 Defining risk and impacts

Risk is commonly defined as the chance of injury, damage, or loss. Therefore, to put oneself or the environment 'at risk' means to participate, either voluntarily or involuntarily, in an activity or activities that could lead to injury, damage, or loss.

Voluntary risks are those associated with activities that we decide to undertake for ourselves such as driving a vehicle, riding a motorcycle and smoking cigarettes. Involuntary risks are those associated with activities that may happen to us without our prior consent or forewarning. Acts of nature such as being struck by lightning, fires, floods etc are one type of involuntary risks. Exposures to environmental contaminants due to the activities of others are other examples of involuntary risks.

In relation to the proposed project, the concept of risk more specifically relates to the chance that some aspect of the project will result in a reduction in the health and/or wellbeing of the local community.

Risk assessment is the process for looking at the potential for negative health impacts – usually for involuntary risks. It is used extensively in Australia and overseas to assist in decision making on the acceptability of the risks associated with the presence of contaminants or stressors in the environment that may impact on human health.

Risks to the public and the environment are determined by direct observation/measurement or by applying mathematical models and a series of assumptions to infer risk. No matter how risks are defined or quantified, they are usually expressed as a probability of adverse effects associated with a particular activity. Risk is typically expressed as a likelihood of occurrence and/or consequence (such as negligible, low or significant) or quantified as a fraction of, or relative to, an acceptable risk number.

In this assessment, the term risk normally refers to the potential for negative impacts on health whereas the term impact has been used to refer to changes due to the project which can have positive or negative impacts on health (i.e. both benefits and risks).

Risks or impacts from a range of facilities (e.g. industrial or infrastructure) are usually assessed through qualitative and/or quantitative risk assessment techniques. In general, risk or impact assessments seek to identify all relevant hazards; assess or quantify their likelihood of occurrence and the consequences associated with these events occurring; and put all this information together to provide an estimate of the risk levels for people who could be exposed, including those beyond the perimeter boundary of a facility.

For HIAs used in environmental impact statements, the focus of the HIA is usually the community outside the boundary of the proposed new/upgraded facility – i.e. the focus is not on the workers at a facility but rather those who live, work or recreate around the facility or the discharge point.

2.3 Overall approach

2.3.1 General

The methodology adopted for the conduct of the Health Impact Assessment is in accordance with national and international guidance that is endorsed/accepted by Australian health and environmental authorities, and includes:

- *Health Impact Assessment Guidelines*. Published by the Environmental Health Committee (enHealth), which is a subcommittee of the Australian Health Protection Committee (AHPC) (enHealth 2017)
- *Health Impact Assessment Guidelines*. Published by the Environmental Health Committee (enHealth), which is a subcommittee of the Australian Health Protection Committee (AHPC) (enHealth 2001)
- Harris, P., Harris-Roxas, B., Harris, E. & Kemp, L., *Health Impact Assessment: A Practical Guide*, Centre for Health Equity Training, Research and Evaluation (CHETRE). Part of the UNSW Research Centre for Primary Health Care and Equity. University of NSW, Sydney (Harris et al. 2007)
- *Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards,* 2012 (enHealth 2012a)
- Schedule B8 Guideline on Community Engagement and Risk Communication, National Environment Protection (Assessment of Site Contamination) Measure, 1999 (National Environment Protection Council (NEPC 1999 amended 2013a))
- Australian Drinking Water Guidelines published by National Health and Medical Research Council (NHMRC 2011 updated 2024)
- Guidelines for Managing Risks in Recreational Water published by National Health and Medical Research Council (NHMRC 2008)
- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual* (Part F, Supplemental Guidance for Inhalation Risk Assessment), EPA-540-R-070-002, January 2009 (United States Environment Protection Agency(USEPA 2009)).

Other Australian or international guidance relevant to each specialist area has also been considered. The HIA has evaluated the guidance used in the other specialists reports to determine if these guidelines are based on the protection of health (for either workplace or community) or were based on some other driver – e.g. practicality/economics etc. Where they are based on matters other than specific protection of health, the HIA has considered a more detailed evaluation of health impacts to ensure any potential for impacts on health are appropriately considered. Guidance relevant for this aspect of the work has been referenced in the relevant section of this HIA.

2.3.2 Study area

The study area for the purposes of this HIA is the same as was specified in the Social Impact Assessment for this project (EMM 2025).

The area covers the following local government areas:

- City of Parramatta Council
- City of Ryde Council (EMM 2025).

The City of Canada Bay Council is also immediately adjacent to the study area near the discharge location (EMM 2025).

2.3.3 Data evaluation and issue identification

This task involved a review of all available information that relates to the proposed design and outcomes from relevant specialist studies undertaken for the project. Such studies included those related to:

- Water quality (including sediment contamination, design and modelling of the river release structure in relation to resuspension of sediments etc)
- Air quality
- Noise and vibration
- Potential soil and groundwater contamination (and requirements for controls during construction)
- Use of hazardous chemicals
- Traffic and transport.

This aspect of the assessment also considered the available guidelines relevant in each area, whether these guidelines are based on the protection of community health, and if a more detailed evaluation of specific impacts is required.

2.3.4 Exposure assessment

This involved the identification of populations located in the project study area (see **Section 4**) which may be exposed to impacts from the project.

The existing environmental conditions at the site as well as the health of the existing population have been considered in relation to the key health effects (with specific health effects termed health endpoints) in this assessment.

2.3.5 Hazard assessment

The objective of a hazard or toxicity assessment is to identify the adverse health effects and quantitative toxicity values or exposure-response relationships that are associated with the key pollutants and stressors that have been identified and evaluated as part of this assessment, where this is relevant.

National guidelines based on the protection of health have been adopted for this assessment where relevant.

2.3.6 Risk characterisation

Risks have been characterised using quantitative and qualitative assessment methods in this assessment.

The assessment has also considered the level of uncertainty associated with the concept design, and all aspects of the technical studies relied on for the conduct of the Health Impact Assessment and within the Health Impact Assessment. The final determination of risks to human health was based on the quantification of risks as well as consideration of these uncertainties.

2.3.7 Identifying management measures

Once risks have been characterised for a project, consideration can be given to management measures that are necessary to include in a project or are commonly included in such a project as they are considered best practice or are required in government guidance.

Management measures will be actions that limit the potential for project activities to impact on the local community or to ensure that the project is undertaken appropriately and continues to comply with all relevant requirements.

2.3.8 Features of the assessment

The Health Impact Assessment has been carried out in accordance with international best practice and the national guidance available in Australia prepared by groups/organisations such as NHMRC, NEPC and enHealth as listed in **Section 2.3.1**.

There are certain features of such assessments that are important to acknowledge.

These relate to the limitations of the methodology and the constraints applied within the assessment to ensure a focus on aspects that can be influenced as part of the Project. These are summarised below:

- The assessment does not present an evaluation of the health status of any specific individuals in the community. Rather, for those aspects where a more quantitative assessment was undertaken, it is a logical process of calculating the potential for exposure to a stressor arising from the project within a community associated with the project. This estimate is then compared to regulatory and published estimates of such exposures that people within a community may be exposed to over a lifetime without unacceptable risks to their health.
- It is usual to ensure such potential for exposures considers a worst case scenario rather than just average levels to ensure risks are assessed appropriately.
- Human Health Risk Assessments (HHRA) and health impact assessments (HIAs) are quite similar. HIAs also include discussions of benefits as well as the potential risks a project might pose while a HHRA generally just considers the risks.
- They are both systematic tools used to review key aspects of a specific project that may affect the health of the local community. These assessments include both qualitative and quantitative assessment methods.
- These types of assessments involve a number of aspects where a qualitative assessment is required to be undertaken. Where this is undertaken, it provides a general indication of potential impacts only.

- These assessments rely on data provided from other studies prepared for the EIS (as listed for this project in **Section 1.4**). The conclusions, therefore, depend on the assumptions and calculations undertaken to generate the data from these other studies utilised in this assessment.
- Conclusions can only be drawn with respect to impacts related to a project as outlined in the EIS. Other health issues, not related to the Project, that may be of significance to the local community are not addressed in the EIS.
- The health impact assessment reflects the current state of knowledge regarding the potential health effects of identified chemicals and pollutants for this project. This knowledge base may change as more insight into biological processes is gained, further studies are undertaken, and more detailed and critical review of information is conducted.

Section 3. Community profile

3.1 General

This section provides an overview of the communities potentially impacted by this project. Much of the information about this area is as outlined in the Social Impact Assessment:

- EMM (2025) Greater Parramatta, Olympic Peninsula Water Cycle Project (GPOP), Social Impact Assessment (SIA). Dated November 2025.

The proposed WRRF will be located within the area defined by Devon Street, Colquhoun Street, Duck River and the Downer Rosehill Sustainable Road Resource Centre. The site is wholly within the City of Parramatta Council area (Parramatta LGA i.e. Local Government Area). This site is to the southeast of Rosehill Gardens Racecourse and to the east of the Sydney Metro West stabling facility which is currently under construction.

The river release pipeline will take advanced treated water from the WRRF to Meadowbank for discharge to Parramatta River. The pipeline runs through areas in both the Parramatta LGA and City of Ryde Council (i.e. Ryde LGA).

The transfer pipeline takes wastewater from the Camellia pumping station to the WRRF. It will run underneath Rosehill Gardens Racecourse which is within the Parramatta LGA.

The brine pipeline will transfer brine from the WRRF to the Northern Suburbs Ocean Outfall Sewer (NSOOS) for treatment and offshore discharge at North Head WRRF. The brine pipeline (i.e. before connection with the NSOOS) will run through areas within the Parramatta LGA.

In reviewing key aspects of the local communities that are relevant to the conduct of the Health Impact Assessment, information has been obtained from the Australian Bureau of Statistics (ABS) Census 2021, information relevant to local government areas (LGAs) (i.e. City of Parramatta and City of Ryde) and NSW Health local health districts (in particular, Sydney and Western Sydney Local Health Districts). In some cases, where local data are lacking, information has been obtained (or compared with) data from larger population areas of Sydney and/or NSW.

3.2 Surrounding area and population

3.2.1 General

The population considered in this assessment includes those living, recreating and working within the areas where the project (WRRF and pipelines) will be constructed – i.e. City of Parramatta LGA and Ryde LGA. Canada Bay LGA has also been considered as some parts of this LGA are close to the project.

3.2.2 Parramatta LGA

Parramatta LGA is located in the centre of Sydney, about 25 km from the Sydney Central Business District. The suburb of Parramatta sits at the point where the Parramatta River mixes salt and fresh water. The LGA spans 84 square kilometres and 35 suburbs, some of which are shared with other councils, such as Melrose Park (EMM 2025).

Parramatta CBD serves as an economic hub for the region, providing employment, education and economic opportunity. The Parramatta CBD is known as Sydney's second city (EMM 2025).

A key landmark of the region is the Parramatta River. The Parramatta River's environmental health, role as a source of recreation for swimming and boating, indigenous and non-indigenous history, the transport options and economic opportunities the river provides, including overall enhanced amenity, are highly important to the community. The river's tributaries, including Duck River and Duck Creek, also form an important part of character of nearby suburbs and play a significant role in the overall river health (EMM 2025).

A key focus of the Sydney Water GPOP Masterplan (2023), which was informed by stakeholders and communities around the Parramatta River, is to make the river swimmable again by 2025. Several sites have already been opened up – Putney Beach at Putney Park and Bayview Park and new ones are being planned including Bedlam Bay at Gladesville. A water play area has been opened at McIlwaine Park in Rhodes (EMM 2025).

Parramatta LGA has a culturally and linguistically diverse mix of residents (EMM 2025).

3.2.3 Ryde LGA

Ryde LGA makes up part of the area where this project will be located. Ryde LGA includes the Meadowbank and Melrose Park statistical areas (SALs) and is connected to the Canada Bay LGA via the Ryde Bridge. Ryde and Canada Bay LGAs are also connected via rail, with the Meadowbank Bridge (also known as the John Whitton Bridge and the Parramatta Railway Bridge) which connects the Meadowbank and Rhodes train stations. The Meadowbank Bridge is heritage listed and multi-purpose, including a pedestrian walkway and cycle path which were added to the bridge in 2000 (EMM 2025).

Ryde LGA is home to the developing Macquarie Park Innovation District, which is considered to be a leading hub for employment and residential amenities. Growth in Ryde LGA is highlighted by the 11% population growth recorded in the 5 years leading to 2021 (i.e. 2016-2021). Projections by the Department of Planning, Housing and Infrastructure (2023) estimate that Ryde's population will increase by 35% from 2021 to 2041 (up to 180,341 residents) (EMM 2025).

Ryde has a high proportion of residents that speak a language other than English at home, with the highest spoken languages being Chinese, Indo-Aryan and Korean languages, indicating cultural diversity (EMM 2025).

3.2.4 Canada Bay LGA

Canada Bay LGA is along the southern bank of the Parramatta River. It has multiple public transport options, including Rhodes, Concord West and North Strathfield train stations. The Cabarita Wharf allows ferries to and from Circular Quay and Barangaroo. The LGA is bordered by the Western Motorway (M4), Parramatta Road and Homebush Bay Drive. Canada Bay is mostly residential, with a number of open spaces which can be used for sport and recreation (EMM 2025).

3.3 Population profile

The population within the study area, as with most areas of NSW, consists of residents and workers as well as those attending schools, day care centres, hospitals and recreational areas.

For the purposes of this HIA, the population statistics have been determined for the local government areas which contain the project works as well as Greater Sydney, NSW and Australia where relevant.

A more detailed assessment of the demographics for the area is provided in the Social Impact Assessment (EMM 2025).

This HIA focuses more specifically on the areas directly adjacent to project components and relevant for considering potential for impacts from the project to community health.

Table 3.1 presents a summary of the populations in the relevant LGAs. Population data have been sourced from 2021 Census QuickStats[1] and 2021 Socio-Economic Indexes[2] from the Australian Bureau of Statistics. Unemployment data are taken from the latest Labour Force statistics for Australia and NSW[3] (July 2025) and the Small Area Labour Statistics for the LGAs[4] (March 2025). Data are compared to data for NSW and Australia as a whole.

It is noted that the Australian Census is only undertaken every 5 years so the most recent data from the Census are those from 2021. The next update to the Census will not occur until the second half of 2026 with data unlikely to be available until 2027 [5].

Table 3.1: Summary of populations surrounding the proposed project site (ABS Census 2021)

Indicator	City of Parramatta LGA	City of Ryde LGA	Greater Sydney	NSW	Australia
Total population	256,729	129,123	5,231,147	8,072,161	25,422,789
Population 0 – 4 years	6.3%	5.6%	6%	5.8%	5.8%
Population 5 – 19 years	16.4%	15.2%	18%	18.1%	18.1%
Population 20 – 64 years	64.7%	64.2%	61%	58.5%	58.8%
Population 65 years and over	12.5%	15%	15%	17.7%	17.2%
Median age	35	37	37	39	38
Household size	2.6	2.5	2.7	3.1	3.1
Unemployment	3%	3.3%	4.1%	4%	4.2%
Tertiary education	53.8%	55.9%	43%	37.1%	35.7%
SEIFA IRSAD	1,063	1,088	--	--	--
SEIFA IRSAD quintile	5	5	--	--	--
Indigenous	0.8%	0.5%	1.7%	3.4%	3.2%
Born overseas	57.6%	52.5%	43.2%	34.6%	33.1%

Notes:

Ref: Australian Bureau of Statistics, Census Data 2021
Tertiary education percentage based on (i.e. Bachelor Degree level and above plus Advanced Diploma and Diploma level)
SEIFA IRSAD = index of socioeconomic advantage and disadvantage,
Quintile is related to rank within Australia and ranges from 1 = most disadvantaged to 5 = most advantaged
Shading relates to comparison against statistics for NSW overall: more vulnerable less vulnerable

[1] https://abs.gov.au/census/find-census-data/search-by-area
[2] https://www.abs.gov.au/statistics/people/people-and-communities/socio-economic-indexes-areas-seifa-australia/latest-release#index-of-relative-socio-economic-advantage-and-disadvantage-irsad-
[3] https://www.abs.gov.au/statistics/labour/employment-and-unemployment/labour-force-australia/latest-release
[4] https://www.dewr.gov.au/employment-research/small-area-labour-markets#downloads
[5] https://www.abs.gov.au/census/about-census

Based on the population data presented in **Table 3.1**, this community generally has the following characteristics:

- Lower proportion of people over 65 than NSW overall
- Similar rate of very young children (0-4 years) compared to NSW overall
- Lower unemployment rate than NSW as a whole
- Higher proportion of people born overseas than NSW as a whole
- Higher proportion of people with tertiary education compared to NSW as a whole.

This community (based on Parramatta and Ryde LGA) lives in an area with significant advantage in regard to the socio-economic indexes put together by the ABS.

The estimated population growth from 2021 to 2041 in the Parramatta LGA is around 40% based on NSW population projections[6]. The estimated population growth from 2021 to 2041 in the Ryde LGA is around 35% based on NSW population projections[7].

The indicators in **Table 3.1** are chosen to provide some insight into the potential vulnerability of a community – including its ability to adapt to environmental stresses. If a community is significantly more vulnerable than the average for NSW, then their ability to adapt to change may be limited so it is important to consider these matters when evaluating a project to ensure some consideration of equity.

The listed indicators show the population relevant for this project is not particularly different to NSW overall – i.e. not more sensitive (or less sensitive) to changes in environmental stresses compared to NSW overall.

3.4 Population health

The health of any community is influenced by a complex range of interactive factors including age, socio-economic status, social capital, behaviours, beliefs, lifestyle, life experiences, country of origin, genetic predisposition and access to health and social care. The health indicators available and reviewed in this report (**Table 3.2**) generally reflect a wide range of these factors.

Data for populations in NSW are available from the NSW HealthStats website primarily based on Local Health Districts (LHD)[8]. These have been summarised in the table below. The age standardised rates for mortality and hospitalisations are statistics based on data from hospitals and other medical professionals. Other data are based on surveys undertaken directly by NSW Health. Data from other sources (including Australian Bureau of Statistics) are based on self-reported information which may be less robust than that provided by NSW Health.

Table 3.2 present a summary of the general population health considered relevant to the area. The table presents available information on health-related behaviours (i.e. key factors related to lifestyle and behaviours known to be of importance to health) and indicators for the burden of disease within the community compared to NSW.

[6] https://www.planningportal.nsw.gov.au/populations .
[7] https://www.planningportal.nsw.gov.au/populations .
[8] https://www.healthstats.nsw.gov.au/home

Table 3.2: Baseline data on health and wellbeing

Parameter/measure	Sydney LHD	Western Sydney LHD	Northern Sydney LHD	NSW
Health behaviours[1]				
Met vegetable consumption guidelines – adults (2024)	5.8% (3.8-7.8%)	2.1% (0.9-3.2%)	6.6% (4.6-8.6%)	4.6% (4-5.2%)
Met fruit consumption guidelines – adults (2024)	39.6% (34.6-44.5%)	31.6% (27.6-35.7%)	46.6% (42.4-50.8%)	38% (36.7-39.4%)
Met vegetable consumption guidelines – children (2023/24)	5.3% (2.1-8.5%)	1.6% (0.0-3.5%)	6.5% (2.6-10.5%)	4.2% (3.1-5.4%)
Met fruit consumption guidelines – children (2023/24)	65.5% (57-73.9%)	47% (38.4-55.6%)	67.6% (60.2-74.9%)	59% (56.2-61.7%)
Increased risk of alcohol-related harm – adult (NHMRC 2020 indicators) (2024)	34.2 (29.6-38.8%)	22.2% (18-26.4%)	32% (27.9-36%)	31% (29.7-32.4%)
Adult population defined as overweight but not obese (2024)	35% (30.2-39.8%)	34.9% (30.8-39.1%)	31.6% (27.7-35.4%)	34.9% (33.6-36.3%)
Adult population defined as obese (2024)	18.8% (15.1-22.4%)	30.1% (25.8-34.5%)	16.4% (13.2-19.5%)	26.5% (25.2-27.7%)
Adults – smoking rates (daily or occasional) (2024)	9% (6.3-11.7%)	13% (9.7-16.3%)	5% (3.1-6.9%)	10.5% (9.6-11.4%)
Adults – vaping rates (daily or occasional) (2024)	10.4% (8.3-12.4)	8.4% (6.5-10.3%)	6.9% (5.1-8.7%)	6.7% (5.9-7.5%)
Sufficient levels of physical activity – adults (2024)	77.7% (73.7-81.6%)	57% (52.5-61.6%)	76% (72.3-79.6%)	64.8% (63.4-66.2%)
Sufficient levels of physical activity – children (2023/24)	16.5% (9.6-23.5%)	13.5% (6.6-20.5%)	14.7% (8-21.4%)	19.8% (17.1-22.5%)
Age standardised rates per 100,000 people[1]				
Mortality – all causes (2022)	504.4 (488.3-521)	530.6 (516.5-545)	424.3 (413.5-435.4)	538.1 (533.8-542.5)
Mortality – cardiovascular (2022)	106.2 (101-111.5)	119.7 (115-124.7)	98.4 (94.9-102.1)	123.6 (121.6-125.7)
Mortality – asthma (2020/22)	1.1 (0.7-1.7)	1.5 (1.1-2)	1 (0.7-1.3)	1.3 (1.1-1.6)
Mortality – COPD (2022)	17 (14.9-19.3)	18.2 (16.3-20.2)	9.8 (8.7-11)	21.9 (21-22.7)
Hospitalisations – cardiovascular (2022/23)	1,295.6 (1,269.3-1,322.2)	1,425 (1,402.2-1,448)	1,454.3 (1,432.9-1,476.1)	1,522.7 (1,515.1-1,530.3)
Hospitalisations – gastrointestinal infection (all ages) (2021/22)	194.9 (184.3-206)	232.2 (223.1-241.7)	221.9 (212.6-231.6)	238.7 (235.4-242.1)
Hospitalisations – respiratory disease (2022/23)	1,263.0 (1,208.3-1,264.1)	1,486.3 (1,463.1-1,509.6)	1,349.2 (1,325.6-1,373.1)	1,505.6 (1,497.3-1,513.9)

Notes:

1 NSW Health Statistics website https://www.healthstats.nsw.gov.au/home
2 Numbers in brackets are the 95% confidence limits – if confidence limits do not overlap then the values are considered to be different and shading has been added

Shading relates to comparison against NSW:

- (orange shading) statistic/data suggestive of a potential higher vulnerability to health stressors within the population.
- (blue shading) statistic/data suggestive of a potential lower vulnerability to health stressors within the population.

While these are health statistics that relate to the general characteristics of a population, it is important to note that the project does not include emissions to air that might impact on respiratory disease levels. Changes in noise can result in changes in cardiovascular disease rates if not appropriately managed. Discharges of wastewater that has not been sufficiently treated to remove microorganisms can result in changes in rates of gastrointestinal disease. These communities do not have particularly different rates for any of these effect types compared to NSW as a whole.

Review of the data presented in **Table 3.2** indicates that the population relevant for this project is mixed in relation to their potential vulnerabilities. Overall, they are generally similar to the larger NSW population.

The data indicate:

- Sydney LHD has similar characteristics to NSW overall or has characteristics that make them potentially less vulnerable to changes in environmental stressors apart from vaping rates
- Western Sydney LHD has similar characteristics to NSW overall in relation to mortality and hospitalisations but has some statistics for behaviours that could make the population generally more vulnerable to changes in environmental stressors – issues around physical activity levels and rates of fruit and vegetable consumption, in particular
- Northern Sydney LHD generally has characteristics that make them potentially less vulnerable to changes in environmental stressors than NSW overall.

Therefore, the communities relevant for this project are generally similar to the characteristics for NSW overall – i.e. they are not more sensitive to changes in their environment due to a project like this one than for NSW.

Section 4. Greater Parramatta and Olympic Peninsula Project (GPOP) Water Cycle Management Project

4.1 Overview

WRRFs play an essential role in managing public health impacts from disease causing microorganisms and from the wide range of chemicals we use every day.

The treatment processes at such facilities are designed to manage the chemicals and microorganisms in wastewater. Such treatment ensures levels after treatment are appropriate for discharge into a waterway or for non-potable reuse.

Generally, treatment processes for wastewater include:

- **Primary treatment** – Coarse solids are removed using screens of different sizes or by adding chemicals to assist in settling the solid materials to the bottom of a tank for later removal. This type of treatment can indirectly reduce the concentration of some chemicals in the wastewater as they adhere to the solids rather than staying in the liquid phase.
- **Secondary treatment** – Biological treatment by bacteria which breakdown organic material in wastewater.
- **Tertiary treatment and advanced treatment** – an additional advanced treatment level beyond primary and secondary treatment, whereby treatment processes can include sophisticated treatment processes like biological nutrient reduction, advanced oxidation and/or reverse osmosis when wastewater is to be treated sufficiently to be discharged/reused.
- **Disinfection/ pathogen control** – this process can occur across all treatment stages and is specifically focused on pathogen control and reduction. Chemicals/ physical processes that kill microorganisms are used to disinfect liquid effluent (e.g. chlorine, ozone, UV light).

The labels of primary, secondary, tertiary treatment just refer to the order in which they are applied to wastewater – i.e. first, second and third.

Figure 4.1 shows the treatment process proposed for this project.

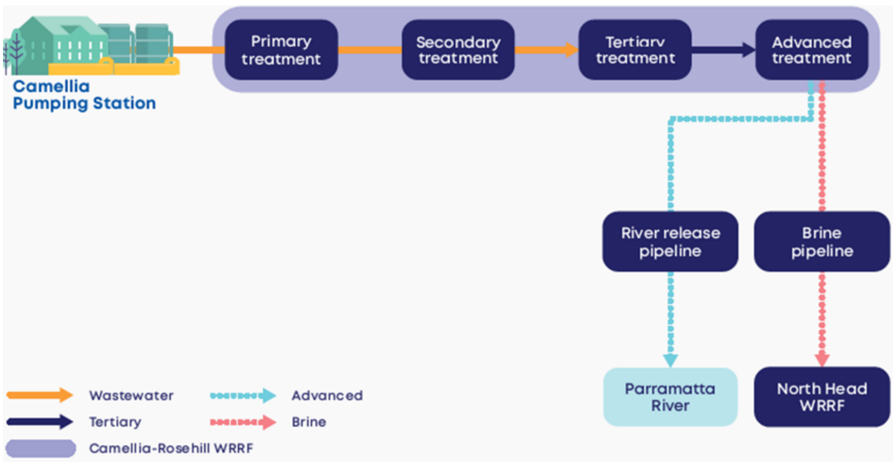


Figure 4.1: Proposed treatment process

4.2 WRRF

The WRRF will be designed to have capacity to treat 70 megalitres of wastewater per day (ML/d). The WRRF will be designed to produce advanced treated water to minimise impacts on Parramatta River. The reverse osmosis (RO) treatment process within the WRRF will 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 (UV/chlorination processes)
- biosolids handling facilities (thickening, digestion and dewatering processes)
- odour control facilities.

The proposed site layout for the new plant is provided in **Figure 4.2**.

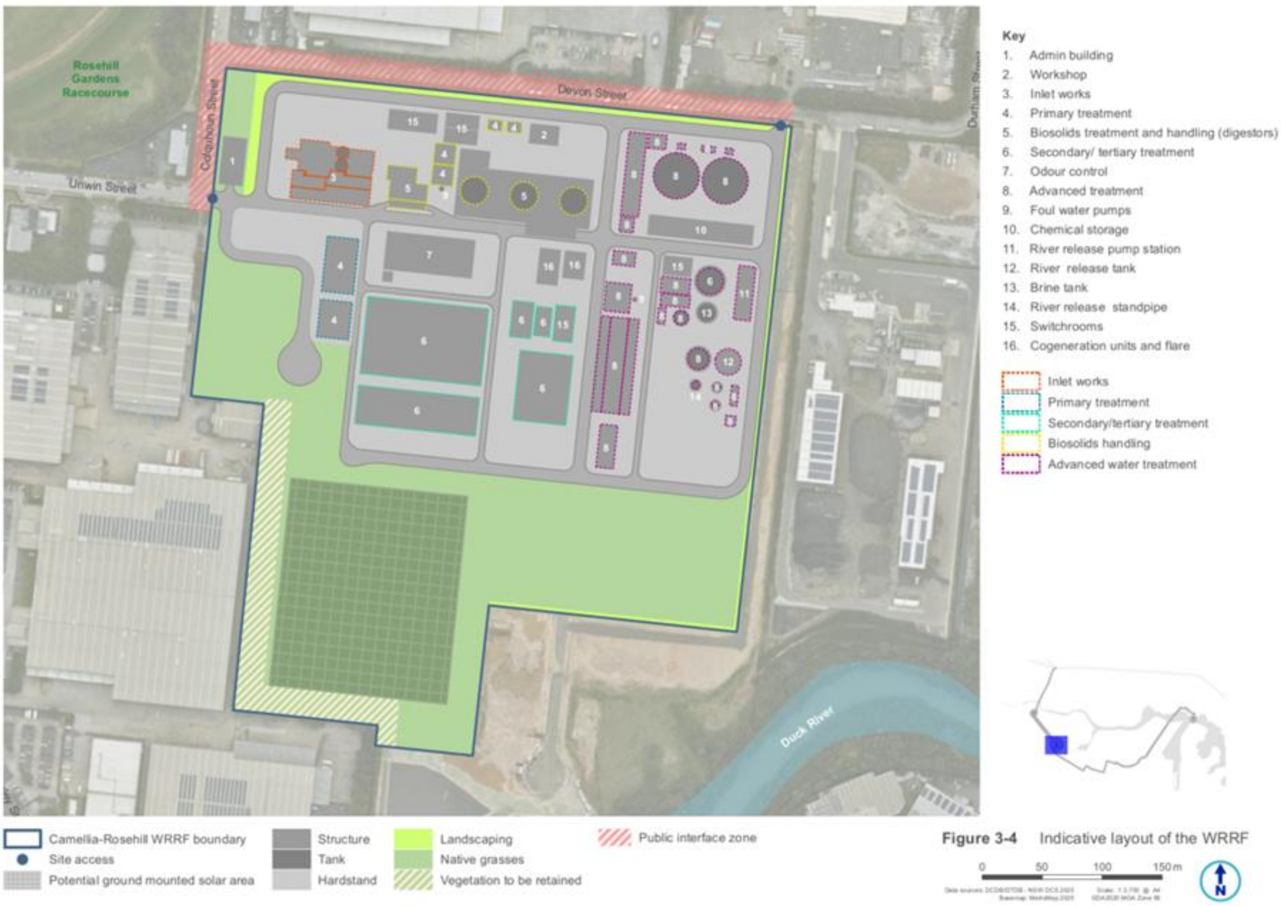


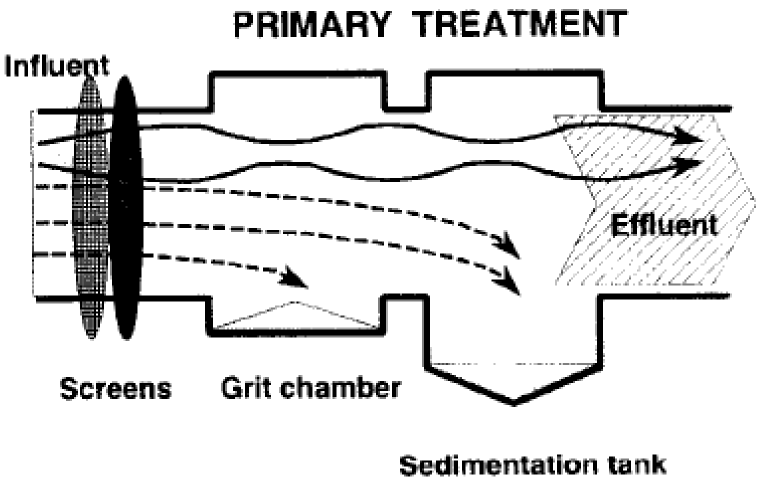
Figure 4.2: Site layout

Each of these types of processes is discussed in more detail in the following sections.

The project has also been designed to allow flexibility for upgrades in the future to support potential opportunities such as recycled water networks or purified recycled water. These are not part of the current project and have not been discussed further in this HIA.

4.3 Primary treatment

Primary treatment is the simplest form of treatment of wastewater and targets the removal of solids. USEPA provides the following diagram to illustrate:



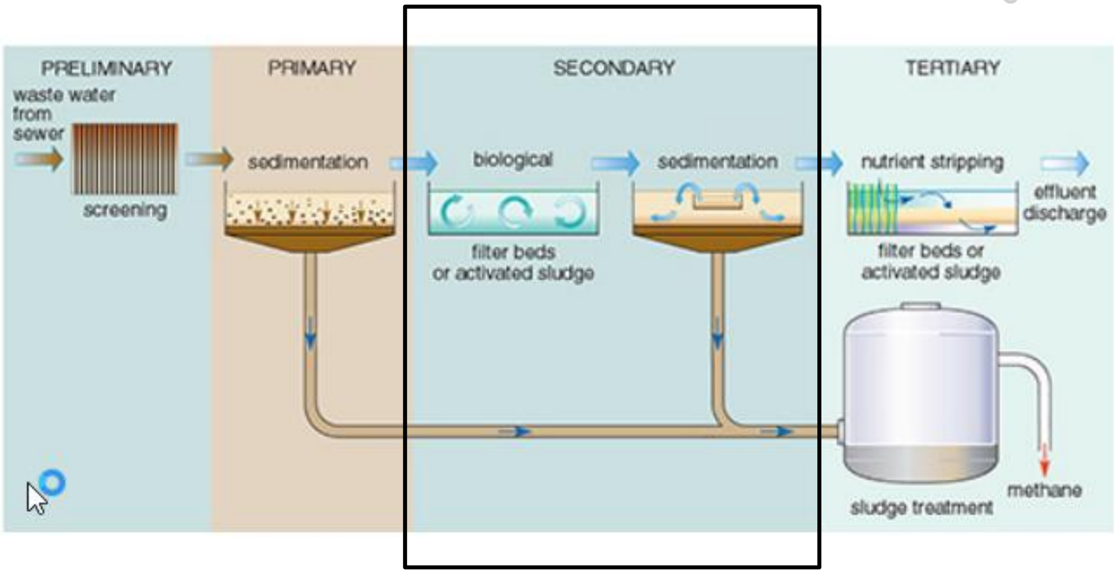
As wastewater moves into the plant, screens are in place to remove large solid materials (litter etc) The flow of wastewater slows slightly as it moves through vessels that are larger than the pipes bringing the wastewater to the plant. This slowing of the flow allows solids to fall to the bottom of the vessels (USEPA 1998). Addition of chemicals like ferric chloride allow particles to bunch together so that they get heavier and fall out of the liquid phase more easily.

For this project, the inlet works and primary treatment will involve the removal of materials such as rags, plastics, papers and large objects through mechanical screens; removal of sand and gravel (grit) through swirling motion; and removal of some organic solids through settling out of solids at the bottom of sedimentation tanks.

Wastewater then continues to flow through to the secondary treatment part of the plant (USEPA 1998).

4.4 Secondary treatment

The secondary treatment of wastewater makes use of bacteria (i.e. activated sludge – i.e. solids with high levels of relevant types of bacteria) to break down solids in general and individual chemicals in particular. It is usually the second step in the plant because it works better if the level of solids has been reduced. The bacteria use the materials present in the wastewater as food, breaking them into their component parts or allowing them to attach to solids and settle to the bottom for removal. Treatment plants make sure these parts of the plant have areas with plenty of oxygen for the bacteria and areas with low levels of oxygen to drive different types of bacteria which act on the chemicals in different ways. This treatment level also includes the mixed bed bioreactor that will form part of this facility.



9

For this project, secondary treatment will involve removal of nutrients, particularly organics, nitrates, ammonia and phosphorus through biological processes and this plant will use a combination of anoxic and aerobic treatment (in the presence and absence of oxygen, respectively).

4.5 Tertiary treatment

Tertiary treatment is the third stage. Often this has involved just disinfection using chlorination or UV treatment to make sure the levels of microorganisms are low enough to not cause any issues when advanced treated wastewater is discharged to the environment.

For this project, tertiary treatment will involve removal of further organic and inorganic solid components through a semi-permeable filtration barrier that retains impurities. This process can be designed to also remove bacteria, viruses and parasites that are harmful to public health through chlorination or ultra-violet treatment.

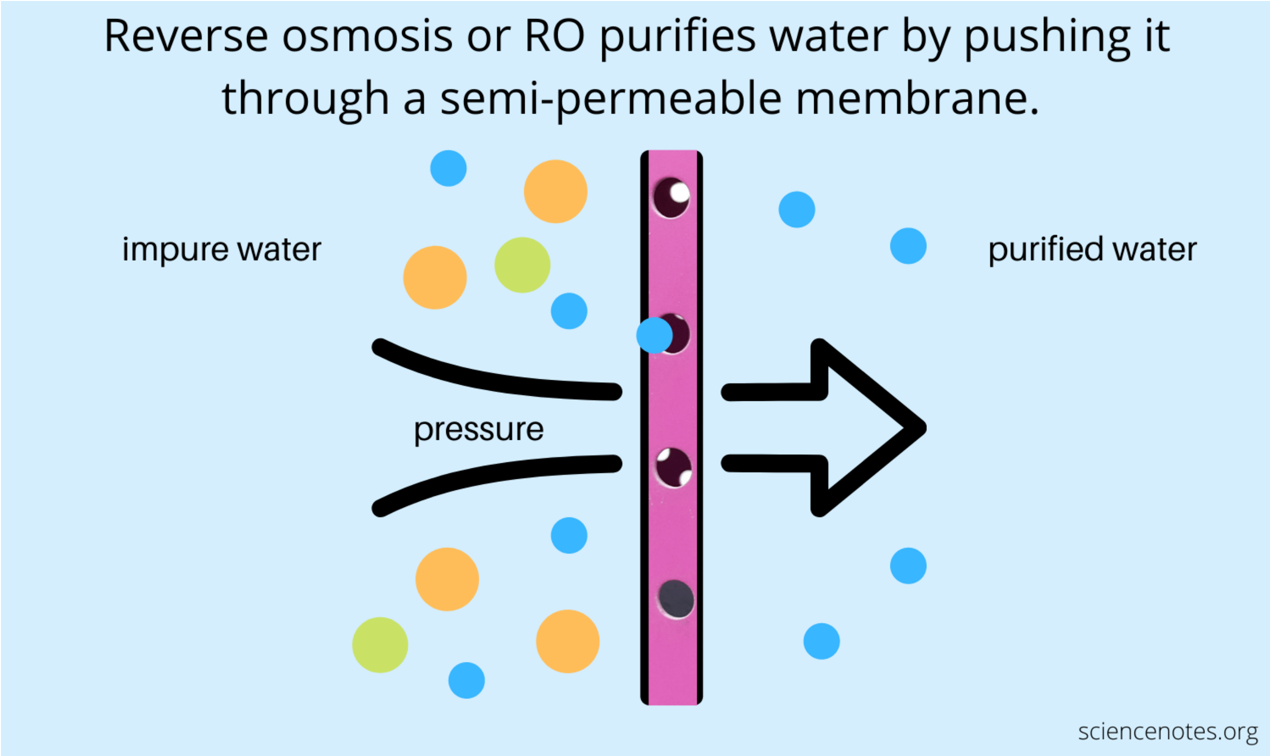
At Camellia-Rosehill WRRF, tertiary treatment will include advanced treatment processes.

4.6 Advanced treatment

More recently, additional more sophisticated processes have become accessible and more cost effective. Processes such as reverse osmosis are recent additions to modern plants.

Reverse osmosis involves a membrane. The membrane is made to have holes within a certain size range (usually less than 0.001-0.000001 micron – i.e. less than 0.000000001 m). Large amounts of pressure are applied to the water on one side of the membrane which forces the water to push through the holes onto the other side. These holes are small enough that other chemicals and microorganisms in the water cannot fit through them, so they stay on the upside. What cannot fit through the holes ends up in a small volume of water and this is called brine. The brine is disposed and does not form part of the advanced treated water. The figure below shows how reverse osmosis works (i.e. desalination).

[9] https://www.open.edu/openlearn/nature-environment/environmental-studies/understanding-water-quality/content-section-5.1



[10]

For this project, removal of any remaining impurities through reverse osmosis followed by removal of bacteria, viruses and pathogens through chlorination or ultra-violet treatment.

Once the wastewater has been fully treated through all processes, the advanced treated wastewater is to be discharged to Parramatta River. Brine from the reverse osmosis process will be transferred to the NSOOS. Another pipeline will be installed to transfer untreated wastewater from the pumping station to the WRRF.

4.7 Pipelines

4.7.1 River release pipeline

The river release pipeline will be around 7 km long. It will take the advanced treated wastewater from the WRRF to the discharge point in Parramatta River.

Figure 4.3 shows the route of this pipeline and also shows that a significant portion of the pipeline will be installed using trenchless technology – i.e. a form of horizontal drilling used to drive the pipeline along under the ground along the proposed route. The rest of the pipeline will require trenches to be constructed along roadways into which the pipe will be installed. The trenches will then be backfilled to return to existing conditions.

[10] https://sciencenotes.org/what-is-reverse-osmosis/

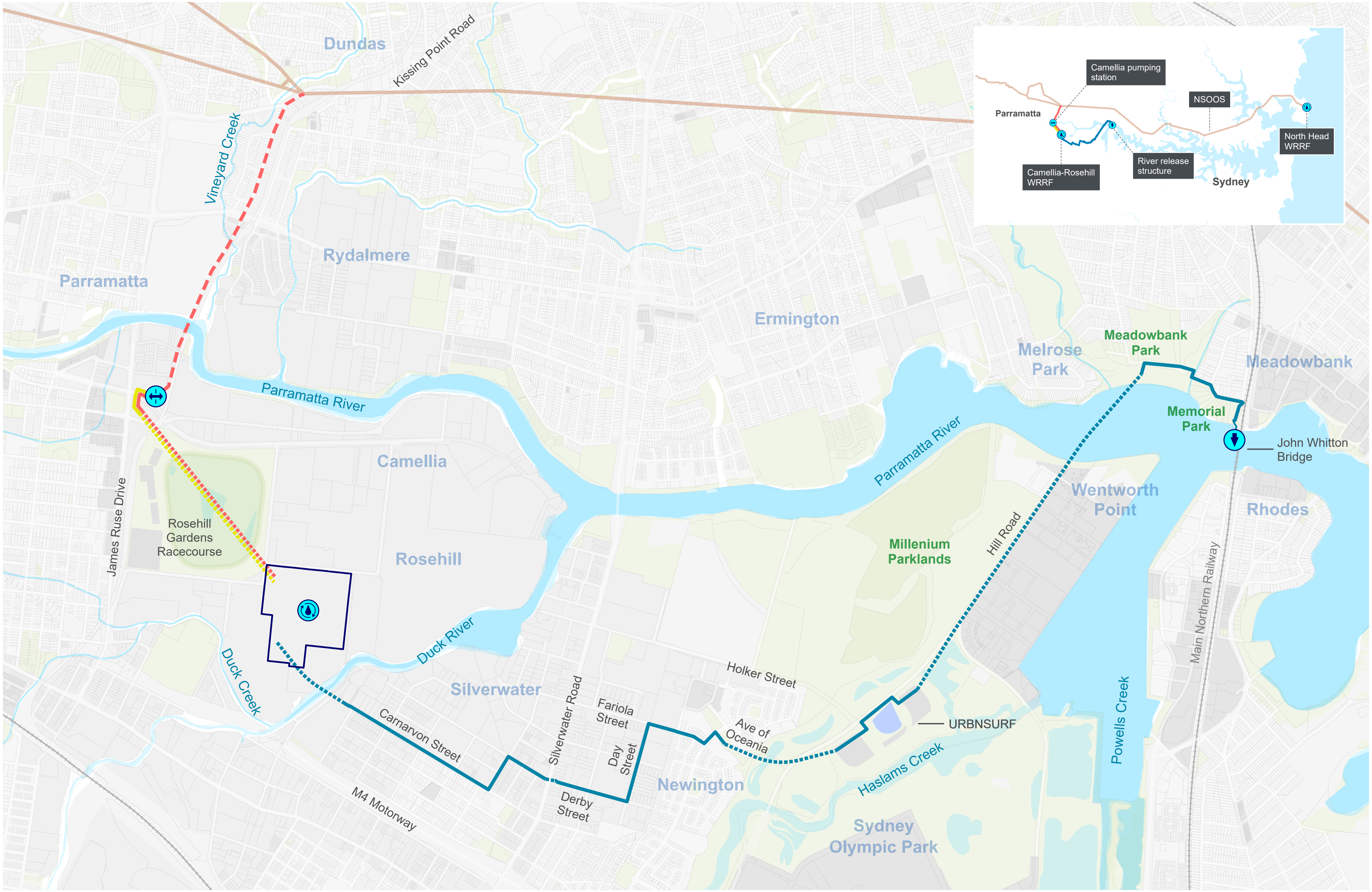


Figure 4-3 Project overview

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2025
Scale: 1:27,500 @ A4
GDA2020 MGA Zone 56

Once the pipeline reaches the discharge point in Memorial Park at Meadowbank, a series of 8 smaller pipelines will extend from underneath the sandstone sea wall out into the river.

These pipes will be spread out across the riverbed over around a 62 m length of riverbed and will extend 75-130 m into the cross section of the river. The pipes will be laid across the riverbed on top of a grout mattress. Once they have been put in place, a layer of concrete will be added to anchor them in place and protect the pipes and diffusers from damage.

These pipes will have diffusers (i.e. multiple small ports along the length of the pipe). The sections of these pipes where the diffusers will be located will be between the first and third piers of the rail bridge – the box outlined in white in **Figure 4.4**. This means the discharge will occur within the centre channel of the river – the deepest area with faster currents.

Figure 4.4: Area in river where diffusers will be located (Google Maps)

The diffusers will point upward (30° above horizontal), face downstream and have a duckbill valve that will feather the discharge. This will ensure the advanced treated water is released slowly into the river current with rapid mixing.

Figure 4.5 show further details of the release structure.

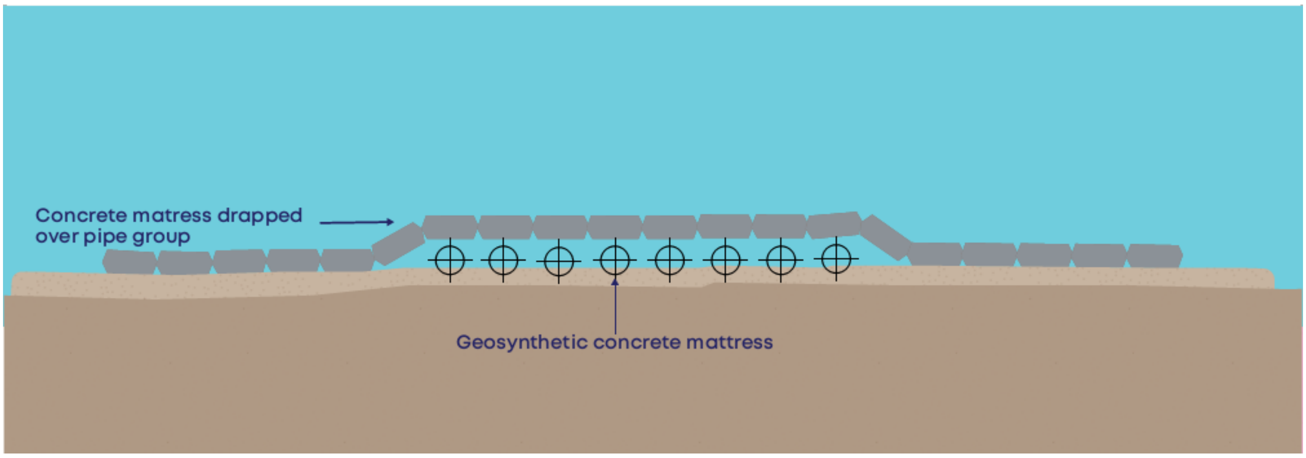


Figure 4.5: River release structure details

4.7.2 Transfer pipeline

Another pipeline required for the project is the transfer pipeline (see **Figure 4.3**). This pipeline will take untreated wastewater from the existing Camellia pumping station located near Grand Ave North and James Ruse Drive. This pipeline will run directly beneath Rosehill Gardens Racecourse and will be installed using open trenching and trenchless technology.

4.7.3 Brine pipeline

Finally, the third main pipeline required for this project is the brine pipeline (see **Figure 4.3**). It will take the brine from the reverse osmosis treatment process from the new WRRF to the Northern Suburbs Ocean Outfall Sewer (NSOOS) where it will connect around Kissing Point Road near Dundas. This is a large sewer main that already takes untreated wastewater from many parts of the northern areas of Sydney to the North Head WRRF and the Northside Storage Tunnel. Wastewater at this WRRF is treated using primary treatment (screening and sedimentation) and then discharged via one of the deep ocean outfalls which is appropriate for managing brine from the reverse osmosis process at this new WRRF (Camellia-Rosehill). This pipeline will be installed primarily by relining existing infrastructure.

Section 5. Health impact assessment: Advanced treated water

5.1 Introduction

This section assesses the potential for impacts on community health associated with managing wastewater via a treatment plant (WRRF) and discharge to Parramatta River.

The estimation of risk follows the general principles outlined in the enHealth document Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards (enHealth 2012a).

Additional national guidance documents (specific to assessing potential for impacts on people due to issues with water) that have been considered in this assessment, where relevant, include:

- NHMRC, Guidelines for Managing Risks in Recreational Water (NHMRC 2008)
- NRMMC, Australian Guidelines for Water Recycling (NRMMC 2006, 2008, 2009a, 2009b)
- NHMRC, Australian Drinking Water Guidelines (NHMRC 2011 updated 2025).

Health impacts associated with water discharges for the project have been assessed on the basis of the information within the following project documents:

- Sydney Water (2025a) Greater Parramatta and Olympic Peninsula Water Cycle Management – Hydrodynamics and Water Quality Impact Assessment UPDATED DRAFT provided to enRiskS on 11 November 2025, Report is UNDATED
- Sydney Water (2025b) Greater Parramatta and Olympic Peninsula Water Cycle Management – Sediment size and chemistry for cores retrieved from the John Whitton Bridge potential release site. Dated June 2025
- Aurecon (2025) Greater Parramatta and Olympic Peninsula Water Cycle Management – Surface Water and Geomorphology Assessment – WORKING DRAFT. Dated 1 September 2025
- Jacobs (2025a) River Release Outfall CFD Modelling Technical Memorandum, Greater Parramatta and Olympic Peninsula (GPOP) Project. Dated 28 July 2025.

5.2 Wastewater

As noted by the World Health Organisation (WHO) (WHO 2018):

"Sanitation saves lives. But history teaches us that it's also one of the key building blocks of development.

Ancient civilizations that invested in sanitary improvements became healthy, wealthy, powerful societies. More recently, modernization and economic growth have followed investments in sanitation systems.

Sanitation prevents disease and promotes human dignity and well-being, making it the perfect expression of WHO's definition of health, as expressed in its constitution, as "A state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity"."

In Australia, having a well managed system for wastewater management as well as a supply of quality drinking water is taken for granted by most people. But it is important that such systems are evaluated and expanded as required to ensure these critical components of public health management continue to do their job.

Every day we use water around our homes for drinking, showering, cooking, cleaning as well as in our toilets. When we use water for these purposes, we add chemicals and microorganisms to the water before it gets washed down the drain.

Some of the chemicals we add come from:

- household cleaning products, cosmetics, personal care products and other things we use around the house
- naturally occurring chemicals that are in the food we eat (like metals taken up from soil by plants)
- chemicals we all excrete as waste products from the metabolic processes within our body. The metabolic processes are those that produce energy and operate the bodily systems we need to keep us alive like the nervous or endocrine systems.

The microorganisms in our bodies also get excreted – both those that are essential for our digestion and those that may bring disease.

Most houses in Australia are connected to the sewer or another type of wastewater treatment process (septic systems, composting toilets, etc). In most areas, such wastewater is collected together and sent to a wastewater treatment plant. Such plants play an essential role in managing public health impacts from disease causing microorganisms and from the wide range of chemicals we use every day.

This project covers the construction and operation of a new wastewater treatment plant to meet the increasing need for such in this part of Sydney, given increases in population and density of homes. The advanced treated wastewater will be discharged into Parramatta River at Meadowbank.

5.3 How does NHMRC determine recreational and drinking water guidelines?

5.3.1 General

While drinking water guidelines are not relevant for the protection of health related to a discharge into Parramatta River because it is estuarine and, therefore, too salty to be used for drinking, the drinking water guidelines are the basis for the recreational water quality guidelines used in Australia.

It is the recreational water quality guidelines that are relevant for this assessment. Recreational water quality guidelines indicate that water is suitable for swimming, boating, surfing, rowing, wading etc – i.e. it is suitable for recreational activities where a person may be incidentally exposed to a small volume of water – a volume much less that would be the case for drinking.

Guidelines for drinking water or recreational water are provided by national health authorities in Australia. The guidance is provided in:

- NHMRC, Australian Drinking Water Guidelines (NHMRC 2011 updated 2025)
- NHMRC, Guidelines for Managing Risks in Recreational Water (NHMRC 2008)
- NRMMC, Australian Guidelines for Water Recycling (NRMMC 2006, 2008, 2009a, 2009b).

To provide an understanding of how the recreational water quality guidelines are determined, it is important to understand how the NHMRC determines the drinking water guidelines. Understanding the basis of both the drinking water and the recreational water guidelines provides confidence that meeting these values are appropriate for protecting people's health.

The Australian Drinking Water Guidelines provide detailed information about:

- Drinking water treatment processes
- Ensuring microbial, physical, chemical and radiological quality of drinking water
- Monitoring required to demonstrate compliance with the quality guidelines
- Specific fact sheets showing how each guideline (chemical and microorganism) was calculated.

As discussed, health effects cannot occur if a chemical or a microorganism is present at a concentration below the relevant threshold for action – i.e. the dose people are exposed to is critical to understanding the potential for health effects.

The recreational water guidelines use the same information as the drinking water guidelines in relation to concentrations that might have effects but adjusted based on the assumption that a person is not exposed to the same volume of water when recreating as they are when they use water for drinking.

5.3.2 Physical characteristics

Drinking water needs to have appropriate physical characteristics. If water tastes or smells unpleasant, people complain. In some situations, where these characteristics are well outside the range provided in the guidelines, skin or eye irritation or even nausea can occur.

These characteristics include:

- Colour
- Turbidity (cloudiness)
- Hardness (can soap get a lather up – this relates to the levels of calcium and magnesium in the water)
- Electrical conductivity (saltiness)
- Taste
- Temperature
- pH
- Odour

Professional judgement and experience with maintenance of relevant infrastructure are used as the basis for these guidelines. In addition to water not being pleasant to use, non-compliance with these types of guideline can impact on water supply infrastructure – increased corrosion of pipes, pumps, other fittings or accumulation of scale (encrustation) on surfaces in these infrastructure components.

Consequently, it is important to ensure water quality meets the guidelines for these physical characteristics as set out in the NHMRC guidelines.

5.3.3 Chemical characteristics

The fundamental building blocks for the entire planet are chemicals. The building blocks of all matter are the chemical elements like carbon or hydrogen or copper or gold. The elements combine to form chemical substances or compounds. Whether it is the water we drink, the air we breathe, the food we eat, the ground we walk on, the houses we live in, the things we have inside our houses or workplaces or what we ourselves are made of, everything is made of chemicals.

Some chemical substances we need to keep us (plants and animals too) alive – like water, oxygen and nutrients. Other chemical substances are naturally occurring, but they can kill us – like spider and snake venoms or well-known poisons like arsenic or mercury. The same applies to the chemical substances we make – some are quite benign and some are quite toxic.

A range of chemical substances are used to manufacture things we use every day like food, clothes, computers, kitchen appliances, cars, houses, roads, trains, planes, hair dyes, beauty products, toothpaste, shampoo, flea rinse for our pets and many other things.

All sources of raw water will have a range of chemicals present.

Naturally occurring chemicals are present in such waters due to wash off from the land and because they may be present in rainwater. For example, metals like copper and zinc will be present in such waters as they wash out of rocks and soil. These are essential nutrients we need to be healthy. Often drinking water is an important source for us to get these essential nutrients. We obtain such essential nutrients from our food and our drinking water. Drinking only water that has been so highly treated that it no longer contains relevant amounts of these chemicals has potential to impact on people's health due to deficiencies just as drinking water with too much of them has potential to impact on people's health due to excess levels.

Other chemicals are present in such waters because we use them around our homes and they wash off when it rains. Things like fertilisers or pesticides may wash off from our gardens but they may also wash off from agricultural/horticultural areas or municipal gardens or playing fields reaching raw water sources that may eventually be used to generate drinking water. Chemicals also wash off from buildings, roads, paths, cars, trains, trucks etc – things like concrete, plasterboard, wood, weatherboards, bricks are all made up of chemicals and components can leach from them. Chemicals are present in our food and in everything else we use inside our homes (cleaning agents, cosmetics, personal care products, medications, clothes) and these can reach surface waters or groundwater if they are present in the wastewater from our homes and that wastewater leaks from the sewage system or if we use grey water on gardens. They can also be present in such waters as they leach from pipes, pumps and fittings in the infrastructure used to supply drinking water, household plumbing or in the equipment required in a dam. In addition, they can be present in wastewater (which may be subject to recycling) because they leach from pipes, pumps and fittings in the infrastructure used to collect wastewater.

The Australian Drinking Water Guidelines include information about chemicals in Sections 6, 7 and 8 of this guidance document (NHMRC 2011 updated 2025).

The Australian Drinking Water Guidelines (and Australian Guidelines for Water Recycling as well as international guidance) provide numerical guideline values for many chemicals. If drinking water contains concentrations of a chemical less than the relevant guideline value, then no impacts on people's health would be expected.

It is important to remember we are exposed to chemicals all day every day (as well as the fact that we are made of chemicals). To prevent impacts on health, keeping concentrations below levels where impacts could occur is what is required. This is based on our understanding that "the dose makes the poison".

Australian authorities calculate drinking water guidelines using the following approach:

$$Drinking\ water\ guideline = \frac{Toxicity\ reference\ value\ (mg/kg\ bw/day)\ x\ body\ weight\ (70\ kg)\ x\ 0.1\ (i.e.10\%)}{Ingestion\ rate\ (2\ L\ per\ day)}$$

This calculation takes a toxicity reference value (i.e. dose that health authorities consider will not have potential to cause effects) and converts that into a concentration that could be present in drinking water and not cause an impact on health. The calculation assumes a person drinks 2 L of water every day of their lives and that they weigh 70 kg. It also assumes drinking water can only provide exposure to 10% of the permissible toxicity reference value – this allows room for exposure from other sources like food to ensure that overall exposure does not exceed the toxicity reference value.

A toxicity reference value (also known as tolerable daily intake or reference dose) is defined in Australia by enHealth as:

> *An estimate of the daily intake of a substance that can occur over a lifetime without appreciable health risk.*

Such values are calculated using data from animal experiments or studies in people. The dose/concentration that caused no effects in such studies is taken and it is adjusted using a range of factors based on how confident we are about the data from the studies. Factors include adjustments for:

- applying animal data to people
- variability between people
- type and amount of data available (strength of the evidence).

These guidelines are based on protection of people's health and so non-compliance with them could impact on community health. It is also noted that they have appropriate conservativism built into their calculation.

5.3.4 Microbial characteristics

The primary focus of all drinking water guidance is providing guidelines and information on treatment processes to ensure microorganisms are well controlled in drinking water. As noted above, all sources of water contain microorganisms. Only some of those are ones that may cause disease in people.

The Australian Drinking Water Guidelines include information about such organisms in Section 5 of that guidance document (NHMRC 2011 updated 2025).

There are a range of types of microorganisms that may be present in raw water including bacteria, viruses, protozoa, fungi and others. As already discussed, not all of the different species that could be present have the potential to cause disease.

Generating guidelines for relevant indicator species of microorganisms needs to consider:

- how many organisms of that species a person needs to be exposed to in order to get sick
- lifecycle of the species – how long they live outside a host (i.e. in the water) etc
- how people can pass the organism to other people (i.e. is there potential for secondary infection)
- monitoring methods – availability and robustness.

In most cases, the Australian Drinking Water Guidelines specify a guideline of non-detect in a 100 mL sample of the water and/or that relevant barriers should be in place to protect the raw water from contamination by sources of such microorganisms (e.g. runoff from livestock grazing areas where manure may be present).

These guidelines are based on protection of people's health and so non-compliance with them (i.e. either having detections of a species of microorganism in a relevant sample or not having the appropriate barriers in place) could impact on community health.

5.4 Description of the approach for this assessment

Impacts on community health due to this project requires that a number of things need to occur before impacts could be relevant. These include:

- advanced treated wastewater is discharged into the Parramatta River
- chemicals or microorganisms present in that advanced treated wastewater (i.e. ones that have not been completely removed at the treatment plant) need to be mixed into the water in Parramatta River
- concentration of a chemical or a microorganism in Parramatta River due to the discharge needs to be sufficient to cause a change in the water quality (i.e. it's higher than is already present in the river)
- a person needs to be able to come into contact with a chemical or microorganism in the water in Parramatta River where such a chemical or microorganism has been added in sufficient amounts by the discharge.

The following points are important to recognise:

- a wide range of chemicals and microorganisms are already present in Parramatta River due to:
  - stormwater runoff across the land (chemicals wash off buildings, roads, parks, vehicles etc etc during rain)
  - leaks of untreated wastewater from the wastewater system
  - leaks of drinking water from the drinking water system
  - interactions with boats (fuels, antifouling treatments etc) (those with motors and without motors – rowing, paddleboards)
  - flooding
  - rainfall
  - disturbance of the sediments in the river
  - and other activities/actions (waves, winds).
- Health effects arising from exposure to chemicals or microorganisms can only occur if a person is exposed to sufficient amounts of a chemical or a microorganism to trigger damage.

For most chemicals, there is a threshold amount below which effects will not occur. This is because if a person is exposed to less than this threshold, then damage cannot occur because the daily intake/dose is not enough to cause sufficient changes in cells or organs to result in actual damage. For example, there are not enough molecules taken in to switch on a receptor or the small amount of changes in a cell caused by a small amount of chemical can be easily repaired before actual long lasting damage can occur.

For disease causing microorganisms, a person must be exposed to more than the infective dose – i.e. the threshold amount of microorganisms that is needed to cause disease. For some species, this infective dose can be as low as 1-10 cells but, for many species, the infective dose is in the order of 1,000-10,000 cells.

The types of health effects that could occur will depend on the chemical or microorganism which could be present at sufficient levels for damage to occur and will vary widely.

Guidance is available from national health authorities in Australia about the quality of water that will not pose a risk to people's health when such water is used in ways relevant for Parramatta River. These documents provide guidelines for individual chemicals and for disease causing microorganisms as well as guidance about how to operate systems to ensure water quality is appropriate. These guidelines indicate what concentration of a chemical or microorganism could be present in water without any impacts on health being expected/likely (NHMRC 2008, 2011 updated 2025).

More details on the approach used by NHMRC in developing these guidelines is provided in **Section 5.3**.

People may come into contact with the water in Parramatta River in the following ways:

- incidentally ingesting water while swimming, boating, wading, rowing
- skin contact with water while swimming, boating, wading, rowing.

The water in Parramatta River is too salty to be considered a potential source for drinking water. It is also too salty to use as source water for agricultural uses as the water (irrigation or stock watering) nor are such uses relevant in the middle of this heavily urbanised area of Sydney.

It is important to note that if people do not come into contact with the river water, then the risk to their health are zero in relation to this project.

The approach adopted for this assessment is to compare the estimated concentration of a contaminant that could be in Parramatta River ***after the discharge of advanced treated wastewater*** from this facility with the relevant recreational water guidelines. These guidelines are designed to be protective for human health for all uses of water relevant for these locations and have been developed by government authorities. As long as a particular chemical or microorganism is present in Parramatta River where this advanced treated wastewater has been discharged at concentrations below the relevant recreational water guideline, the risk of health effects is negligible.

5.5 Existing environment

5.5.1 Background

Parramatta River has a catchment area of more than 235 km^2 extending from Blacktown Creek in the west to its confluence with the Lane Cove River in the east. The main sub-catchments include:

the upper Parramatta River (upstream of Charles Street Weir), Vineyard Creek, Duck River, Homebush Bay, Iron Cove Bay, Hen and Chicken Bay and the Ponds Subiaco Creek system. The remaining sub-catchments comprise of smaller bays, creeks, and foreshore land draining to the river. It is the largest river entering Port Jackson. The river is tidal to the Charles Street weir in Parramatta, some 19 km upstream of the commencement of the river at Balmain, or approximately 30 km from Sydney Heads (Sydney Water 2025a).

The Parramatta River estuary is a drowned river valley, consisting of a varying bathymetry including shallow embayments and deeper sections located within the main river channel along with intertidal mudflat areas (i.e. not underwater at low tide). Over the past two centuries there have also been extensive modifications to the estuary bed, including both dredging and reclamation works (Sydney Water 2025a).

In addition to the bathymetry of the main channel (i.e. Parramatta River), the creek and estuary systems feeding into the channel are controlled by three major forcing mechanisms: ocean tides, freshwater inflows and wind and wave driven flows. Within the estuary, a maximum tidal range of 2.1 m is experienced (Sydney Water 2025a).

Under low rainfall conditions, the estuary is vertically well mixed. During such dry periods, residence times increase with a maximum of 225 days estimated in the uppermost parts of the estuary. The embayments along the southern shore are likely to be among the most poorly flushed areas. Conversely, the system may become stratified during high precipitation events of over 50 mm/day (Sydney Water 2025a).

While generally considered to be highly urbanised, the catchment consists of numerous land uses including residential, commercial, environmental protection, education, industrial, open space and recreation (Sydney Water 2025a).

The catchment has a long history of industrial development including oil refining, a tannery, a meatworks, a lumber yard and facilities manufacturing asbestos products (such as boards and pipes), plasterboard, bricks, roof tiles, chrome chemicals, chlorinated hydrocarbons, bitumen, rubber tyres, paints, arsenic-based herbicides, food products, paints, plastic pipes, and pharmaceuticals (Sydney Water 2025a).

The estuary and its catchment have also been exposed to persistent stress over the last two centuries due to historical and current impacts from human activities. Consequently, the river's embankments and sediments are contaminated with a range of heavy metals and other chemicals. Historically, industrial development has impacted upon the southern side of the harbour and river substantially more than the northern side (Sydney Water 2025a).

As with any heavily urbanised harbours, there are a wide range of contaminants in the sediments in Parramatta River.

Many groups of researchers (academics, CSIRO and government regulators) have undertaken research about contamination levels in Sydney Harbour sediments. Details can be found in a range of reports and publications (Birch, G & Taylor 1999; Birch, GF et al. 2007; Birch, GF et al. 2015; Manning, T & Batley 2023; Manning, T et al. 2008; Manning, TM et al. 2017; Manning, TM et al. 2007; McCready et al. 2006; McCready et al. 2000; Piro et al. 2012; Roach et al. 2007; Roach & Runcie 1998; Roach et al. 2008).

Contaminated sediments in the river resulted in a complete (i.e. commercial and recreational) fishing ban in Homebush Bay (due to contamination by dioxin-like compounds) (commenced in 1989), a fishing advisory for Parramatta River and Port Jackson (commenced in 2006) and a commercial fishing ban throughout the rest of Sydney Harbour and its tributaries, including the Parramatta River (also commenced in 2006). Guidance is provided by government authorities about fishing in Sydney Harbour[11]. The document outlining the guidance is included in this HIA at **Appendix A**.

The fishing advisory indicates that recreational fishing is permissible in Parramatta River but all fish caught should be released back to the river (or at least not eaten). For fish caught in other parts of Sydney Harbour, a few servings of fish per week may be permissible depending on the fish species.

The document about fishing in Sydney Harbour also notes that collection of shellfish is not permitted for any species in Sydney Harbour and all of its tributaries including Parramatta River. This includes pipis, cockles, mussels, snails, whelks, oysters and abalone.

Contamination in Homebush Bay arose from the former Union Carbide chemical manufacturing facility. This site operated between the 1930s and 1980s. The components of Agent Orange were manufactured at the site. In addition to chemical manufacturing, land reclamation using waste from the Union Carbide site resulted in more locations having elevated levels of dioxin-like compounds. These compounds are a byproduct of the process for manufacturing the components of Agent Orange. As a result, it is not permissible to fish at all in Homebush Bay.

It is also not permissible to fish at all in Duck River. Contamination in Duck River was due to a petrol refinery and other industrial facilities.

While concentrations of dioxin-like compounds arising from the Union Carbide manufacturing site are quite elevated compared to many locations globally, the mean concentrations of heavy metals, other organochlorine compounds (such as the pesticide DDT) and polycyclic aromatic hydrocarbons in surficial sediments of Port Jackson, including the study area, are similar to many urbanised harbours.

The river is also used for a wide range of boating activities including rowing. Other recreational activities were not common in the river until the last decade when controls on water quality have been improved and information about water quality has become available via Beachwatch and Riverwatch.

Bathymetry of the river is shown in **Figure 5.1**. This figure shows that there is a deep channel running down the river with quite a deep area in the area where the release structure will be located.

[11] https://www.dpi.nsw.gov.au/fishing/recreational/resources/info/local-fishing-guides/sydney-harbour

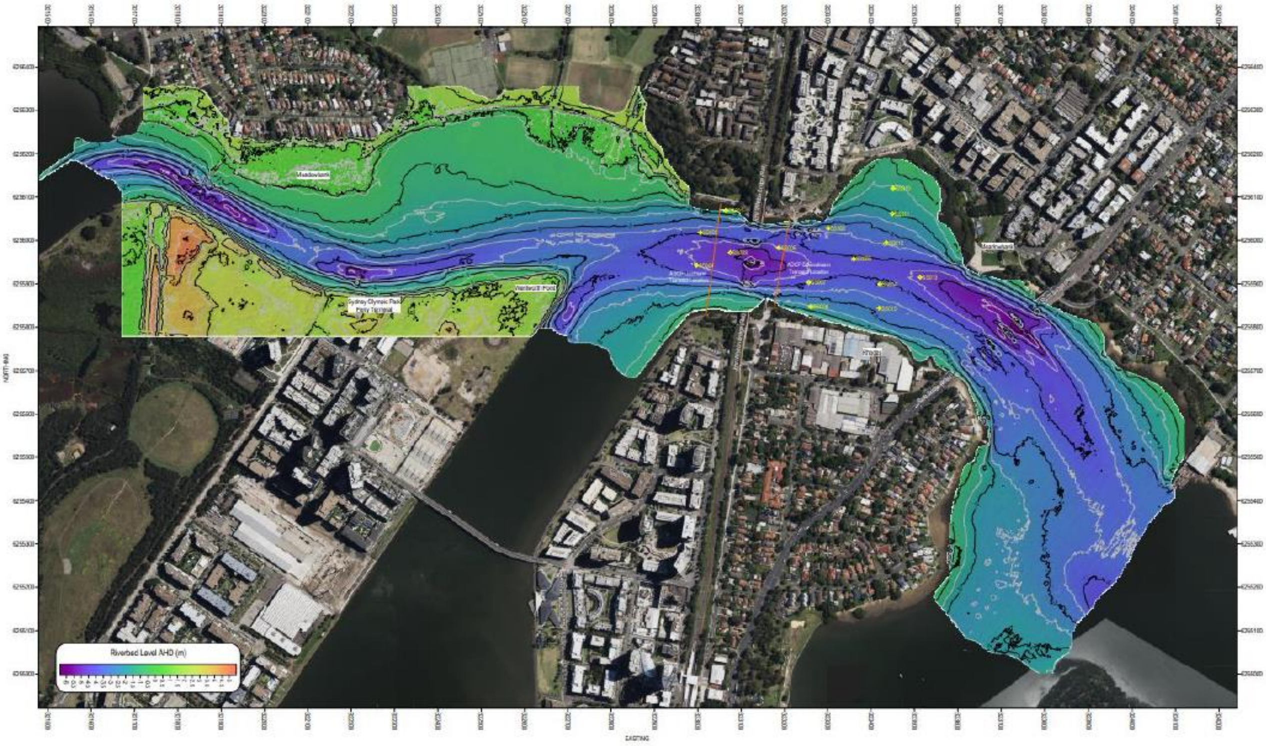


Figure 5.1: Bathymetry of this part of Parramatta River (Sydney Water 2025a)

5.5.2 Surface water characteristics

Data from existing monitoring programs of water quality in Parramatta River have been sourced for this assessment as discussed in Sydney Water (2025a). Data are available from the following programs:

- Sydney Water Riverwatch water monitoring program (2020-2025)
- Sydney Water GPOP baseline water quality monitoring program (2024-2025)
- Sydney Institute of Marine Science (SIMS) monitoring (2012-2014).

Monitoring locations are shown in **Figures 5.2** and **5.3**.

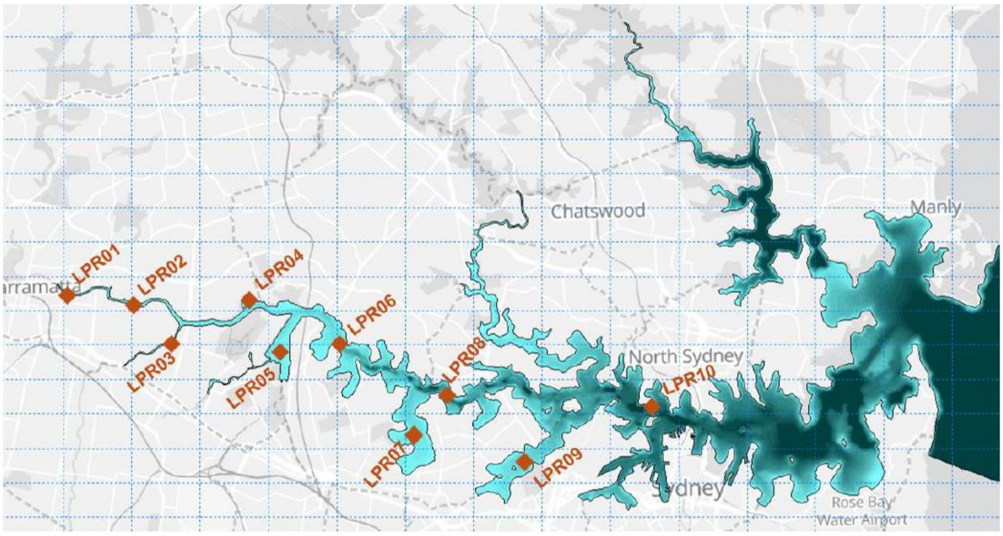


Figure 5.2: Monitoring locations for SIMS program (Sydney Water 2025a)

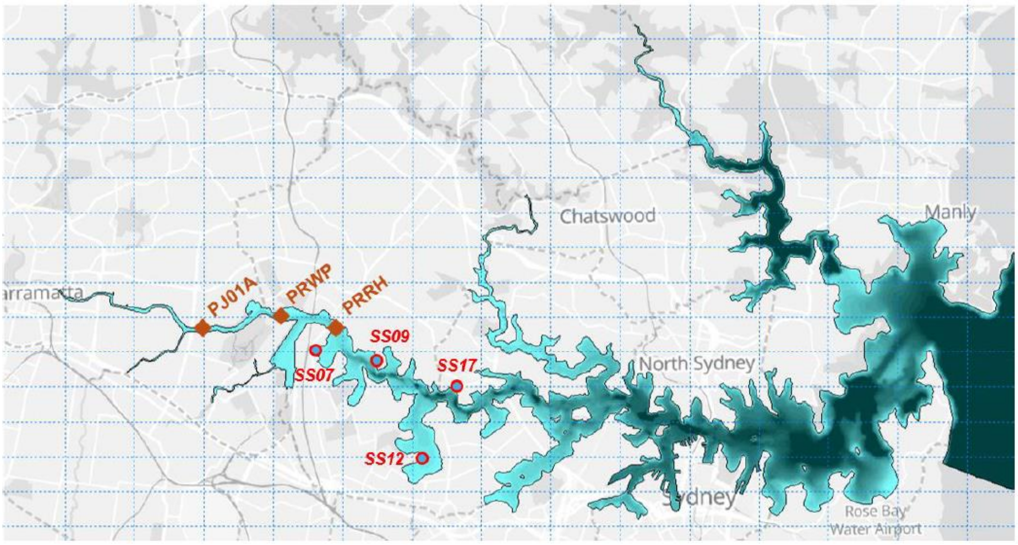


Figure 5.3: Monitoring locations for Sydney Water programs (Sydney Water 2025a)

General water quality parameters have been monitored at these locations. These include salinity, total nitrogen (TN), oxidised nitrogen (NOx), ammonia (NH_4) and total phosphorus (TP) and enterococci.

As noted above, guidelines for water based on the protection of people are available from NHMRC.

The recreational water quality guidelines are the most relevant for this situation. The recreational water guidelines are based on exposure from incidental ingestion during boating, swimming and surfing and other water based activities (NHMRC 2008). Recreational water guidelines are based on the drinking water guidelines adjusted for the lower level of exposure (0.2 L (during recreation) vs 2 L (drinking)) – i.e. they are multiplied by 10 to generate recreational guidelines.

Salinity is an indicator of the saltiness of the water. Water to be used for drinking should have conductivity less than around 1,000 µS/cm to limit issues with taste. No impacts on health are expected from consuming small amounts of salty water but the taste can be unpleasant so the Australian Drinking Water Guidelines provide guidance. However, for Parramatta River, when people are swimming or boating, it is common for these activities to occur in seawater as well as freshwater so a guideline for salinity is not needed for recreational situations (NHMRC 2008, 2011 updated 2025).

Total nitrogen, oxidised nitrogen, ammonia and total phosphorus are indicators for nutrients. Nutrients come from many sources including all types of manure and breakdown of vegetation. There are no guidelines for drinking water for TN or TP and health effects are not expected in most circumstances. There are drinking water guidelines for nitrate and nitrite (i.e. oxidised nitrogen) (based on health) and for ammonia (based on protecting infrastructure).

Enterococci are an indicator of the microbiological quality of the water for recreational waters. Guidelines for the presence of enterococci in recreational waters are provided by NHMRC – excellent quality recreational water (Class A) has levels less than 40 cfu/100 mL while good quality recreational water (Class B) has levels less than 200 cfu/100 mL. The levels of these organisms in urban waterways will be highly variable as they can be present in waters due to stormwater (present in manure from pets, native animals etc as well as people) and due to sewer overflows or leaks (NHMRC 2008, 2011 updated 2025).

These parameters are always present in natural waterways. It is important to understand the normally expected levels in a waterway to assist in determining if changes due to a new activity (such as a discharge from this new facility) cause noticeable changes and/or result in levels above national guidelines.

The background water quality – i.e. existing Parramatta River conditions – are listed in **Table 5.1**. The table shows the comparison of the current concentrations in Parramatta River and the relevant guidelines based on protection of people's health for recreational waters. These guidelines are designed to be protective for human health for all uses of water relevant for these locations and have been developed by government authorities. As long as a particular chemical or microorganism is present in Parramatta River at concentrations below the relevant recreational water guideline, the risk of health effects is considered negligible.

Table 5.1: Parramatta River existing water quality (Sydney Water 2025a)

Parameter	Units	Existing water quality	Guideline
Total chlorine	mg/L	Less than limit of reporting – i.e. non-detect	50/0.6
Aluminium	mg/L	0.012	2
Copper	mg/L	0.0016	20/1
Mercury	mg/L	0.0001	0.01
Zinc	mg/L	0.0135	3
Ammonia	mg/L	0.05-0.7	0.5 mg/L as an aesthetic based guideline (i.e. impact on corrosion of pipes and fittings) – only data re health effects in summary indicate effects are not likely until levels reach >1,000 mg/L
Oxidised nitrogen	mg/L	0.05-1	500 (NO_3^-) 30 (NO_2^-)
Total nitrogen	mg/L	0.25-1.6	NG based on health
Inorganic phosphorus	mg/L	0.025-0.06	NG based on health
Total phosphorus	mg/L	0.03-0.13	NG based on health
Enterococci	cfu/100 mL	0-24,000	200
Salinity	µS/cm	30,000-50,000	NG relevant for recreational water – estuarine part of the river so salinity will vary across every tidal cycle

Notes:

1 Guidelines have been taken from NHMRC Drinking Water Guidelines (NHMRC 2011 updated 2025) adjusted based on (NHMRC 2008) – i.e. multiplied health based guidelines for drinking water by 10 to give recreational water guidelines. The drinking water guidelines also include guidelines based on aesthetic considerations such as odours, changes in taste, impacts on pumps and infrastructure or domestic activities. These include the second value listed for chlorine and copper. Value for zinc is only aesthetic based.

2 NG = no guideline available

None of the listed chemical contaminants are currently present in Parramatta River at concentrations close to or above any of these guidelines.

The levels of enterococci are, at times, above the guidelines from NHMRC (2008). This is to be expected. It is the long term dataset that needs to show compliance with these guidelines for this parameter. Often storm events or other sources only change the levels for hours to days. This current situation is managed by authorities by recommendations about not swimming in Sydney Harbour after rain (for up to 3 days). It is noted that monitoring of waters around Sydney Harbour are undertaken as part of the Beachwater/Riverwatch program[12]. These programs include regular monitoring of enterococci.

5.5.3 Sediment characteristics

General

As discussed in **Section 5.3.1**, there is a long industrial history for Parramatta River. These historical activities have resulted in contaminated sediments throughout Parramatta River and Sydney Harbour.

As part of the investigations for this project, Sydney Water has undertaken an investigation of the chemical contamination present in sediments around John Whitton Bridge where the release

[12] https://www.beachwatch.nsw.gov.au/home and https://urbanplunge.sydneywater.com.au/

structure will be located (Sydney Water 2025b). This area is important to understand as this is the area where sediments could be disturbed during construction or operations.

The presence of contaminants in these sediments is not due to any actions related to this project. Such chemicals are present in these sediments due to historical industrial activities. However, the discharge and related activities may cause the chemicals already present to move with the sediments if they are disturbed or to wash out from sediments in the centre channel into the water if the sediments are disturbed. If this occurs these chemicals which could then travel to areas where people may recreate. Where those sediments remain undisturbed in the centre channel of the river, it would be difficult for a person to come into contact with the sediments or the chemicals in those sediments.

Such processes are not commonly considered in areas where there is no (or little) historical contamination of sediments, but they are an important aspect for this assessment as indicated by the SEARs.

It is important to note, however, that there are already many processes or activities that may disturb sediments in Parramatta River – primarily movement of boats especially the ferries but also including flooding and high wind situations. In relation to this project, it is whether there is more disturbance of sediments due to the new discharge than is the case now rather than whether there is any disturbance of sediments by the discharge at all.

The study took sediment samples (cores around 2 m in length – i.e. a tube of sediment that extended into the bed of the river to around 2 m depth). The sampling locations are shown in **Figure 5.4**. The figure also shows the wake of a ferry that travels through this area.

The cores were separated into 3 sections

- material in the top surficial sediments (classified as top 8 cm of the core)
- intermediate depth sediments (classified as material between 0.2-0.35 m depth)
- deep sediments (classified as material greater than 0.5 m depth).

These 3 layers were designed to give information about historical contamination as well as the whether the nature of the sediments near the surface makes them easily resuspended/disturbed due to the particle size and characteristics.

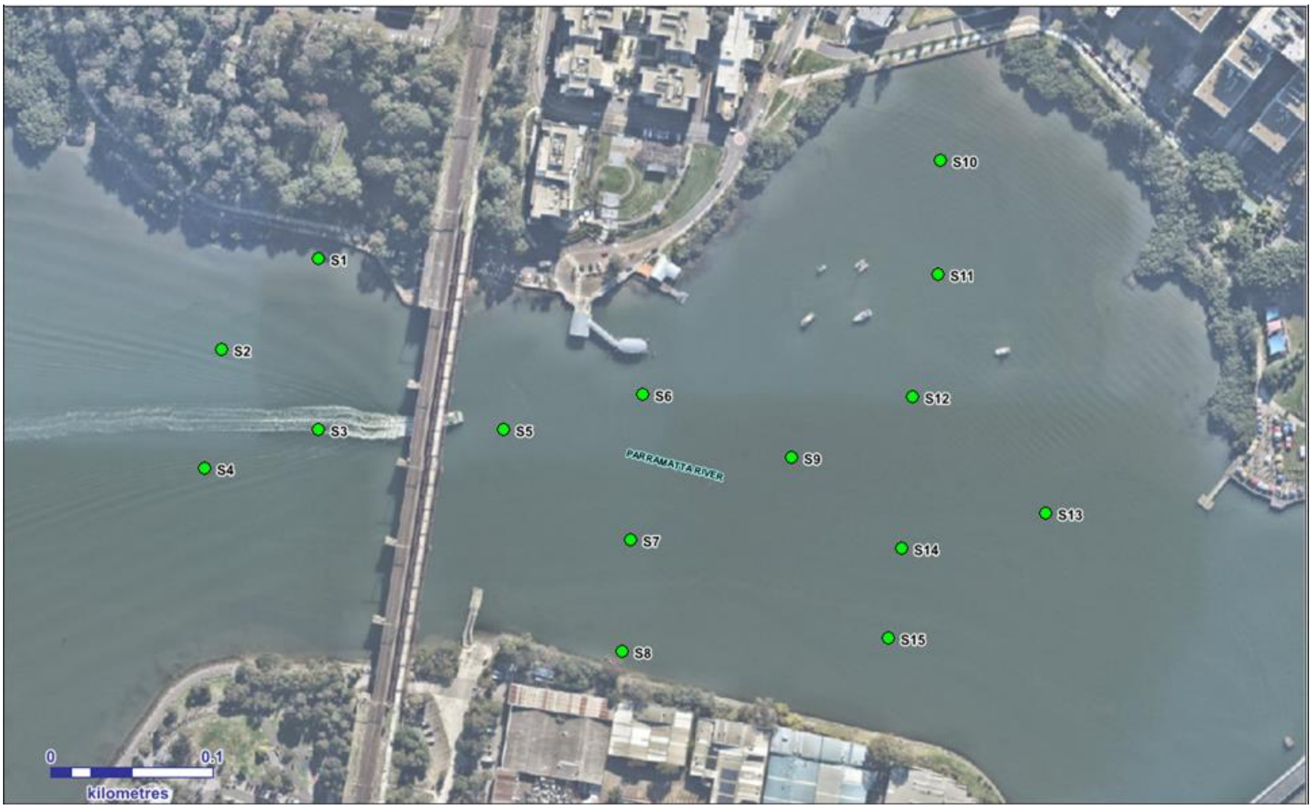


Figure 5.4: Sediment sampling locations in Parramatta River (Sydney Water 2025b)

Location S1 is close to the shoreline near where the discharge structure will move from land to the river and it was difficult to obtain appropriate samples from this location due to the presence of large amounts of shell rather than sediment within the area that was cored.

Locations S2, S3 and S4 in **Figure 5.4** are in the area where the discharge structure will be located.

Locations S5-S15 are in the area which may have potential for sediments to be disturbed due to any change in the currents resulting from the added volume of water entering the river.

Each sediment sample (i.e. each part of the core from each sampling location) was analysed for the following:

- metals/metalloids – arsenic, cadmium, chromium, cobalt, copper, lead, manganese, nickel and zinc
- calcium was also analysed to indicate shell content within the sediments
- polycyclic aromatic hydrocarbons (PAHs) including acenaphthene, acenaphthylene, anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, phenanthrene and pyrene
- dioxin-like compounds (including polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans)
- particle size distribution.

Particle size distribution

The particle size distribution for all of the samples indicated that these sediments are a mix of clay and silt with very little sand. Such fine material means these sediments may be prone to resuspension (especially compared to sandy sediments) unless present as cohesive muds. These findings also indicate that this area of Parramatta River is a depositional zone (i.e. suspended material falls out in this area onto the riverbed rather than being swept along with the tidal current). These results do mean that ensuring the potential for resuspension/disturbance of these sediments is a key driver for the design of the release structure.

Polycyclic aromatic hydrocarbons

Polycyclic aromatic hydrocarbons are naturally occurring chemicals that are formed whenever something is burned/combusted. They are also present in vegetation and in decaying vegetation (e.g. peat). They have been present in our environment for millions of years.

They are also present in our environment from a number of human activities including:

- gasworks – there was a large gasworks at Mortlake historically which resulted in coal and coal tar being present in the river – this is the major source of these chemicals in this area
- combustion – all burning of organic matter (wood, vegetation, fossil fuels etc) generates these chemicals so they are present in the particles and dust from along roads, in homes and in many other places – runoff from these areas will take these chemicals to the river.

These chemicals prefer to adhere to sediments rather than be dissolved in water.

It is important to note the following:

- there are many chemicals that fall into the “polycyclic aromatic hydrocarbons” group
- it has been standard practice for decades to measure 16 individual members of the group and undertake risk assessments and generate guidelines for those 16 only – on the basis that controlling for those 16 will control for the whole group as other members of the group will be present at much lower concentrations
- the 16 individual chemicals have been broken into 2 groups
    - carcinogenic PAHs – this group includes benzo(a)pyrene and ones that are very similar to that chemical (includes benzo(a)pyrene, benzo(e)pyrene benzo(a)anthracene, benzo(b&k)fluoranthene, benzo(ghi)perylene, chrysene, indeno(1,2,3-cd)pyrene and dibenzo(a,h)anthracene)
    - other lower molecular weight PAHs – this group includes the remaining members of the 16
- for the group labelled as carcinogenic PAHs, there are potency factors to apply to generate a concentration that is equivalent to the amount of benzo(a)pyrene (chosen as the reference compound) – similar to the calculations for dioxin-like compounds (NEPC 1999 amended 2013d, 1999 amended 2013b).

The availability of guidelines based on protection of human health for this group of chemicals when present in sediments are quite limited. Sediment guidelines are usually based on ensuring protection of aquatic organisms.

For this HIA, it is important to use guidelines that focus on people. Other documents forming part of this EIS will focus on ecosystems.

The ASC NEPM includes guidelines for PAHs in soil based on protection of human health. There are guidelines for low density residential, high density residential, open space/parklands and commercial/industrial land uses. The differences in these guidelines are based on differing assumptions about how much soil a person might be exposed to when at a site being used for a particular land use. For example, it is assumed that at a low density residential house, a person might spend quite some time gardening potentially every day while, at a commercial/industrial site, it would be much more unlikely that a person working at such a site would touch the soil so only a small amount is assumed in the calculation.

The ASC NEPM guidelines are based on a standard set of assumptions about how much soil a person would come into contact with while undertaking activities at a site for each land use. Sediments are somewhat different to soil because they are wet. The wet sediments are much more likely to stick to the skin when a person comes into contact, however, the sediments are also much more likely to wash off from the skin as a person leaves the water so the length of time a person may be exposed could be much shorter. As a result, using the soil guidelines to determine if there are elevated levels of these chemicals is likely to be appropriate and conservative.

Therefore, the guidelines that have been adopted are those included in the ASC NEPM for the carcinogenic PAHs group for low density residential land use (i.e. the most conservative value) and soil guidelines from the USEPA Regional Screening Levels for residential locations for the remaining compounds not specifically covered in the ASC NEPM (NEPC 1999 amended 2013c, 1999 amended 2013b; USEPA 2024).

The concentrations of the various chemicals in this group reported for the sediments in this part of the Parramatta River and the relevant guidelines are summarised in **Table 5.2**.

Table 5.2: Polycyclic aromatic hydrocarbons in sediments (Sydney Water 2025b)

Chemical	Average	Range (mg/kg)	Guideline (mg/kg)
Carcinogenic PAHs			
Benzo(a)anthracene	0.2	<0.01-0.92	See guideline for benzo(a)pyrene equivalents
Benzo(a)pyrene	0.4	<0.01-1.23	
Benzo(b&k)fluoranthene	0.6	<0.01-1.937	
Benzo(e)pyrene	0.3	<0.01-1	
Benzo(ghi)perylene	0.2	<0.01-0.594	
Chrysene	0.2	<0.01-0.856	
Dibenzo(a,h)anthracene	0.04	<0.01-0.119	
Indeno(1,2,3-cd)pyrene	0.2	<0.01-0.64	
Benzo(a)pyrene equivalents	0.5	0.005-1.7	3^{N}
Other PAHs			
Acenaphthene	0.01	<0.01-0.031	$3,600^{U}$
Acenaphthylene	0.08	<0.01-0.405	$3,600^{US}$
Anthracene	0.08	<0.01-0.247	$18,000^{U}$
Fluoranthene	0.5	0.018-2.29	$2,400^{U}$
Fluorene	0.02	<0.01-0.086	$2,400^{U}$
Naphthalene	0.01	<0.01-0.029	130^{U}
Perylene	0.06	<0.01-0.189	5.4^{U}
Phenanthrene	0.2	<0.01-0.855	$1,800^{US}$
Pyrene	0.7	0.019-3.86	$1,800^{U}$

Notes:

N = Health investigation level A (low density residential land use) from ASC NEPM (NEPC 1999 amended 2013c)

U = USEPA regional screening levels for residential soil (USEPA 2024)

S = Use of surrogate value for one of the other compounds as no guideline available – acenaphthene used for acenaphthylene and pyrene used for phenanthrene

None of the PAHs are present in these sediments at concentrations above these guidelines so, even if these sediments are disturbed by this project and people could be exposed, the risks to people will be negligible.

Dioxin-like compounds

Dioxin-like compounds are naturally occurring chemicals that are formed whenever something is burned/combusted. They have been present in our environment for millions of years.

They are also present in our environment due to a number of human activities including:

- chemical manufacturing – dioxin-like compounds were formed during the manufacturing of the chemicals used to make Agent Orange which occurred at the former Union Carbide site adjacent to Homebush Bay
- combustion – all burning of organic matter (wood, vegetation, fossil fuels etc) generates these chemicals so they are present in the particles and dust from along roads, in homes and in many other places – runoff from these areas will take these chemicals to the river.

These chemicals prefer to adhere to sediments rather than be dissolved in water.

It is important to note the following:

- there are many chemicals that fall into this group
- it is standard practice to measure 17 individual members of this group – 7 polychlorinated dibenzo-*p*-dioxins and 10 polychlorinated dibenzofurans – this group is considered to adequately represent the whole group as other members of the group are considered to be less toxic as they do not have the shape that allows them to interact with the Ah receptor – this is the receptor that controls for the most sensitive effects
- for each of these 17 compounds there are potency factors to apply to generate a concentration for the mixture that is equivalent to the amount of 2,3,7,8- tetrachlorodibenzo-*p*-dioxin (the most toxic of these compounds – chosen as the reference compound) (NEPC 1999 amended 2013d, 1999 amended 2013b)
- World Health Organisation publishes these potency factors. The factors are occasionally updated by an expert group. A set of factors was published in 1998, then updated in 2005 and then updated again in 2022 (DeVito et al. 2024; Van den Berg, M. et al. 1998; Van den Berg, Martin et al. 2006)
- the factors published most recently have been adopted for this assessment – i.e. the 2022 update (DeVito et al. 2024).
- combining the measured concentration of each of the 17 individual compounds and their potency factors gives a concentration in terms of the reference compound (i.e. 2,3,7,8-TCDD). All of these can be summed to give a “total equivalent concentration” or TEQ. It is this value that is then compared to guidelines based on protecting human health.

The availability of guidelines based on protection of human health for this group of chemicals when present in sediments are quite limited. Sediment guidelines are usually based on ensuring protection of aquatic organisms.

For this HIA, it is important to use guidelines that focus on people. Other documents forming part of this EIS will focus on ecosystems.

The ASC NEPM does not include soil guidelines for dioxin-like compounds but the USEPA regional screening levels for residential land use do include values for this group so they have been adopted for this assessment (NEPC 1999 amended 2013c, 1999 amended 2013b; USEPA 2024).

The concentrations of the various chemicals in this group reported for the sediments in this part of the Parramatta River and the relevant guidelines are summarised in **Table 5.3**.

Table 5.3: Dioxin-like compounds in sediments (Sydney Water 2025b)

Chemical	Range (pg/g)	Average (pg/g)	Potency factor	Average (pg TEQ/g)	Guideline (pg TEQ/g)
Polychlorinated dibenzo-p-dioxins					
2,3,7,8-TCDD	<0.1-18,000	495	1	495	See below
1,2,3,7,8-PeCDD	<0.6-260	20	0.4	8	
1,2,3,4,7,8-HxCDD	<1-330	31	0.09	2.8	
1,2,3,6,7,8-HxCDD	5.2-6,000	313	0.07	22	
1,2,3,7,8,9-HxCDD	2.7-1,100	72	0.05	3.6	
1,2,3,4,6,7,8-HpCDD	150-190,000	11,600	0.05	580	
OCDD	5,200-2,640,000	160,000	0.001	160	
Polychlorinated dibenzofurans					
2,3,7,8-TCDF	<0.1-450	38	0.07	2.7	See below
1,2,3,7,8-PeCDF	<0.6-9,200	450	0.01	4.5	
2,3,4,7,8-PeCDF	<0.6-560	30	0.1	3	
2,3,4,6,7,8-HxCDF	<0.6-680	36	0.1	3.6	
1,2,3,4,7,8-HxCDF	<0.6-4,800	257	0.3	77	
1,2,3,6,7,8-HxCDF	<0.6-600	28	0.09	2.5	
1,2,3,7,8,9-HxCDF	<0.6-1,000	43	0.2	8.6	
1,2,3,4,6,7,8-HpCDF	<0.6-14,000	670	0.02	13	
1,2,3,4,7,8,9-HpCDF	<0.5-2,000	87	0.1	8.7	
OCDF	<1.3-56,000	2,900	0.002	5.8	
WHO (2022) TEQs (full dataset	--	--	--	1,350	51[U1] 720[U2]
WHO (2022) TEQs (location 8 at 1 m depth removed)	--	--	--	650	

Notes:

U1 = USEPA regional screening levels for residential soil (USEPA 2024)

U2 = USEPA regional screening levels for commercial/industrial soil (USEPA 2024)

These results reflect the current/existing situation in Parramatta River sediments in this part of the river.

Location 8 was the location where the concentrations were highest for the dioxin-like compounds in the existing sediments, particularly in the deep sediments at around 1 m below the riverbed. Most other locations (and depths) were an order of magnitude or more lower than the values in these deep sediments. Location 8 is adjacent to the shoreline on the southern side of the Parramatta River and is potentially the area most impacted by sediments washing directly out of Homebush Bay while the Union Carbide site was operational. Given the location, it is unlikely this project could disturb the sediments at this shoreline location.

If the results for this sample are removed from the dataset, the WHO (2022) TEQ result for the average of all the rest of the samples is 650 pg TEQ/g – approximately half.

Further discussion of these results based on the depth of samples is also useful. The WHO (2022) TEQs average results include:

- 490 pg TEQ/g for the surface sediments
- 950 pg TEQ/g for the intermediate depth sediments
- 2,500 pg TEQ/g for the deep sediments.

These results show that the material that could be disturbed by this project are the sediments with smaller concentrations. The historical contamination was significant and sediments deep within the profile have much higher concentrations than those at the surface. While the intermediate depth sediments may get resuspended at times – during significant disturbance events (floods, storms etc) – the levels in the surface sediments are much lower showing only small amounts of these more contaminated sediments reach the surface during such events. It is the surface sediments that are the ones that could most commonly be disturbed.

The surface sediment results still show that the concentrations of this group of chemicals in these sediments are in excess of guidelines that would be protective of human health for residential situations (USEPA 2024). These guidelines do assume a person can come into direct contact with the sediments on a daily basis resulting in potential for incidental ingestion and skin absorption of these chemicals while gardening and interacting in a backyard.

For these sediments, the potential for a person to come into direct contact with the sediments is small and, if such could occur, the sediments would easily wash off before the person left the water so any exposure to these chemicals in these sediments is unlikely.

If the commercial/industrial guideline is used instead which is still conservative (assumes contact every day at work (240 days per year)), then the surface sediments are in compliance.

Metals

The metals and metalloids are elements – the building blocks of all matter – so they are naturally occurring. They are present in rocks and soil and sediments and as a result they are in the food we eat, the water we drink and the air we breathe. They are also in the environment due to activities of people. When material is burnt, small amounts are emitted due to their presence in the fuel. They are present in tyres and materials that form roads so when vehicles travel around the dust that is generated contains some of these elements. There are many products we use at home and at work that also contain these elements.

The availability of guidelines based on protection of human health for metals when present in sediments are quite limited. Sediment guidelines are usually based on ensuring protection of aquatic organisms.

For this HIA, it is important to use guidelines that focus on people. Other documents forming part of this EIS will focus on ecosystems.

The ASC NEPM includes soil guidelines for metals, so they have been adopted for this assessment (NEPC 1999 amended 2013c, 1999 amended 2013b). The concentrations of metals reported for the sediments in this part of the Parramatta River and the relevant guidelines are summarised in **Table 5.4**.

Table 5.4: Metals in sediments (Sydney Water 2025b)

Chemical	Average	Range (mg/kg)	Guideline (mg/kg)
Arsenic	17	8-33	100[N]
Cadmium	1	0.03-2.9	20[N]
Chromium	170	8-1,000	100[N]
Cobalt	8	3-14	100[N]
Copper	90	3-160	6,000[N]
Lead	180	8-320	300[N]
Manganese	90	25-160	3,800[N]
Nickel	14	2-30	400[N]
Zinc	490	14-930	7,400[N]

Notes:

N = Health investigation level A (low density residential land use) from ASC NEPM (NEPC 1999 amended 2013c)

These results show that concentrations of most metals in these sediments are not elevated in relation to relevant screening guidelines based on protection of people from Australian guidance – i.e. national soil screening guidelines for soil that will be present in low density residential backyards. The risks posed by their presence should people come into contact with them are, therefore, negligible.

The concentration of chromium is above the relevant conservative screening guideline. The ASC NEPM guideline for low density land use applies to chromium VI – the more problematic form of chromium. Most chromium in the environment is in the chromium III form. This is because this is the preferred form under most environmental conditions. So, while the average concentration of total chromium measured in these samples was above the HIL-A value, it is highly unlikely that chromium VI is above that guideline.

It is noted that there has been an industrial source of chromium upstream in Parramatta River at Camellia. That area has been remediated so levels of chromium washing off into Parramatta River should be reducing.

5.5.4 Swimming and recreational locations

In addition to assessing the potential issues in relation to people coming into direct contact with surface water at the release point or the nearby sediments, another aspect of importance here is the potential for locations recently opened for swimming or recreation such as Putney Beach and McIlwaine Park to be impacted by the discharge of advanced treated or tertiary treated water or by the disturbance of sediments from the area of the release structure.

Putney Beach (swim site) is around 2 km downstream of the location where the discharge structure will be located. McIlwaine Park (water play area) is in Brays Bay around 1.5 km from the discharge structure. The locations are shown on **Figure 5.5**.

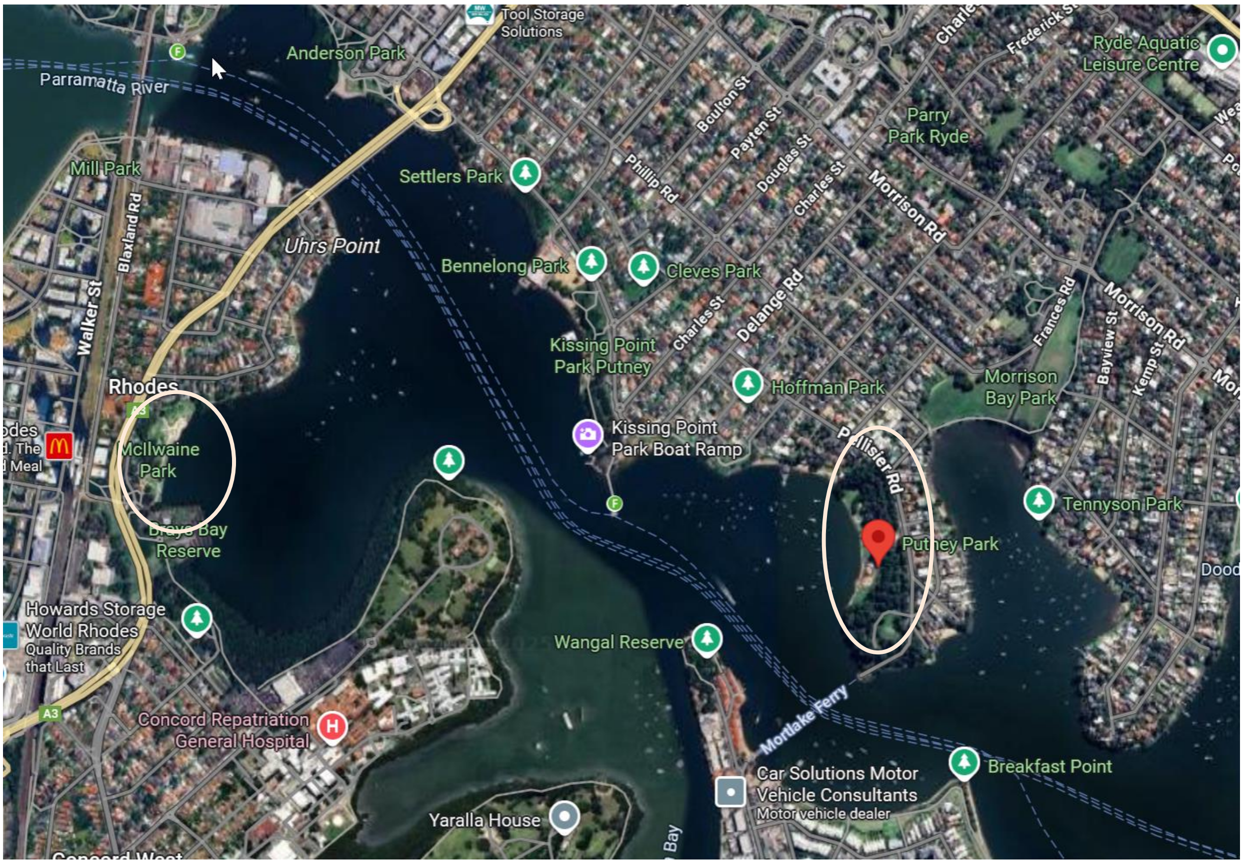


Figure 5.5: Locations of Putney Beach and McIlwaine Park (Google Maps)

Another location that is relevant is the dog beach just upstream of John Whitton Bridge. This location is shown in **Figure 5.6**. This location is a place where dogs can enter the water to play and their owners may wade as well.

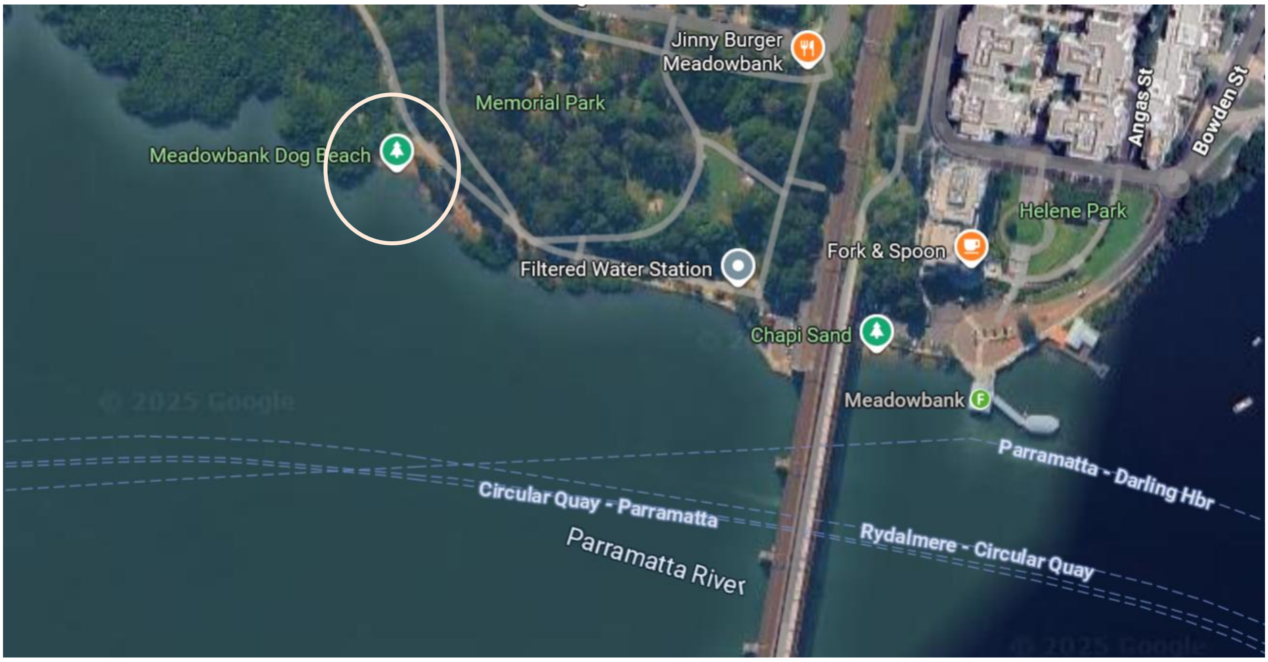


Figure 5.6: Locations of Meadowbank Dog Beach (Google Maps)

All of these locations are ones where sediments from the discharge structure area could be washed to if the sediments are disturbed or where changes in water quality due to the discharge could occur. As a result, designing the structure to minimise disturbance of the sediments in the vicinity of the structure to the maximum extent practicable and to ensure rapid mixing of the advanced treated or tertiary treated water has been an important aspect of the project design process.

5.6 Water quality specific project details

5.6.1 General

The advanced treated water will be discharged into the Parramatta River via the river release structure at Meadowbank near John Whitton Bridge (Sydney Water 2025a).

5.6.2 Discharge structure

Due to the levels of contamination in these sediments from historical activities, particular attention has been paid to the design of the discharge structure. Jacobs (2025a) has undertaken detailed modelling of the potential for sediment disturbance for various configurations.

They note that the design of the nozzles along the discharge pipes must prioritise minimising turbulence and shear stresses at the riverbed (Jacobs 2025a).

The design has, therefore, considered the following configurations:

- Nozzles need to be directed away from the riverbed – ideally in upward direction but straight up may not ensure good mixing so balance is needed
- Velocity of the discharge needs to be limited so the flow doesn't cause scouring or flow recirculation
- Impacts of tidal flows and other river currents must be considered to ensure the design allows the treated water to mix into the river easily at all times
- Flow from the nozzles needs to be such that they do not impact on recreational users (fishing boats, paddleboard users and kayaks etc) (Jacobs 2025a).

It is noted that fishing restrictions exist in Parramatta River which are likely to mean there will be few, if any, boats undertaking fishing in the area (see **Appendix A** for details). There are, however, ferries travelling through this area. People on the ferries do not tend to come into contact with the water in the river during their travel – at least not in the same way as when people undertake fishing or other recreational activities.

Computational fluid dynamics modelling (CFD modelling) was undertaken for a range of scenarios to ensure the most effective design was found (Jacobs 2025).

Twelve different scenarios were modelled by Jacobs:

- 6 background scenarios that did not include the discharge to allow understanding of the existing (and future) conditions in the river
- same 6 scenarios but with the discharge to allow understanding of the potential for changes in flows in the river due to the discharge.

These scenarios included high flows, average flows and low flows (Jacobs 2025a).

The modelling looked at the impacts of the discharge flow over around 300 m of the river – 135 m upstream of the pipes/nozzles and 185 m downstream. This area was broken up into tiny mesh blocks (>millions) which allow the changes in flow to be considered in detail across the whole area including the impact of specific aspects that vary in each spot like depth of riverbed, location of structures, characteristics of the sediments (particle size distribution) etc (Jacobs 2025a).

Modelling was used to optimise the arrangement of the nozzles and flows through the nozzles. This results in determining the most appropriate way to angle the nozzles and indicated that an estimated discharge velocity of around 2.5-3 m/s for each nozzle would be appropriate. Given the diameter of the nozzle this results in around 30 L/s being discharged through each nozzle. While the velocity of the river flow is around 0.1 m/s on average (order of magnitude less), this is across the horizontal extent of the river which means 30 L/s for each nozzle is mixing into 1,000s of L/s in the river (Jacobs 2025a).

The placement of the nozzles was then evaluated taking into account the varying depth across the riverbed and the location of the bridge piers to make sure the nozzles were placed appropriately (Jacobs 2025a).

The nature of these sediments indicated that flows in the river near the riverbed of less than 0.1 m/s would be unlikely to disturb sediments as there is not enough speed to overcome the stickiness of the sediment particles. If the discharge caused a change in velocity in the river more than 1.2 m/s, then disturbance of sediments may be significant (Jacobs 2025a).

The CFD modelling was undertaken with and without the discharge to determine the difference in velocities at the riverbed due to the discharge. In most cases and at most locations, the velocity of the flows near the riverbed with the discharge were 0.1 m/s or less. There were some locations where flows at the riverbed were between 0.1 and 0.2 m/s which may result in some very minor sediment disturbance just adjacent to a nozzle particularly during extremely low flow conditions at the turn of the tide when the tidal flows in the river slow (Jacobs 2025a).

The addition of a geosynthetic concrete mattress beneath the pipes and nozzles (as shown in **Figure 5.7**) and an overlying concrete mattress to anchor the structure in place was then considered to ensure sediment disturbance will be minimised to the maximum extent possible (Jacobs 2025a).

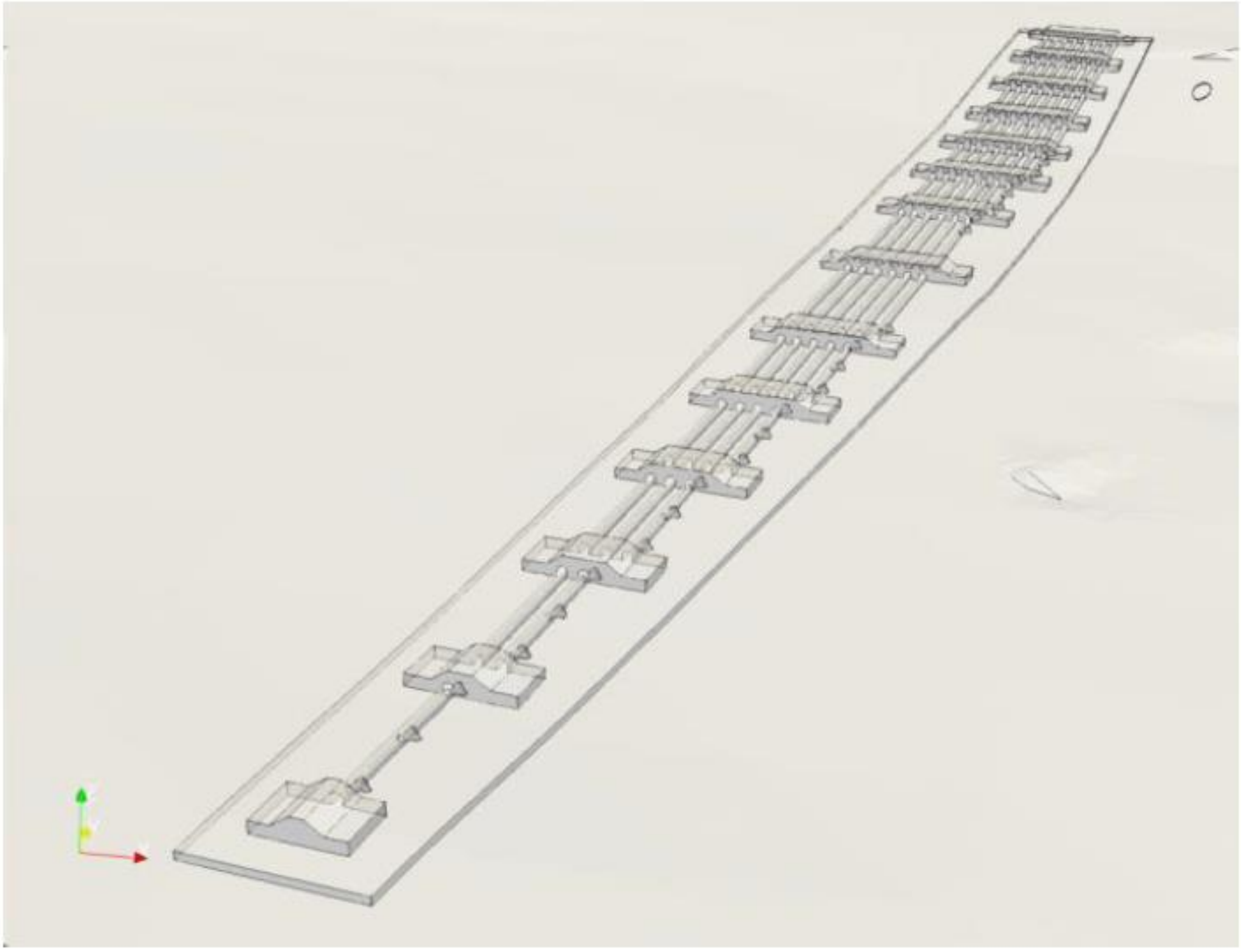


Figure 5.7: Extent of base on which pipes and nozzles will be placed (Jacobs 2025a)

Further modelling was undertaken to check if the change in flows due to the discharge could make any difference to boats and other recreational activities on the river surface. The focus of this work was on a paddleboard during low flow conditions close to the discharge structure – as shown in **Figure 5.8** (Jacobs 2025a).

The modelling showed that the change in flows due to the discharge would not be noticeable at the river surface even under these worst case conditions (Jacobs 2025a).

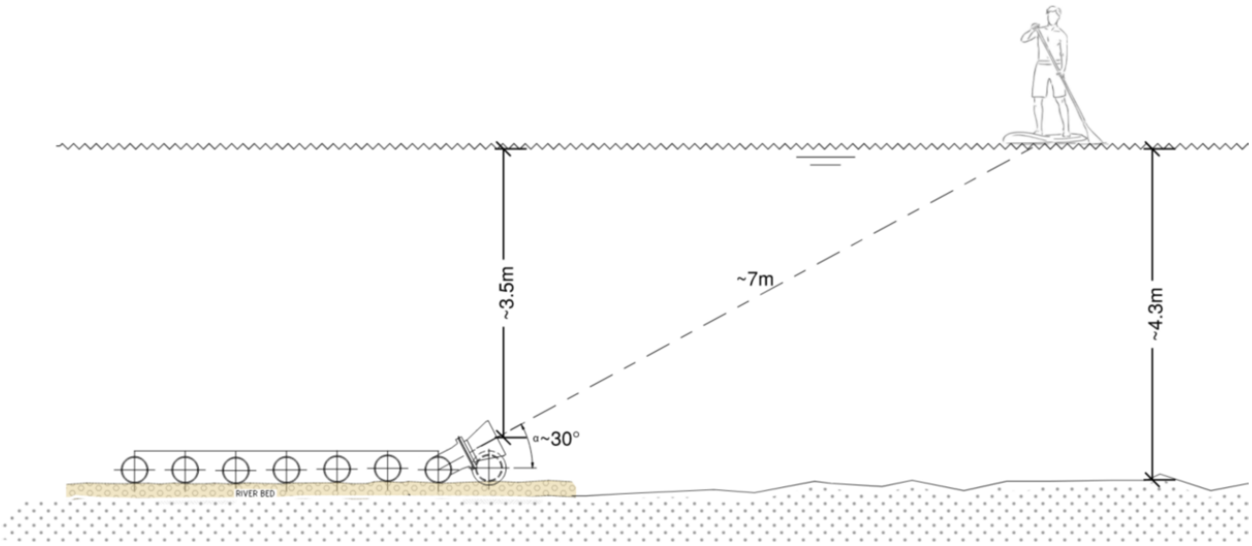


Figure 5.8: Model scenario used to assess impacts on recreational users (Jacobs 2025a)

Therefore, appropriate modelling has been undertaken to inform the design of the discharge structure with the goals to minimise potential for sediment disturbance to the maximum extent practicable along with ensuring no impacts on recreational activities in the river.

5.7 Assessment of health impacts related to surface water quality

5.7.1 Construction

Potential for impacts on water quality during construction have been considered – particularly in relation to the discharge structure in Parramatta River (Sydney Water 2025c).

During construction of most parts of this project, potential for changes in water quality impacts are to impacts of any changes in the way stormwater runoff occurs or in the quality of water in the stormwater, particularly where earthworks are being undertaken. Such stormwater could be impacted by higher levels of suspended solids as it runs across cleared areas and picks up soil as it goes. This is common with all types of construction where the ground is cleared of vegetation (Sydney Water 2025c).

Guidance is available from government sources which indicate requirements for managing stormwater during construction so that stormwater containing excess levels of suspended solids does not enter waterways. This includes having exclusion zones immediately adjacent to waterways or guiding stormwater runoff into retention ponds to slow the movement of water so the particles can settle out. Works such as those required for this project must be undertaken in accordance with those requirements (Sydney Water 2025c).

Mitigation measures will be in place during construction to protect waterfront areas. Where works will occur further away from such waterways, stormwater runoff will need to travel further to reach the waterways allowing time for particles to settle etc. It is also assumed appropriate stormwater and erosion controls will be incorporated on the WRRF site and on the pipeline routes, where possible, to ensure to the extent practicable that muddy stormwater does not leave the work sites (Sydney Water 2025c).

In relation to construction of the river release structure, works will need to be carefully managed to minimise disturbance of the sediments during works and to ensure the materials being placed in the river do not have impacts on water quality. Detailed planning for this part of the works will be required in the construction environmental management plan and would include matters such as:

- Timing works in line with appropriate parts of the tidal cycle
- Effective and timely communication with those who use the river in that area to coordinate access – especially in regard to ferry movements and those who use the area for rowing training
- Use of silt curtains or other sediment control devices around the works to minimise movement of sediments due to the works
- Careful placement of pea gravel or other relevant material prior to works commencement to help hold the existing fine sediments in place (i.e. such material should not be dropped from height but placed carefully as close to the riverbed as possible)
- Continuous monitoring of turbidity (with alert system to those working in the river) to alert workers when a silt curtain or other control device has failed or moved
- Consideration of the nature of the materials being used in the river release structure to ensure materials that are unlikely to impact on water quality are chosen – plastic pipes etc are unlikely to have impacts on water quality but use of concrete may need to be carefully managed to ensure pH issues do not arise and that the concrete sets with the desired characteristics.

It is expected that there will be negligible impacts on water quality that could impact on people during construction as long as appropriate management actions are put in place.

5.7.2 Operations

General

The focus of this assessment is the potential for impacts on community health from changes in water quality due to discharges of advanced treated or tertiary treated water into Parramatta River from the Camellia WRRF (Sydney Water 2025a).

Potential for such impacts has been subject to detailed water quality modelling in Sydney Water (2025a&c). Detailed modelling of Parramatta River and Port Jackson has been undertaken using the MIKE series of models. In addition, modelling using the MOUSE series of models to evaluate changes in flows through the sewage system has been undertaken.

Modelling of water quality has been based on a range of scenarios that included consideration of expected changes in the catchment (changes in land use etc) as well as issues around the performance of the proposed wastewater treatment plant.

The assessed scenarios include:

- Baseline scenario (i.e. current conditions without the project).
- Background scenarios for potential future conditions at 2056 with no discharges for this project but considering the situation with and without the standard requirements for assessing impacts of climate change.
- Project scenario for conditions at 2056 where there are discharges to Parramatta River for this new WRRF. This scenario has also considered with and without the standard

requirements for assessing impacts of climate change. This scenario includes 63 ML/day of advanced treated wastewater from the new facility for all situations except when maintenance is occurring for the reverse osmosis part of the plant – at these times, the discharge will be high quality treated water (i.e. all processes apart from reverse osmosis) at 70 ML/day. This is expected to only occur for 2 days at a time, on 2 occasions each year (Sydney Water 2025a).

The modelling has assumed the treated water to be discharged to Parramatta River has the characteristics listed in **Table 5.5**.

Table 5.5: Assumed water quality parameter values for advanced treated wastewater for use in modelling (Sydney Water 2025a)

Parameter	Advanced treated water	Tertiary treated water
Total suspended solids (mg/L)	4	1
Salinity (g/L)	0.08	0.75
Salinity (µS/cm)	200	1,500
Flow (ML/d)	63	70
Total nitrogen (mg/L)	0.35	3
Organic nitrogen (mg/L)	0.1	1.2
Ammonia (mg/L)	0.03	0.2
Oxidised nitrogen (NO_2 + NO_3) (mg/L)	0.22	2.5
Nitrate (mg/L)	0.1	2.5
Total phosphorus (mg/L)	0.009	1
Inorganic phosphorus (mg/L)	0	0.002
Free reactive phosphorus (mg/L)	0.006	0.66
Organic phosphorus (mg/L)	0.003	0.338
Dissolved oxygen (mg/L)	6	5.9
Enterococci (CFU per 100 mL)	0	0
Temperature (°C)	23.2	23.2
Total organic carbon (TOC) (mg/L)	0.5	10

In regard to overall loads to the river, the modelling has looked at the loads of total nitrogen, total phosphorus and enterococci due to the new facility. Runoff from the catchment and wet weather overflows have been considered as well as the discharge of the treated water. The modelling looked at loads downstream to Cockatoo Island.

Nutrients

Figure 5.9 shows the estimated annual loads of total nitrogen for an average rainfall year. The graphs shows that the new discharge makes only a very small contribution to the overall load of this nutrient in the river system. This is shown in the Sc3 scenarios.

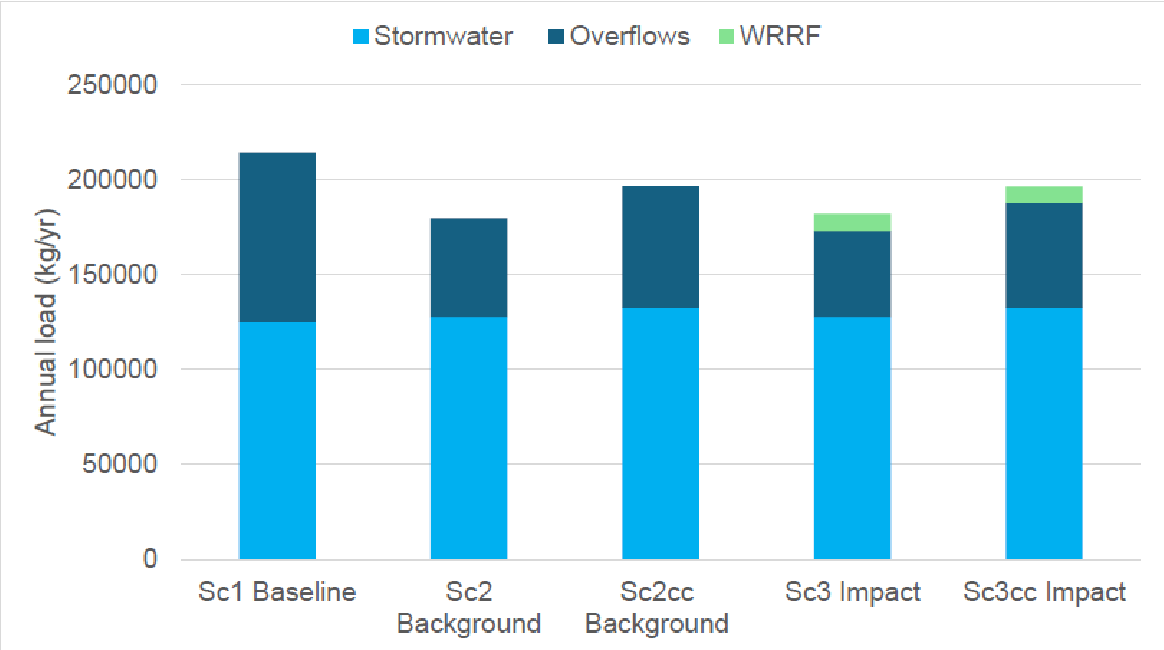


Figure 5.9: Estimated annual loads for total nitrogen – average rainfall year (Sydney Water 2025a)

This graph shows that stormwater (i.e. light blue part of the bar) – i.e. rainfall runoff – makes the most significant contribution to loads.

The treated water will have very low levels of total nitrogen (and other forms of this nutrient) so the overall nitrogen levels in the river will be lower as a result of the WRRF discharge – this is due to the high level of treatment at the Camellia-Rosehill WRRF and the increase in capacity of the overall system which will reduce overflows of untreated wastewater. Concentrations of the nitrogen species in the advanced treated water will be in compliance with the relevant guidelines and so impacts on health will be negligible.

Figure 5.10 shows the estimated annual loads of total phosphorus for an average rainfall year. The graphs shows that the new discharge makes only a very small contribution to the overall load of this nutrient in the river system. This is shown in the Sc3 scenarios.

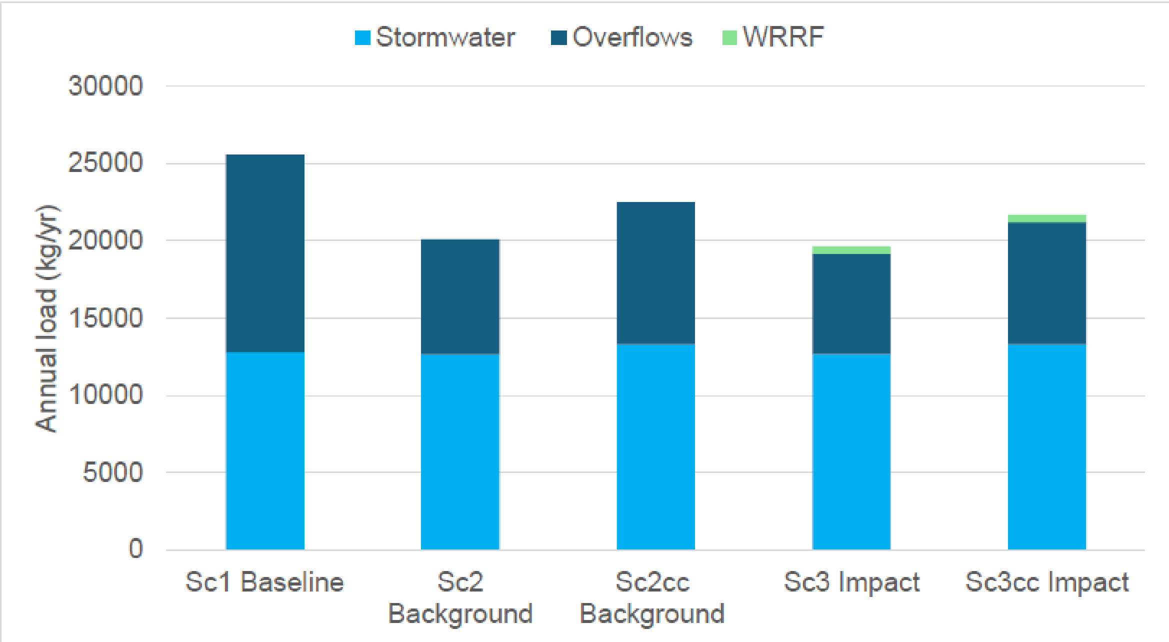


Figure 5.10: Estimated annual loads for total phosphorus – average rainfall year (Sydney Water 2025a)

This graph shows that, again, stormwater (i.e. light blue part of the bar) – i.e. rainfall runoff – makes the most significant contribution to loads.

The treated water will have very low levels of total phosphorus (and other forms of this nutrient) so the overall phosphorus levels in the river will be lower as a result of the WRRF discharge – this is due to the high level of treatment at the Camellia-Rosehill WRRF and the increase in capacity of the overall system which will reduce overflows of untreated wastewater.

These figures also show that annual loads are expected to decrease over time with the new facility – i.e. Sc3 is a lower total than Sc1 and Sc2. This is because there will be fewer overflows of untreated wastewater from the sewage system as this facility provides an expansion to the overall capacity of the system. This means overflow frequency and volumes will reduce.

Microbial water quality

Figures 5.11, 5.12 and **5.13** show the estimated 95th percentile concentrations of enterococci for an average, lower and higher rainfall year at each of the various swim/recreational locations downstream of the location of the discharge structure.

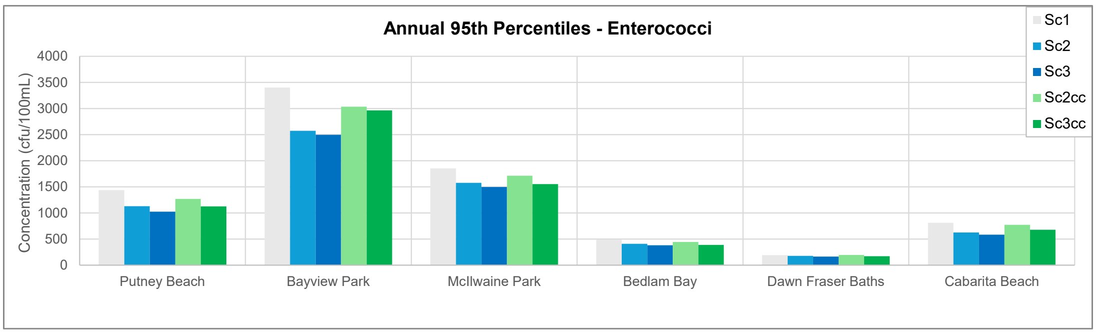


Figure 5.11: Estimated 95th percentile concentrations of enterococci – average rainfall year (Sydney Water 2025a)

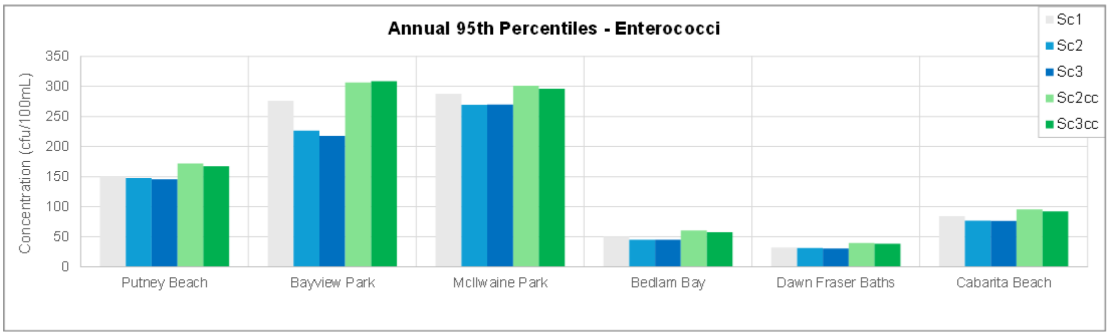


Figure 5.12: Estimated 95th percentile concentrations of enterococci – low rainfall year (Sydney Water 2025a)

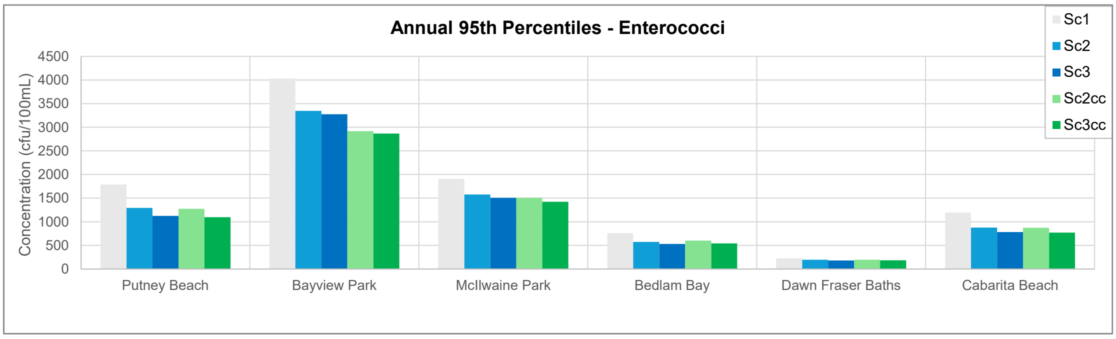


Figure 5.13: Estimated 95th percentile concentrations of enterococci – high rainfall year (Sydney Water 2025a)

The grey bars show the modelled concentrations under the current conditions. The modelled concentrations for scenarios 2 and 3 show the same or improved microbiological quality of water in Parramatta River compared to the current situation - in particular, scenario 3 (i.e. situation in 2056 with the proposed discharge). This is due to the effectiveness of the treatment to be provided which will ensure that the advanced treated water to be discharged will have no detectable enterococci so adding that volume of water into the river (i.e. 70 ML/day) with no additional microorganisms will result in a similar or slightly low predicted concentration.

These graphs also show that concentrations of enterococci are much lower in low rainfall years compared to average rainfall or high rainfall years which would be due to the lack of stormwater flows into the river as well as the lack of overflows of untreated wastewater.

Enterococci levels in Parramatta River at locations where people may swim in the vicinity of this discharge structure have also been modelled. This includes Putney Beach (i.e. closest swim site).

Figure 5.14 shows the predicted difference in the concentrations of enterococci levels at Putney Beach between Scenario 2 and 3 – i.e. difference for 2056 with and without the proposed discharge. All the changes in these concentrations show the same or lower concentrations with the proposed discharge compared to the situation without the proposed discharge. For most of the year concentrations will be the same with and without the proposed discharge. During times when higher rainfall is expected (February, March) peak concentrations are reduced due to the increase in flow with no increase in enterococci levels for the actual discharge plus the reduction in overflows due to the higher capacity of the system with the new plant and associated discharge.

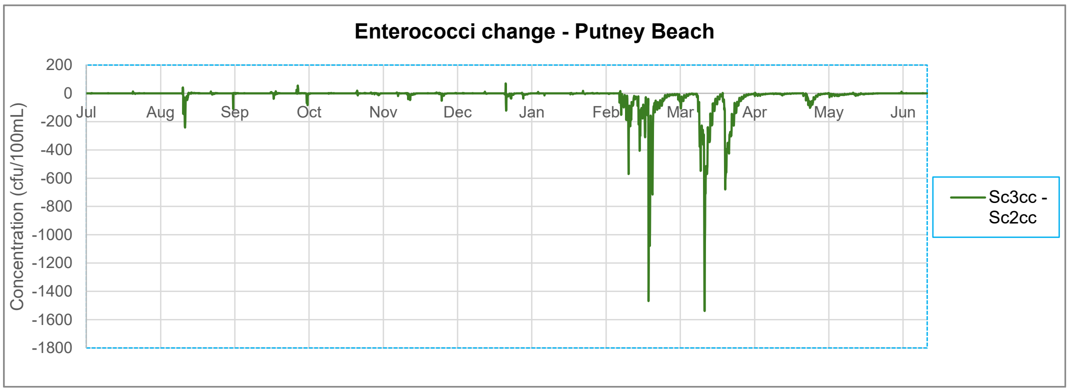


Figure 5.14: Predicted change in concentrations of enterococci at Putney Beach between the 2056 scenarios with and without the discharge for a high rainfall year (Sydney Water 2025a)

This means it is expected that there will be no noticeable change in the enterococci concentrations due to this project which is as expected, given the advanced level of treatment to be provided at this WRRF and the design of the river release structure which should ensure thorough mixing.

Salinity

The treated water will have a very low level of salinity, given the reverse osmosis treatment process. This is an estuarine area of Parramatta River where salinity already varies over a large range on a daily basis (i.e. across each tidal cycle) so it would not be expected that the discharge would cause any noticeable change in the River.

Dilution – in relation to other chemicals

The potential for the advanced treated water to be diluted immediately at the point of discharge through the diffusers and downstream of this area is important to consider when evaluating the potential concentrations of other chemicals that could be present in Parramatta River as a result of this discharge. The understanding of dilution generated in the modelling (as discussed here) is combined with the understanding of the concentrations of other chemicals that may remain in the advanced treated water (discussed below) to provide the concentrations of such chemicals people recreating in the River may be exposed to and to allow comparison with recreational water quality guidelines.

Dilution of the discharge has been modelled for peak flow velocity, median flow velocity and low flow velocity across the tidal cycle. As shown in **Figures 5.13, 5.14** and **5.15**, a dilution of at least 25 fold will be occurring even under the lowest flow situation (see **Figure 5.15**) with dilution of up to 100 fold at peak flow velocity (see **Figure 5.13**) which occurs at the mid point in the tidal cycle. These dilutions occur by around 30 m downstream of the diffusers (i.e. immediately downstream of the John Whitton Bridge approximately).

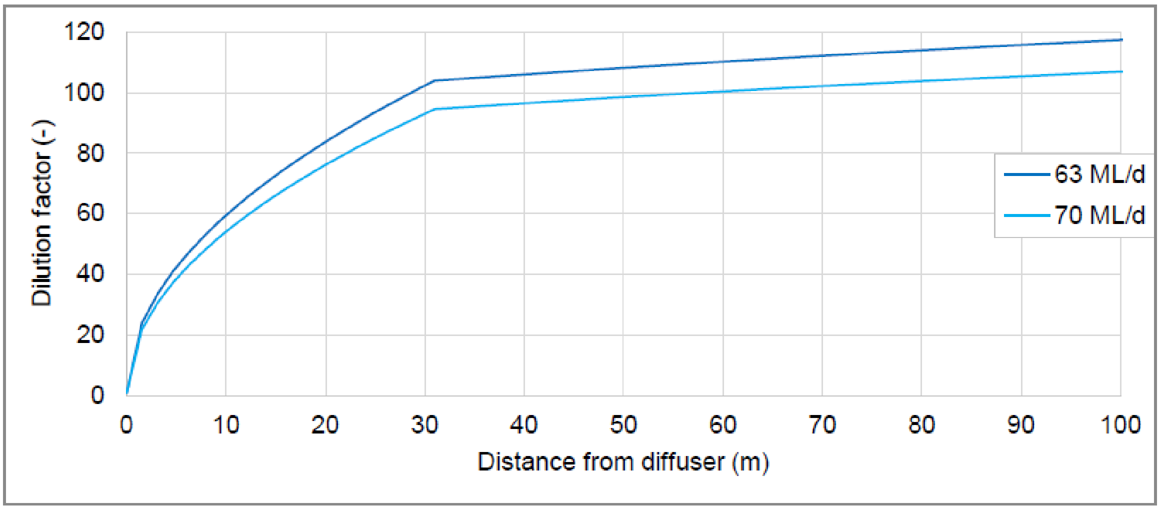


Figure 5.13: Dilution of discharge – peak flow velocity (Sydney Water 2025a)

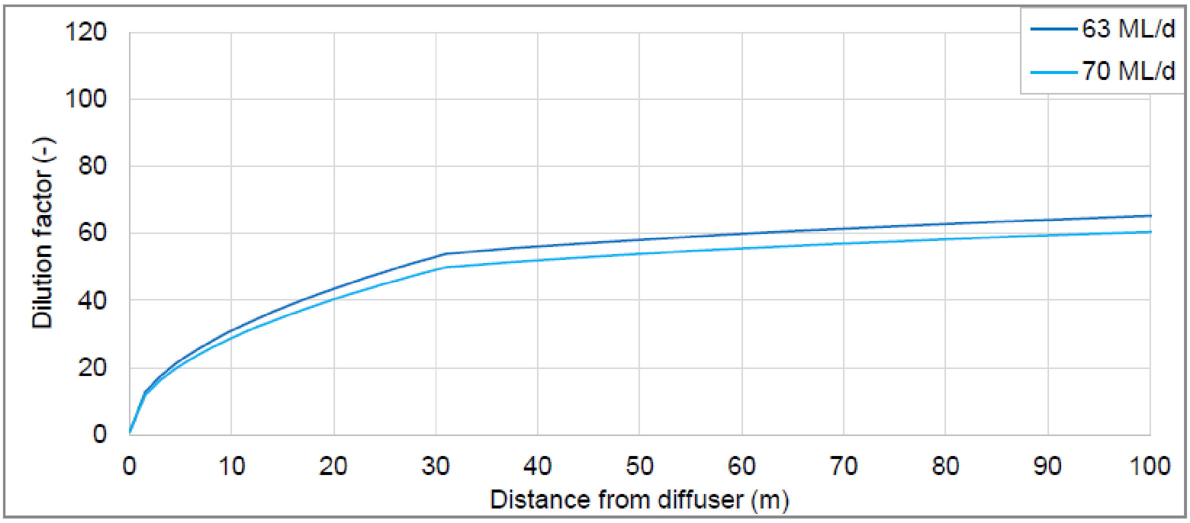


Figure 5.14: Dilution of discharge – median flow velocity (Sydney Water 2025a)

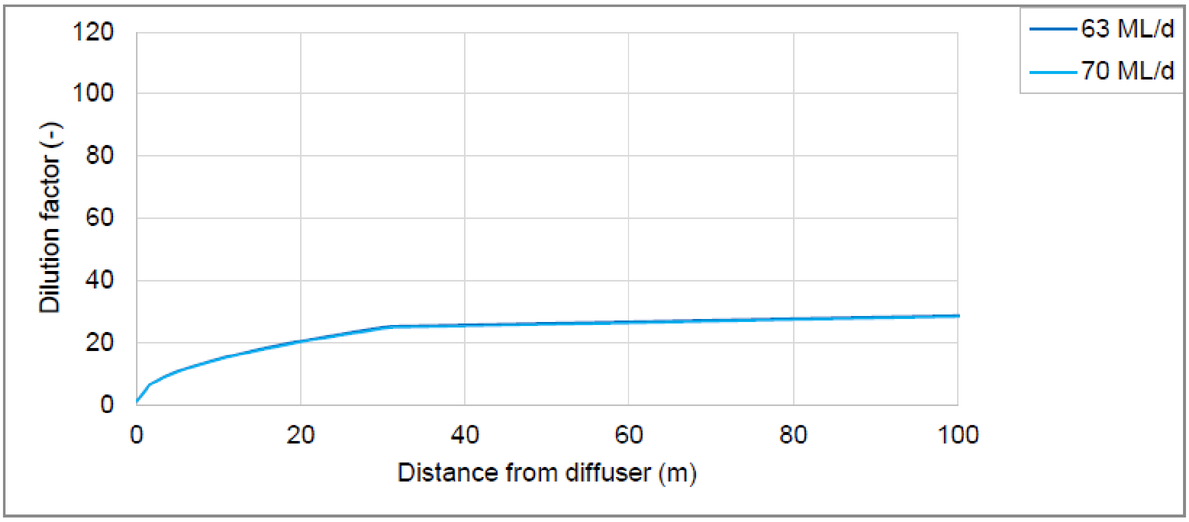


Figure 5.15: Dilution of discharge – low flow velocity (Sydney Water 2025a)

Other chemicals

As discussed in **Section 5.3.3**, a wide range of chemicals will be present in untreated wastewater. Many of these chemicals will be naturally occurring ones from the metabolism in people of food and water. Others will be from the personal care products (like shampoo), cleaning products (like dishwashing or clothes washing detergents) or medicines (like Panadol or Nurofen) that we all use every day. Other chemicals will come from stormwater runoff or from industrial discharges.

The treatment processes proposed for this WRRF will treat many of these contaminants (break them down into component parts etc). The reverse osmosis process will further remove many of the remaining contaminants. This does not mean that there will be 100% removal but that levels will be reduced significantly, if not close to 100% removal.

As part of the water quality impact assessment, monitoring data for treated water quality at the St Marys advanced water treatment plant (as indicator for water subject to reverse osmosis) and at Penrith, St Marys and Rouse Hill water recycling plants (as indicator for water subject to tertiary treatment) were compared to relevant guidelines.

This comparison identified that total chlorine and copper were contaminants that could be present in advanced treated water (i.e. from a plant with reverse osmosis) at concentrations that warrant further consideration.

It also identified that total chlorine, nitrate, aluminium, copper, mercury and zinc could be present in tertiary treated water (i.e. from a plant with tertiary treatment (but not reverse osmosis)) at concentrations that warrant further consideration. It is important to note that the information in relation to potential contaminants in tertiary treated water is only relevant for this discharge when the reverse osmosis unit is not operational which is expected to only be for up to 2 days on 2 occasions during the year based on maintenance requirements or potentially some additional days should there be a failure in relevant parts of the facility.

It is noted that water quality guidelines for the protection of ecosystems were used to identify these chemicals in Sydney Water (2025a). These are the guidelines relevant to protecting aquatic ecosystems rather than identifying potential for impacts on people should they be exposed to the treated water. This means that these contaminants may not actually be relevant in relation to potential for impacts to people.

Table 5.6 shows the comparison with the assumed concentrations of these contaminants in treated water, background water quality and the guidelines relevant for protecting people's health – the recreational water quality guidelines.

Table 5.6: Comparison to guidelines for protecting people's health

Contaminant	Assumed concentration in advanced treated water (mg/L)	Assumed concentration in tertiary treated water (mg/L)	Background water quality in Parramatta River (mg/L)	Recreational water quality guideline (mg/L)	Water quality guideline for protecting aquatic ecosystems (mg/L)[1]
Total chlorine	0.01	0.0072	0	$5^{A}/50^{R}$	0.0072
Aluminium	--	0.037	0.012	0.2^{Ae}	0.055
Copper	0.0014	0.012	0.0016	$2^{A}/20^{R}$	0.0013
Nitrate[2]	--	0.004	0.01	$50^{A}/500^{R}$	2.4
Mercury	--	0.0002	0.00001	$0.001^{A}/0.01^{R}$	0.00006
Zinc	--	0.07	0.0135	3^{Ae}	0.008

Notes:

1	= values from ANZG (2018) used in Sydney Water 2025a
2	= concentrations for nitrate in Table 4-10 in the Water Quality Impact Assessment are flagged as being in terms of µg/L but this cannot be the case. The values listed must be for concentrations in terms of mg/L as it is not possible to measure nitrate at less than 1 µg/L and it is also not likely that concentrations of nitrate in Parramatta River are less than 1 µg/L. In addition, the 95% species protection water quality guideline is 2.4 mg/L.
R	= NHMRC recreational water quality guideline – the value that is 10x the drinking water guideline (NHMRC 2008)
A	= NHMRC drinking water guideline (value on which recreational water quality guideline is based) (NHMRC 2011 updated 2025)
Ae	= NHMRC drinking water guideline based on aesthetic characteristics – i.e. taste, odour, potential for damage to infrastructure, potential for spots on washing (NHMRC 2011 updated 2025) These guidelines are not adjusted in relation to recreational water quality as the aesthetic issue may still be relevant at the same concentration as for drinking water systems. It is also noted that the aesthetic issue may not be at all relevant for a recreational water quality situation – e.g. impacts on pipes and pumps (i.e. infrastructure) are unlikely to be relevant for a recreational location.
U	= USEPA regional screening level for tap water (USEPA 2024)
UR	= USEPA regional screening level for tap water adjusted to be a recreational water quality guideline using Australian guidance (i.e. 10x) (USEPA 2024)

Based on this information, the following is noted:

- Most of these listed contaminants will always be present in urban waterways like Parramatta River – due to weathering of rocks, runoff from roads, parks, homes and other buildings, leaching from paints on boats and other watercraft etc – the issue is whether the discharge for this project will increase/change the concentrations in the river.
- Existing water quality in Parramatta River includes:
  - concentrations of copper that are already at the concentration/slightly higher than the expected concentrations in the advanced treated water (i.e. the difference between 0.0014 and 0.0016 mg/L is not measurable).
  - for most other contaminants concentrations in the advanced treated water and/or the tertiary treated water are similar to those already in the river.
- When the treated water is released into the river (whether advanced treated >99% of the time or tertiary treated water on around 4 days per year), it will be immediately diluted by the water already in the river. The release structure has been designed to ensure this occurs rapidly as discussed above.
- If the concentrations of most contaminants in the treated water prior to it being discharged are already the same or lower than the existing levels in the river, then the discharge cannot cause concentrations of a contaminant to increase in the river (i.e. the water quality in the river to get worse).
- For treated water that has been subject to reverse osmosis treatment (i.e. advanced treated water), none of the flagged contaminants will be present at concentrations above guidelines relevant for recreational water quality so risks to community health will be low/negligible.
- For treated water that has not received reverse osmosis treatment (i.e. tertiary treated water that will only be discharged for around 4 days per year), all contaminants will be at concentrations well below recreational water quality guidelines so risks to community health will be low/negligible.
- Also, as discussed above (under dilution), there is at least a 25 fold dilution of the discharge in the area immediately around the discharge structure even during low flow conditions at high tide or a low tide (i.e. when the tide turns and water flow in the river flow drops to its

- lowest level for a short time). Under other tidal conditions, the dilution can be up to 100 fold close to the structure.
- Dilution levels will be even higher as the water mixes across the whole river and moves downstream with the river flow toward swim sites and other recreational areas (up and downstream of John Whitton Bridge), so concentrations of contaminants from the discharge will be even lower than those considered in **Table 5.6**.

Consideration of the potential for impacts on aquatic ecosystems is provided in some of the other technical papers including Sydney Water (2025a) and Stantec (2025b).

5.8 Ongoing management and monitoring

It is important to manage and monitor the treatment processes used at the Camellia-Rosehill WRRF. This verifies that processes are operating correctly and are producing water that meets relevant guidelines. It also means action can be taken in the unlikely situation that water does not meet those guidelines, to ensure any water of unsuitable quality does not get discharged to Parramatta River.

Regular monitoring will occur for advanced treated and tertiary treated water and for water in the Parramatta River once the project has been implemented to ensure that conditions are as considered in this EIS. Such monitoring will be incorporated into the Environment Protection Licence from the NSW EPA for this plant (Sydney Water 2025a).

Monitoring of the treated water will be undertaken in accordance with the requirements of the Environment Protection Licence from the NSW EPA for this plant (Sydney Water 2025a).

Ambient monitoring within the receiving environment in Parramatta River will be undertaken approximately every 3 weeks as part of the existing Sydney Water Aquatic Monitoring program (SWAM). Monitoring will be undertaken at 2 locations – 1 upstream of the discharge structure and 1 downstream of the discharge structure. The final locations for monitoring will be based on consultation with NSW EPA (Sydney Water 2025a).

Aspects of the project have been specifically designed to mitigate existing issues that are already impacting on water quality within Parramatta River – especially wet weather overflows – i.e. operation of this project should improve water quality within the river. This has been addressed primarily by increasing the overall capacity of the system during wet weather events. This increased capacity arises because of the new WRRF and reduces the need for wastewater to be transferred into the NSOOS – which currently can reach capacity at times during such wet weather events resulting in overflows of untreated wastewater into the environment around Parramatta River.

5.9 Outcomes of health impact assessment

Table 5.7 presents a summary of the outcomes of the assessment undertaken in relation to the impacts on community health of changes in water quality, associated with the proposed project.

Table 5.7: Summary of health impacts – water

Water quality	
Benefits	Provision of sufficient treatment plants to manage wastewater in an urban area is a benefit to the health of the community. This project is also expected to increase the capacity of the system in this area which will reduce overflows etc. This will result in improved water quality in Parramatta River.
Impacts	The project has been designed to minimise any potential for changes to water quality in Duck River and Parramatta River that might impact on community health. In particular, the design of the river release structure has been very detailed. Risks to community health due to changes in water quality are expected to be negligible as long as all relevant mitigation measures and design features are included in the project.
Mitigation	The detailed design for the river release structure is a primary tool in mitigating any potential changes in water quality due to the project. Other mitigation measures include standard stormwater management measures for all large construction measures such as collection of stormwater from relevant areas, inclusion of retention ponds where needed on construction sites and enforcing exclusion zones for works adjacent to waterfront locations.

Section 6. Health impacts: Air

6.1 Introduction

This section presents a review of impacts on health associated with predicted air emissions and odours relevant to the operation of the project. The estimation of risk follows the general principles outlined in the enHealth document Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards (enHealth 2012a).

Health impacts associated with air emissions for the project have been assessed on the basis of the information within the technical paper:

- WSP (2025), Air Quality Impact Assessment, Greater Parramatta and Olympic Peninsula Water Resource Recovery Facility. Dated June 2025.

6.2 Health impacts associated with air quality changes or odours

6.2.1 Dust

Particles or dust are always present in air but concentrations can vary.

Particles arise from:

- wind blowing across the ground surface disturbing soil
- dust that has settled on vegetation become airborne again when disturbed by wind
- all forms of combustion/burning – naturally occurring (volcanos, bushfires, etc) and due to human activities (home heating, bushfires, building fires, cooking/BBQs, vehicles, power stations, etc)
- people or animals moving through the landscape disturbing the soil as they travel through
- land clearing/construction (homes, roads, farms, commercial/industrial facilities) – removal of vegetation allows more windblown dust to be generated.

Whenever earthworks are undertaken, there can be windblown dust at a site that can add to the existing levels of particles in the atmosphere.

Unlike many other pollutants, particulates comprise a broad class of diverse materials and substances, with varying morphological (shape), chemical, physical and thermodynamic properties, with sizes that vary from less than 0.005 microns to greater than 100 microns. Particulates can be derived from natural sources such as crustal dust (soil), pollen and moulds, and other sources that include combustion and industrial processes.

Numerous epidemiological studies[13] have reported significant positive associations between particulate air pollution and adverse health outcomes, particularly mortality as well as a range of adverse cardiovascular and respiratory effects.

[13] Epidemiology is the study of diseases in populations. Epidemiological evidence can only show that this risk factor is associated (correlated) with a higher incidence of disease in the population exposed to that risk factor. The higher the correlation the more certain the association. Causation (i.e. that a specific risk factor actually causes a disease) cannot be proven with only epidemiological studies. For causation to be determined a range of other studies need to be considered in conjunction with the epidemiology studies.

The potential for particulate matter to result in adverse health effects is dependent on the size and composition of the particulate matter. The common measures of particulate matter that are considered in the assessment of air quality and health risks are:

- Total suspended particulates (TSP): This refers to all particulates with an equivalent aerodynamic particle[14] size below approximately 50 microns in diameter[15]. It is a fairly gross indicator of the presence of dust with a wide range of sizes. Larger particles (termed 'inspirable', comprising particles around 10 microns and larger) are more of a nuisance than a health hazard as they would deposit out of the air (measured as deposited dust) onto the ground close to the source and, if inhaled, are mostly trapped in the upper respiratory system[16] and do not reach the lungs. Finer particles (smaller than 10 microns, termed 'respirable') tend to be transported further from the source and are of more concern with respect to human health as these particles can penetrate into the lungs (see following point). Not all of the dust characterised as total suspended particulates is thus relevant for the assessment of health impacts, and TSP has not been further evaluated in this assessment. The assessment has only focused on particulates of a size where significant associations have been identified between exposure and adverse health effects.
- Fine particulates as PM_{10} (particulate matter below 10 microns in diameter, µm) and $PM_{2.5}$ (particulate matter below 2.5 µm in diameter) and ultrafines (particulate matter below 0.1 µm in diameter), as illustrated in **Figure 6.1.** These particles are small and have the potential to penetrate beyond the body's natural clearance mechanisms of cilia and mucous in the nose and upper respiratory system, with smaller particles able to further penetrate into the lower respiratory tract[17] and lungs. Adverse health effects may result when particles reach down into the lungs and this depends on the size, number and nature of the particles (OEHHA 2002). In relation to dust emissions from earthworks, these are predominantly from crustal materials and comprise PM_{10} and larger particles with a smaller fraction of $PM_{2.5}$ present.

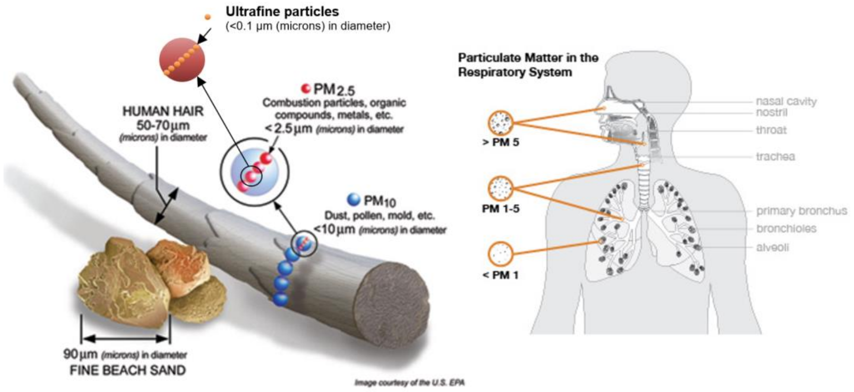


Figure 6.1: Illustrative Representation of Particle Sizes and Penetration into the Lungs

[14] The term equivalent aerodynamic particle is used to reference the particle to a particle of spherical shape and particle of density one gram per cubic metre.
[15] The size, diameter, of dust particles is measured in micrometers (microns).
[16] The upper respiratory tract comprises the mouth, nose, throat and trachea. Larger particles are mostly trapped by the cilia and mucosa and swept to the back of the throat and swallowed.
[17] The lower respiratory tract comprises the smaller bronchioles and alveoli, the area of the lungs where gaseous exchange takes place. The alveoli have a very large surface area and absorption of gases occurs rapidly with subsequent transport to the blood and the rest of the body. Small particles can reach these areas, be dissolved by fluids and absorbed.

In this case, TSP and PM_{10} are the primary types of particles that could be emitted from earthworks during construction.

6.2.2 Odour

The release of odours from industrial developments can affect a community's quality of life. In any community there will be people who are very sensitive to odours and those that hardly notice them with most people being somewhere in between these two extremes (NSW DEC 2006b).

Unpleasant odours have often been seen as early warning signs of potential issues for human health but there are a range of health complaints that can occur just due to exposure to odours. Complaints like irritation of eyes, nose or throat, headaches, nausea, sore throat, hoarseness, cough, nasal congestion, stress, shortness of breath and others are common in some people when exposed to unpleasant odours (or even pleasant ones). Effects can also occur due to the irritant effects of the odorous chemicals or because people become sensitised to a particular odour over time (learned aversion) (Schiffman & Williams 2005).

People are exposed to many unpleasant odours, often for only short moments in time and these are unlikely to cause health effects but can be annoying. However, when such odours persist or include irritant chemicals, health effects become possible (Schiffman & Williams 2005).

As a result, the NSW EPA provides guidance on the management of odours from sources such as those within the project. There is a legal framework within which this guidance sits as the release of offensive odours into off-site areas is not permitted under the POEO Act (NSW DEC 2006b).

The objective is to ensure that the potential for unpleasant odours in off-site areas is negligible by ensuring appropriate engineering and management of any industrial facilities that could release such odours. The idea is to avoid odours by controlling them at source. This could consist of changing the processes to use or produce less odorous chemicals or appropriate control of emissions from processes where odorous chemicals cannot be avoided (NSW DEC 2006b).

Guidelines have been developed which aim to ensure odours are negligible outside the boundary of a facility. If odours are negligible in off-site areas, then the risks to human health will be negligible. These are discussed in **Section 6.5.3**.

6.2.3 Nitrogen dioxide

Nitrogen oxides (NOx) refer to a collection of highly reactive gases containing nitrogen and oxygen, most of which are colourless and odourless. Nitrogen oxide gases form when fuel is burnt including when waste is used as fuel. Motor vehicles, along with industrial, commercial and residential (e.g. gas heating, cigarettes or cooking) combustion sources, are primary producers of nitrogen oxides.

In terms of health effects, nitrogen dioxide is the only oxide of nitrogen that may be of concern (WHO 2000). Nitrogen dioxide is a colourless and tasteless gas with a sharp odour. Nitrogen dioxide can cause inflammation of the respiratory system and increase susceptibility to respiratory infection. Exposure to elevated levels of nitrogen dioxide has also been associated with increased mortality, particularly related to respiratory disease, and with increased hospital admissions for asthma and heart disease patients (WHO 2013). Asthmatics, the elderly and people with existing cardiovascular and respiratory disease are particularly susceptible to the effects of elevated nitrogen dioxide (Morgan et al. 2013; NEPC 2010).

Guidelines are available from NEPC (NEPC 2021) which indicate concentrations of nitrogen dioxide considered to be acceptable by national health authorities. These guidelines are based on protection from adverse health effects following both short term (acute) and longer term (chronic) exposure for all members of the population including sensitive populations like asthmatics, children and the elderly. The AAQ NEPM values includes guideline values of 0.08 ppm for a 1 hour average concentration and 0.015 ppm for an annual average concentration – i.e. 150 µg/m^3 and 28 µg/m^3 respectively.

The NSW EPA has also published guidance on assessing impacts of facilities on air quality in:

- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW EPA 2022).

This document provides guidelines to assess potential issues related to nitrogen dioxide emissions from a facility. This document also provides guidance on how to undertake air dispersion modelling to understand how emissions from a particular facility get mixed into the atmosphere. The guideline values listed in the NSW EPA guidance for nitrogen dioxide are the same as those listed from the AAQ NEPM in terms of units of ppm.

Turning these limits into values in terms of µg/m^3 depends on the temperature assumed in the conversion calculation. The calculation assuming 25^{o}C and standard pressure gives values of 150 µg/m^3 for 1 hour average concentrations and 28 µg/m^3 for annual average concentrations. The values listed in NSW EPA (2022) are based on a conversion assuming 0^{o}C and standard pressure (i.e. 164 µg/m^3 and 31 µg/m^3 respectively). These values are not significantly different.

6.3 Potential sources of air emissions for this facility

6.3.1 Construction

Sources of air emissions during construction of this project related primarily to dust because earthworks are required. In addition, vehicles and plant undertaking these works will result in combustion gases being emitted to the atmosphere – carbon monoxide, oxides of nitrogen, sulfur dioxide and particles. These are always present in the atmosphere as they are emitted from all combustion sources – naturally occurring combustion sources like bushfires and volcanos – and those from the activities of people – vehicles, home heating, BBQs, cooking, fire pits etc. This assessment is designed to evaluate whether there could be any difference in air quality due to this project.

6.3.2 Operations

Once the plant has been completed and becomes operational, odours are the main emissions to air that could arise. Sydney Water operate many of these types of treatment plant and so they have good information about the potential for odours.

The use of the biogas co-generation unit means that there will continue to be a combustion source at the site, emissions of combustion gases, especially oxides of nitrogen, will occur. Movements of vehicles will also have the potential to generate some combustion gases and kick up some dust – but these are likely to be only on occasion and make a negligible contribution to air emissions so they have not been considered further.

6.4 Description of the approach for this assessment

6.4.1 General

Potential for changes in air quality due to this project have been assessed based on the project footprint. The project area considered is the extent of all sensitive receivers potentially impacted by emissions to air from construction or operation of the project (WSP 2025).

During construction, the main potential for impact on air quality is the release of dust/particles into the air during earthworks, vegetation removal, surface grading/compaction, landscaping etc. Control of dust emission is a common issue to manage during most construction works. During operation of this project, the main potential impact on air quality is the possibility of odours from the project as well as the emissions of nitrogen dioxide from the biogas cogeneration units (WSP 2025).

The air quality assessment has included:

- Review of the existing environment (land use, ambient air quality and meteorology).
- Review of the proposed construction methodology including equipment and processes.
- Identification of construction activities which may lead to emissions.
- Identification of nearby sensitive receptors to construction activities.
- A qualitative air quality assessment with a focus on construction particulates and dust.
- Review of operational activities and identification of sources of odour emissions.
- Identification of project specific mitigation measures to manage the potential for dust and odour impacts (WSP 2025).

The assessment was undertaken in line with government guidance – in this case:

- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW EPA 2022).
- Guidance on the assessment of dust from demolition and construction from the UK Institute of Air Quality Management (IAQM 2024).
- Technical Framework for Assessment and management of odour from stationary sources in NSW (NSW DEC 2006b).

Assessment criteria for dust/particles and for odour were taken from the Approved Methods Manual (NSW EPA 2022).

Estimating odours or pollutants in off-site areas involves information such as:

- Odour/pollutant concentration (or emission rate) at the project.
- Information about how air moves around the project area based on the meteorological conditions and the terrain.

This information is used to estimate how the pollutants/odours are mixed and transported in the air and the concentration that may be present at ground level at different locations surrounding a proposed new facility.

Figures 6.2 and **6.3** illustrate the processes which govern how the emissions get mixed into the atmosphere. These processes are relevant for odours as well as particles/dust or other chemicals.

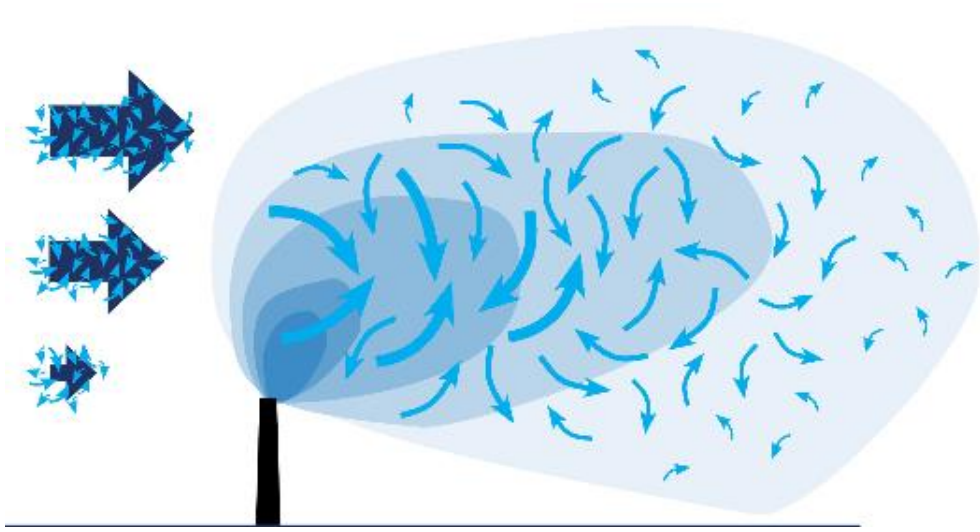


Figure 6.2: Turbulence in the air, how it mixes and dilutes pollutants/odours emitted from a stack (NSW Chief Scientist 2018)

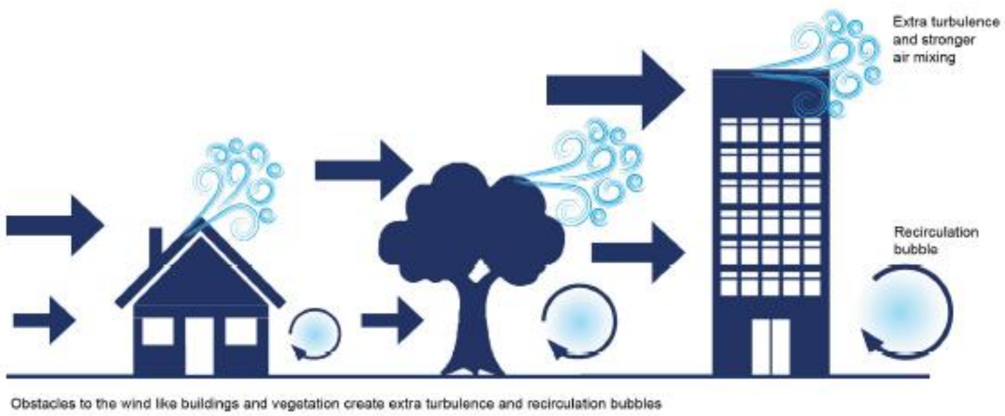


Figure 6.3: Turbulence in the air and how it is affected by buildings and vegetation (NSW Chief Scientist 2018)

Figure 6.2 shows that most of the pollutants/odours remain up in the atmosphere away from where people could be exposed. However, small amounts do eventually reach ground level.

Air dispersion modelling determines what proportion of the amount leaving a site could reach ground level at different locations. Such modelling looks at worst case weather characteristics (ones that can actually occur – i.e. based on real meteorological data) to ensure that the amount that could reach ground level in areas where people live or work neighbouring a proposed facility are not underestimated.

6.4.2 Construction

The UK Institute of Air Quality Management (IAQM) guidance (IAQM 2024) requires consideration of the potential for dust from construction activities.

The guidance provides the following matrix to allow rapid assessment of the potential likely risks for a project – the magnitude of dust emissions. **Table 6.1** shows the matrix.

Risks are low (i.e. low dust emissions) when there are limited earthworks or construction activities. Risks of nuisance dust or other issues increase as the size and volume of activities increases.

Table 6.1: IAQM risk matrix guidance (IAQM 2024)

Risk level	Type of construction activity			
	Demolition	Earthworks	Construction	Trackout
Low	Total building volume <12,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <6 m above ground, demolition during wetter months.	Total area <18,000 m^2, soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any time, formation of bunds <3 m in height.	Total building volume <12,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber).	<20 Heavy duty vehicles (HDV) (>3.5t) outward movements in any one day, surface material with low potential for dust release, unpaved road length <50 m.
Medium	Total building volume 12,000 m^3 – 75,000 m^3, potentially dusty construction material, demolition activities 6-12 m above ground level.	Total site area 18,000 m^2 to 110,000 m^2, moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 3 m – 6 m in height.	Total building volume 12,000 m^3 – 75,000 m^3, potentially dusty construction material (e.g. concrete), on-site concrete batching.	20-50 HDV (>3.5t) outward movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50 m – 100 m.
High	Total building volume >75,000 m^3, potentially dusty construction material (e.g. concrete), on-site crushing and screening, demolition activities >12 m above ground level.	Total site area >110,000 m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >6 m in height.	Total building volume >75,000 m^3, on-site concrete batching, sandblasting.	>50 HDV (>3.5t) outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100 m.

This guidance also includes consideration of how close people may be to the activities as an indicator of their exposure. The rating process is outlined in **Table 6.2**.

Table 6.2: Population and distance matrix (IAQM 2024)

Sensitivity rating	Number of people nearby	Distance from a project			
		<20 m	<50 m	<100 m	<250 m
High	>100 people	High	High	Medium	Low
	10-100 people	High	Medium	Low	Low
	1-10 people	Medium	Low	Low	Low
Medium	>1 person	Medium	Low	Low	Low
Low	>1 person	Low	Low	Low	Low

Where a high rating is to be applied (i.e. where people are present close to a proposed new facility), more detailed assessment and significant control measures are required.

The ratings for the size of the activity and the sensitivity of the community surrounding a proposed new facility are combined to get a final rating for a project. This process is outlined in **Table 6.3**.

Table 6.3: Final rating matrix for dust during construction (IAQM 2024)

Sensitivity rating for the location	Dust emission magnitude rating		
	Large	Medium	Small
During demolition			
High	High	Medium	Medium
Medium	Medium	Medium	Low
Low	Low	Low	Negligible
During earthworks and construction			
High	High	Medium	Low
Medium	Medium	Medium	Low
Low	Low	Low	Negligible
During track out			
High	High	Medium	Low
Medium	Medium	Medium	Low
Low	Low	Low	Negligible

Once the final rating has been determined for a project, appropriate control/mitigation measures are considered and incorporated into the project. Applying appropriate controls during works based on the rating relevant for the project ensures dust is controlled during construction and this applies for all construction sites.

6.4.3 Operation

<u>Air dispersion modelling</u>

To assist in understanding how odours or other air emissions might travel around the area adjacent the project, air dispersion modelling was undertaken for this project. The modelling tool chosen for this project was CALPUFF – a commonly used tool recommended by government authorities. Such models take information about the local terrain and meteorology as well as how the project operates and might result in emissions to air. These information sources are combined to estimate concentrations at ground level.

In this case, estimated emissions from the various parts of the project shown in **Figure 6.4** were used in the modelling.

Figure 6.4: Potential emission sources used in modelling (MBR – membrane bioreactor, OCF – odour control unit, COGEN – biogas cogeneration unit)

Emissions from the odour control unit and the biogas cogeneration unit were modelled as point sources (i.e. emission from a single stack) and the other equipment were modelled as area sources – i.e. distributed over an area.

Information about potential odour levels (or nitrogen dioxide concentrations) being emitted from these different equipment types were taken from other locations operated by Sydney Water, technical specifications for such equipment determined by Sydney Water as well as information from equipment manufacturers.

The air dispersion model includes consideration of the impacts on wind flows due to buildings, tanks etc as well as hills and slopes in the area close to the locations of these potential sources of odour or gases – i.e. building downwash etc.

The model was used to estimate the potential for odours and nitrogen dioxide at ground level at each location within the grid established for the model. **Figure 6.5** shows the grid over which concentrations were estimated.

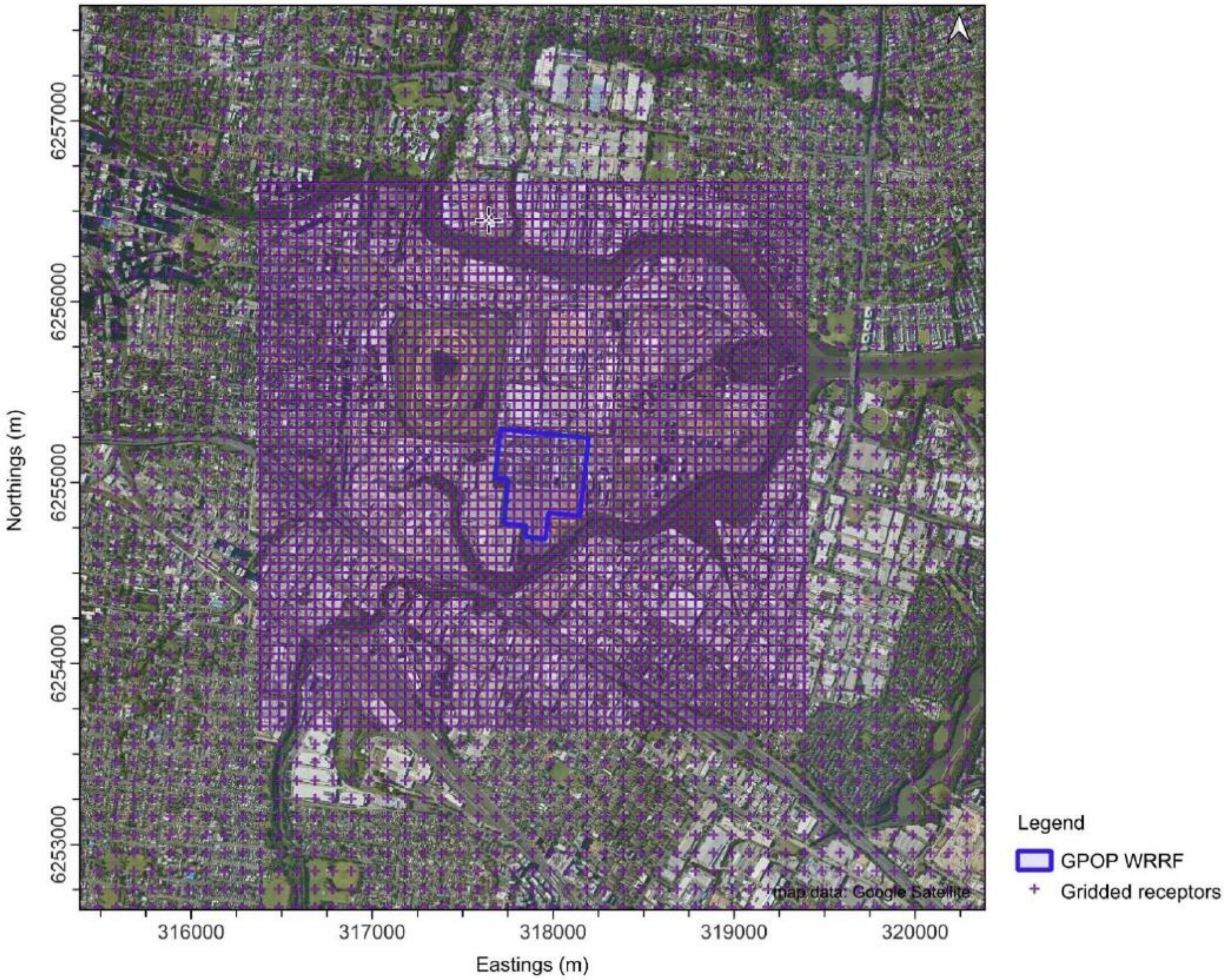


Figure 6.5: Locations assessed for this project

The modelling generated concentrations at each of these grid locations. The grid extends a considerable distance from the project to ensure that all relevant areas are covered by this assessment.

<u>Odour</u>

Consideration of the potential for odours to impact on people living or working near a facility that may have odours is important. Often buffer distances or separation distances are provided in government guidance for activities known to be odorous.

In NSW, guidance relevant for this assessment includes:

- NSW EPA (2006) Technical framework: Assessment and management of odour from stationary sources in NSW (NSW DEC 2006b).

Odours were modelled as described above in line with this guidance. This includes application of an adjustment to the modelled odour units estimates to adjust for the time over which the model estimates ground level concentrations and the time taken for people to recognise odours. This was done in line with government guidance and ensures ground level odours are not underestimated.

NSW EPA guidance on the assessment of potential for odour provides some initial screening guidelines that indicate the level of effort to apply to an odour impact assessment depending on the distance from the potential odour source and the locations where people may spend time.

The screening criteria for odour range from 2 odour units when a facility is located within a densely populated area and 7 odour units when a facility is located near 1-2 houses. These odour unit predictions/measurements are based on essentially the maximum odour predicted to occur from a facility (i.e. 99^{th} percentile).

Table 6.4: NSW EPA air quality assessment criteria for odour

Population of affected community	Criterion (odour units (OU)) (nose response time average, 99^{th} percentile)
Single rural residence (≤~2)	7
~10	6
~30	5
~125	4
~500	3
Urban (>2,000) and/or schools and hospitals	2

Nitrogen dioxide

The modelling of nitrogen dioxide concentrations was undertaken using the estimates of concentrations in the gas released from the cogeneration units and the air dispersion modelling discussed above. This is in line with government guidance and normal practice.

6.5 Assessment of health impacts from air emissions from the project

6.5.1 Existing environment

Before considering the potential for changes in air quality due to a project, it is important to understand the nature of the existing air quality.

Air quality in remote locations is likely to have few contaminants – other than those present everywhere like particles and other gases. In urban areas where people live or work and where vehicles frequent, the quality of the air is likely to be impacted by all the things people do – driving, living, gardening, cooking, BBQs, cleaning etc etc. So, understanding the nature of the existing air quality is critical to understanding whether the project will actually change anything.

Information about which way the winds blow across an area is important for understanding existing air quality and whether a new project could impact on locations where people are living, working or recreating. Wind roses are used to show the wind patterns. **Figure 6.6** shows the wind roses for this location.

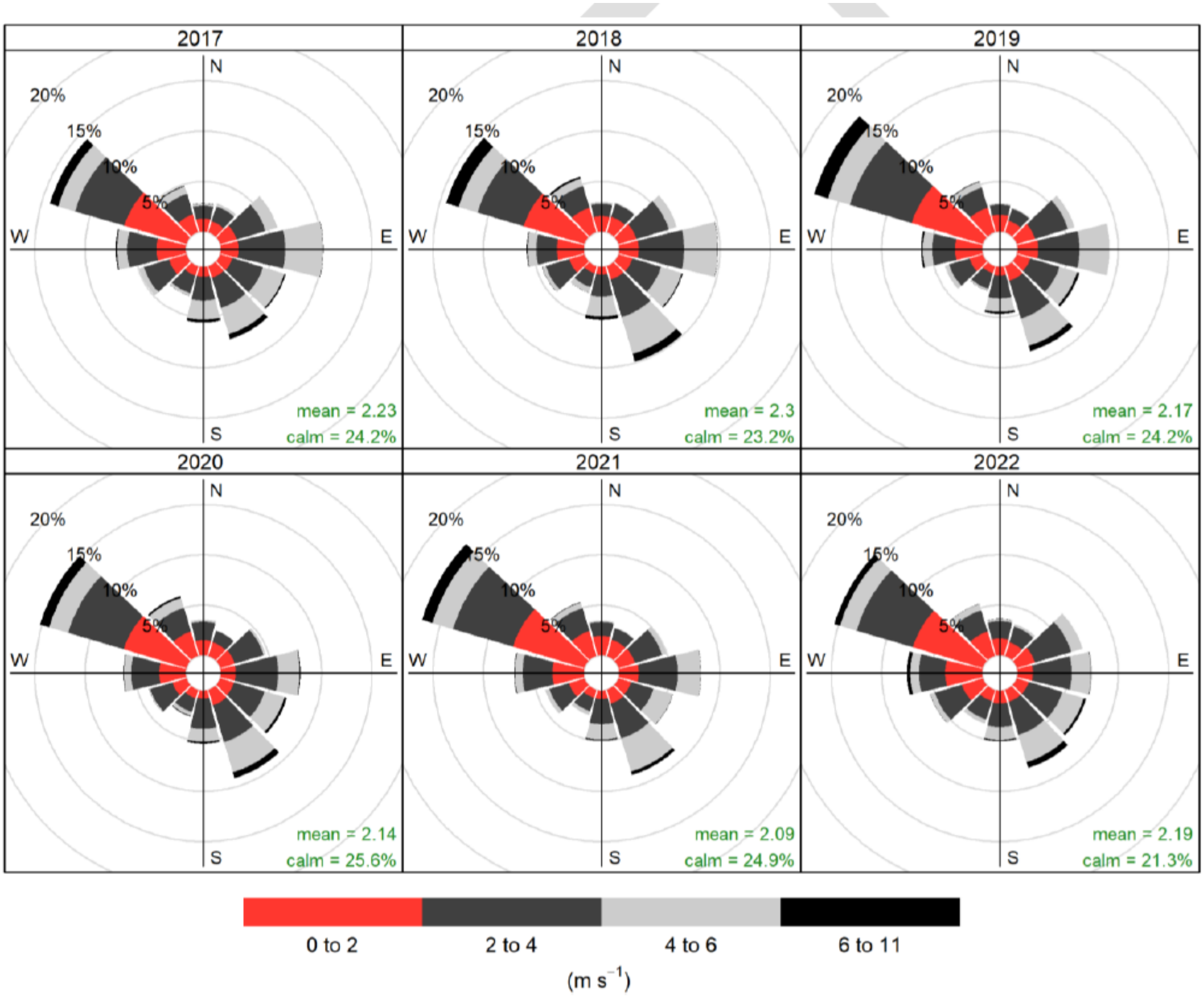


Figure 6.6: Annual wind roses for Sydney Olympic Park weather station (operated by Bureau of Meteorology)

These wind roses show that the strongest prevailing winds are those from the northwest.

Information about existing air quality has been obtained from the closest NSW Government monitoring station – Parramatta North[18]. This station is located 5.5 km from the site of this project so is relevant. The station provides data for a range of chemicals that are commonly found in air – usually called criteria pollutants. These include particles (i.e. dust – $PM_{2.5}$ and PM_{10}), ozone, carbon monoxide, nitrogen dioxide and sulfur dioxide.

Current yearly averages for these chemicals are listed in **Table 6.5**. The current average values are compared to the national guidelines from the National Environmental Protection (Ambient Air Quality) Measure (NEPC 2021).

[18] https://www.airquality.nsw.gov.au/central-west-sydney/parramatta-north

Table 6.5: Existing air quality (based on data provided in Table 4.3 in WSP (2025))

Pollutant	Annual average concentrations (2018-2023)	National guidelines (NEPC 2021)
$PM_{2.5}$ (µg/m^3)	5.2-10.4	7 (annual average)
PM_{10} (µg/m^3)	14.1-25.5	25 (annual average)
Ozone (µg/m^3)	31.3-38.6	127 (8 hour average)
Nitrogen dioxide (NO_2) (µg/m^3)	13.4-22	28 (annual average)
Sulfur dioxide (SO_2) (µg/m^3)	Not detected	52 (24 hour average)

Notes:
National guidelines for particles are provided for the range of annual average concentrations for 2018 to 2023.

The highest concentrations in these annual average ranges were from 2018 and 2019 – i.e. the years impacted by the Black Summer bushfires. On average, the air quality measurements at this station indicate "good" air quality as per NSW EPA ratings [19].

These results indicate that existing air quality in the project area is as would be expected in heavily urbanised areas – at or close to the national guidelines.

There are a range of existing industrial sources in the project area that may contribute to impacts on air quality. These include facilities manufacturing asphalt and other products required for road construction, provision of printing services, storage of petroleum hydrocarbons, building product manufacturers and a range of other types of waste treatment facilities. These facilities have been considered in the air quality impact assessment (WSP 2025).

Figure 6.7 shows the locations of the other industrial facilities that were considered for this project.

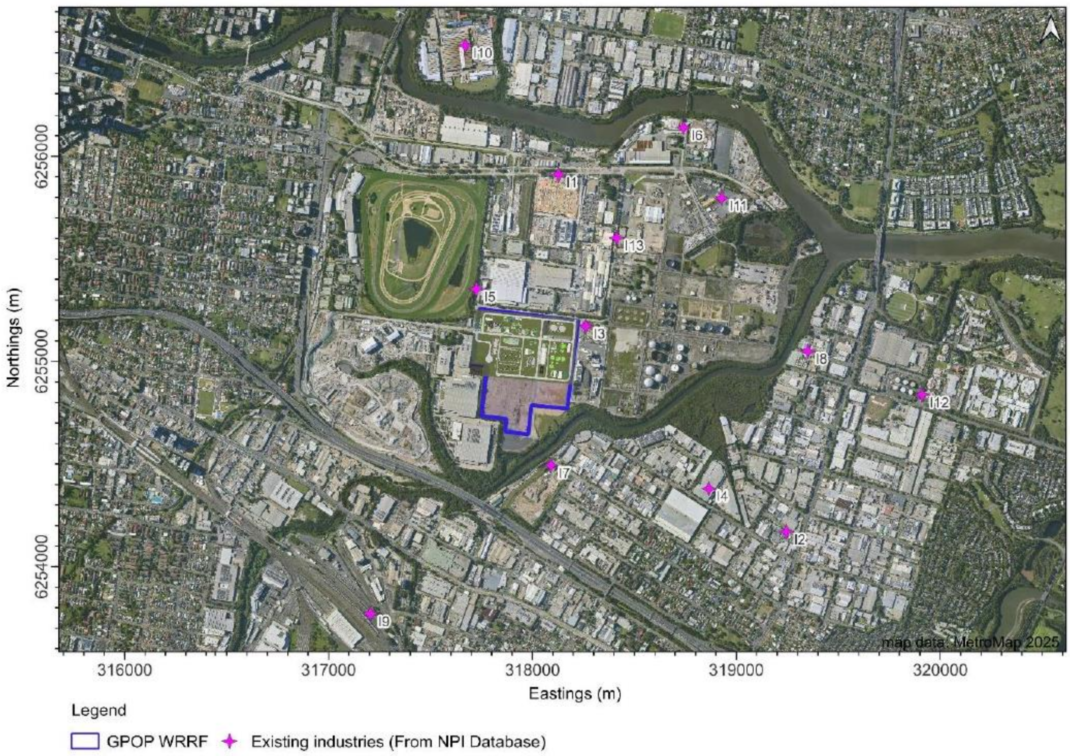


Figure 6.7: Other industrial facilities

[19] https://www.airquality.nsw.gov.au/air-quality-in-my-area

6.5.2 Construction

The IAQM approach was applied to this project as discussed in **Section 6.4.2**.

<u>WRRF site</u>

In relation to the size of the project, the rating for potential dust generation is **large** in relation to earthworks, construction activities and track out activities. There is no demolition of structures proposed for this project so the demolition part of the IAQM approach is not relevant (WSP 2025).

For the project site, the rating for the sensitivity of the local environment to excess dust is **medium.** Homes and businesses are located within 100-250 m of the site. It is noted that the surrounding area is largely industrial (WSP 2025).

This means the overall rating for the works at the WRRF site is medium risk in regard to potential for dust generation. Appropriate controls need to be included in the project to manage dust well. Such controls would include things like:

- Dust suppression on stockpiles (covers, treatments)
- Minimising the time stockpiles are stored at the site
- Storage of aggregate and other materials used in construction
- Housekeeping using water assisted sweepers (i.e. not dry).

The control measures to be adopted for all aspects of this project will be outlined in a construction dust management plan (WSP 2025).

<u>Pumping station upgrade</u>

In relation to the size of the project, the rating for potential dust generation is **small** in relation to earthworks, construction activities and track out activities. There is no demolition of structures proposed for this project so the demolition part of the IAQM approach is not relevant (WSP 2025).

For the project site, the rating for the sensitivity of the local environment to excess dust is **low** to **medium** depending on whether the works occur as part of earthworks, construction or trackout (WSP 2025).

This means the overall rating for the works in relation to the pumping station upgrade is **negligible to low risk** in regard to potential for dust generation. Therefore, normal dust suppression actions (i.e. normal part of managing a construction site) are expected to be sufficient to manage dust well for this part of the project (WSP 2025).

<u>Pipelines</u>

In relation to the size of the project, the rating for potential dust generation is **large** in relation to earthworks, construction activities and track out activities in and around the pipeline routes. There is no demolition of structures proposed for this project so the demolition part of the IAQM approach is not relevant (WSP 2025).

For the pipeline routes, there are homes and businesses located quite close in some parts, so the sensitivity rating is **high** for these locations (WSP 2025).

This means the overall rating for the pipeline routes is **high risk** and appropriate controls need to be included in the project to manage dust well. Such controls would include things like:

- use of trenchless approaches for installation of pipelines wherever possible
- solid screens/barriers installed during open trenching along the pipeline routes where trenchless works are not possible
- plant should include dust suppression options wherever possible
- appropriate stockpile management (covers etc)
- appropriate housekeeping for the site
- transport of materials should be undertaken in vehicles with appropriate dust controls (i.e. covers, washdown, wheel washing etc) (WSP 2025).

The control measures to be adopted will be outlined in a construction dust management plan (WSP 2025).

This assessment confirms negligible risks to community health in the local area due to changes in dust levels during construction of this project when all relevant control measures are implemented for each aspect of the project.

6.5.3 Operation

Odour

The odour assessment focused on the worst case results provided by the modelling. These are the results that could only occur 1% of the time based on the potential for worst case odours from the project and the worst case meteorology – i.e. atmospheric conditions that limit how much wind is occurring so any emissions from the project remain close by with limited dilution.

The estimated ground level odour levels under these worst case conditions are shown in **Figures 6.8** and **6.9**.

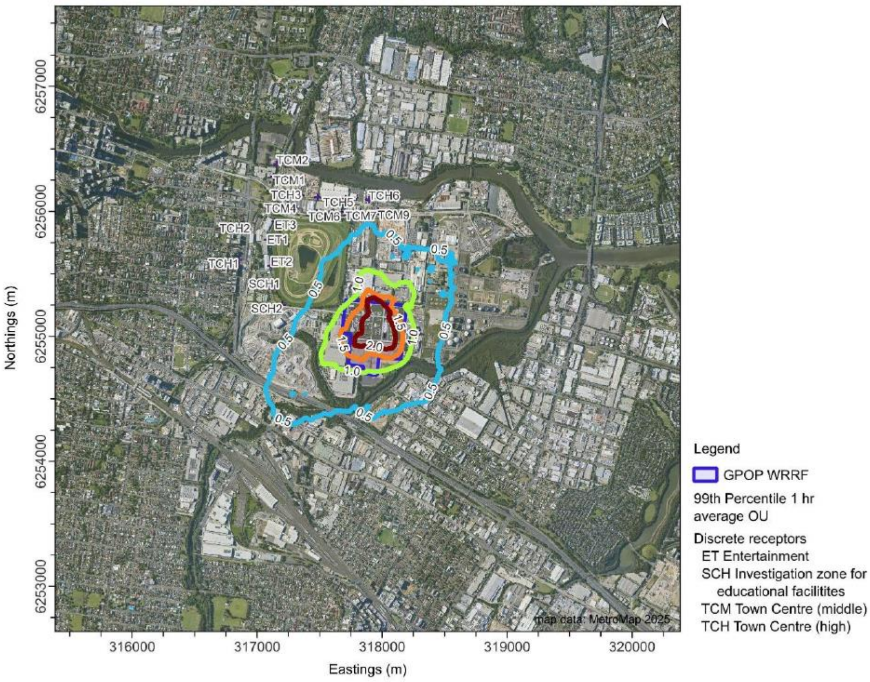


Figure 6.8: Modelled 99th percentile odour levels (WSP 2025)

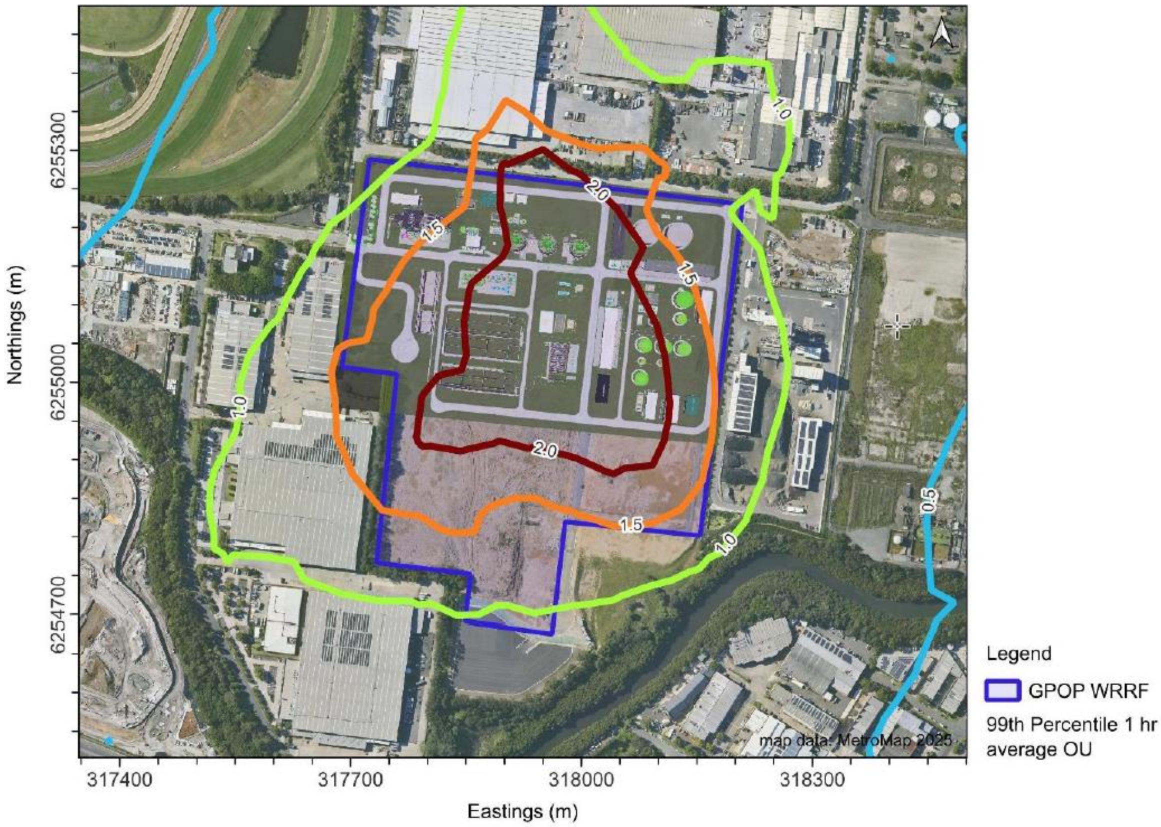


Figure 6.9: Modelled 99th percentile odour levels (zoomed in) (WSP 2025)

These figures show that the potential for odours to be noticeable outside the WRRF is very small. Under the worst case conditions used in the modelling (as per government guidance), the highest level of odour estimated to be in the off-site area is an odour unit of 1. The modelling indicates that this level of odour extends only a small amount into the neighbouring industrial sites. For all other conditions (i.e. other than worst case), will have lower levels of odour than has been modelled for this assessment (WSP 2025).

An odour unit of 1 is defined as the level of odour that is the theoretical minimum that can be detected by a person. This will vary depending on the type of odour. The detection of such a low level of odour will also vary for different people as people have widely varying abilities to detect odours (WSP 2025).

NSW EPA guidance indicates that such facilities should show in this type of modelling that odour will not exceed 2 odour units in the off-site area and this is the case for this project. There is a small area to the north of the site (i.e. the road) where the 2 odour unit contour extends past the site boundary but it is constrained to the roadway (WSP 2025).

Levels at various locations around the project such as the town centre, close to education facilities and entertainment locations, are less than 1 odour unit and, in the main, less around 0.4-0.6 odour units – i.e. not detectable.

This assessment confirms negligible risks to community health in the local area due to changes in odour during operation of this project.

Nitrogen dioxide

A detailed assessment of nitrogen dioxide concentrations in the area around the project due to the operation of the biogas cogeneration units showed that using matched background data from the Parramatta air quality station – the data are matched between measured nitrogen dioxide levels and the hourly meteorological conditions. This allows a detailed understanding of the existing nitrogen dioxide concentrations that already exist in the area to compare against potential changes due to the operation of the project (WSP 2025).

Figure 6.10 shows the contours for the annual average concentrations of nitrogen dioxide.

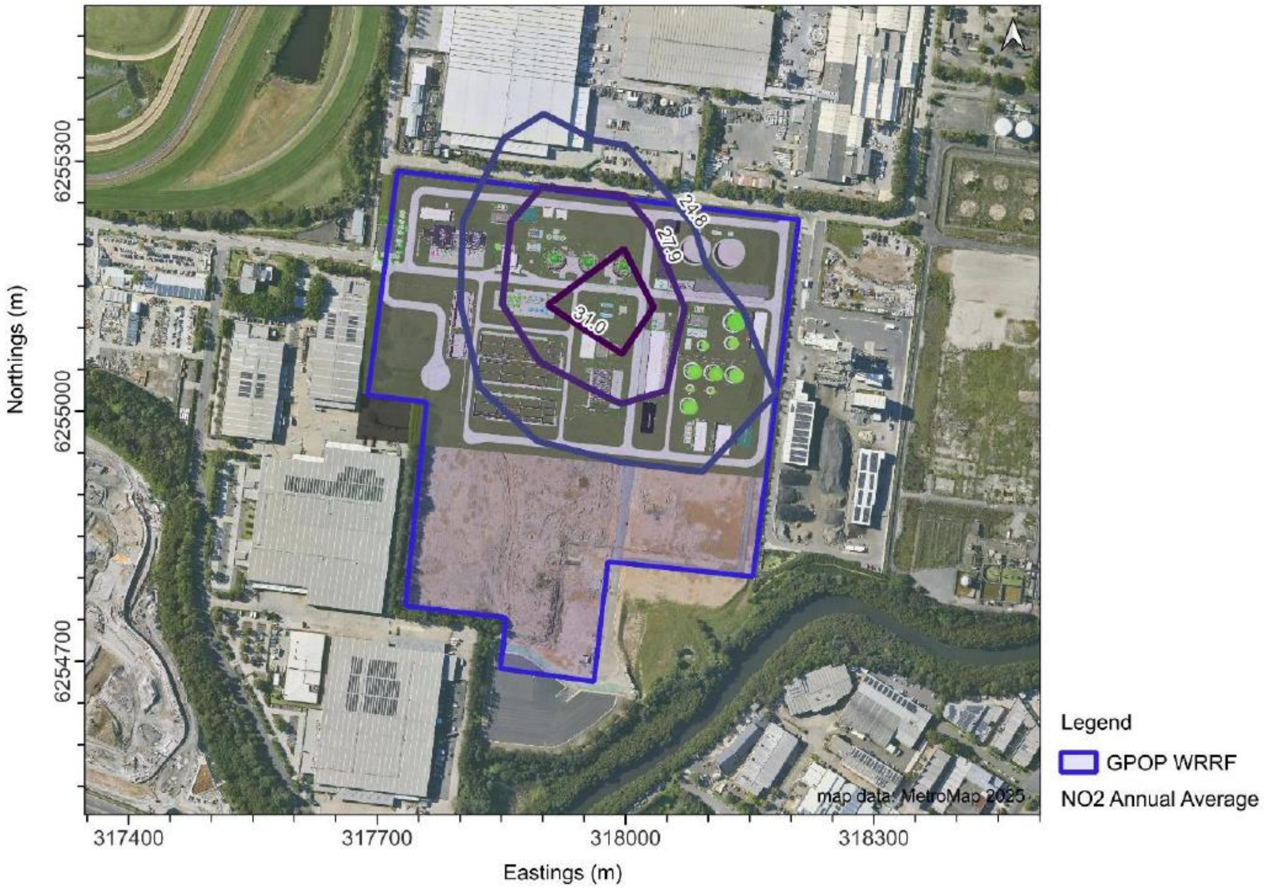


Figure 6.10: Annual average nitrogen dioxide concentrations

This figure shows that there is very little change in nitrogen dioxide concentrations compared to existing air quality due to the operation of the biogas cogeneration units. The existing air concentrations of nitrogen dioxide are 13-22 μg/m^3. This compares to the values shown on **Figure 6.10** of 24-25 μg/m^3 in the off-site area – i.e. negligible difference.

This assessment confirms negligible risks to community health in the local area due to changes in nitrogen dioxide concentrations during operation of this project.

6.6 Outcomes of health impact assessment

Table 6.6 presents a summary of the outcomes of the assessment undertaken in relation to the impacts on community health of changes in air quality, associated with the proposed project.

Table 6.6: Summary of health impacts – air quality

Air quality	
Benefits	Provision of sufficient treatment plants to manage wastewater in an urban area is a benefit to the health of the community
Impacts	Negligible impacts to community health are predicted during both construction and operations in regard to changes in air quality arising from this project.
Mitigation	Mitigation measures will be required to control dust during construction in line with the IAQM methodology. Control measures for air quality are those built into the design of the project – such as the odour control unit and other measures. As long as these measures are included in this project, no further mitigation measures are required based on this assessment.

Section 7. Health impacts: Noise and vibration

7.1 Introduction

This section presents a review and further assessment of impacts on health associated with noise, relevant to the project. Health impacts associated with noise or vibration for the project have been assessed on the basis of the information within the technical paper:

- AECOM (2025), Greater Parramatta and Olympic Peninsula Water Cycle Management Project, Noise and Vibration Impact Assessment. Dated 27 June 2025.

7.2 Health impacts associated with noise

Environmental noise has been identified (I-INCE 2011; WHO 2011) as a growing concern in urban areas because it has negative effects on quality of life and well-being and it has the potential for causing health effects. With increasingly urbanised societies, impacts of noise on communities have the potential to increase over time.

Sound is a natural phenomenon that only becomes noise when it has some undesirable effect on people or animals. Unlike chemical pollution, noise energy does not accumulate either in the body or in the environment, but it can have both short-term and long-term adverse effects on people. These health effects include (WHO 1999, 2011):

- sleep disturbance (sleep fragmentation that can affect psychomotor performance, memory consolidation, creativity, risk-taking behaviour and risk of accidents)
- annoyance
- hearing impairment
- interference with speech and other daily activities
- impacts on children's school performance (through effects on memory and concentration)
- impacts on cardiovascular health.

Other effects for which evidence of health impacts exists, but for which the evidence is weaker, include:

- effects on mental health (usually in the form of exacerbation of existing issues for vulnerable populations rather than direct effects)
- tinnitus (which can also result in sleep disturbance, anxiety, depression, communication and listening problems, frustration, irritability, inability to work, reduced efficiency and a restricted participation in social life)
- cognitive impairment in children (including deficits in long term memory and reading comprehension)
- some evidence of indirect effects such as impacts on the immune system.

Within a community, the severity of the health effects from exposure to noise and the number of people who may be affected are schematically illustrated in **Figure 7.1**.

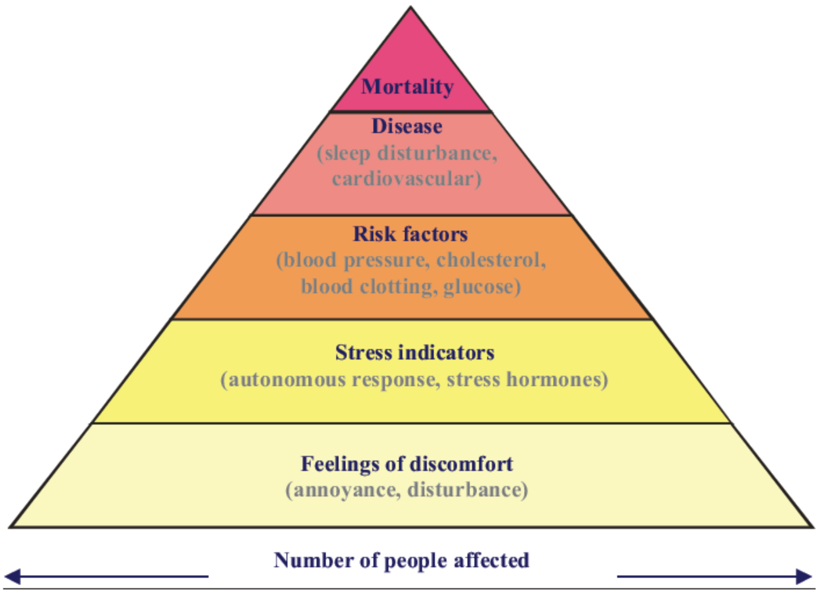


Figure 7.1: Schematic of severity of health effects of exposure to noise and the number of people affected (WHO 2011)

Often, annoyance is the major consideration because it reflects the community's dislike of noise and their concerns about the full range of potential negative effects, and it affects the greatest number of people in the population.

There are many possible reasons for noise annoyance in different situations. Noise can interfere with communication or other desired activities. Noise can contribute to sleep disturbance, which can obviously be very annoying and has the potential to lead to long-term health effects. Sometimes noise is just perceived as being inappropriate in a particular setting without there being any objectively measurable effect at all. In this respect, the context in which sound becomes noise can be more important than the sound level itself.

Different individuals have different sensitivities to types of noise and this reflects differences in expectations and attitudes more than it reflects any differences in underlying auditory physiology. A noise level that is perceived as reasonable by one person in one context (for example in their kitchen when preparing a meal) may be considered completely unacceptable by that same person in another context (for example in their bedroom when they are trying to sleep). In this situation, the annoyance relates, in part, to the intrusion from the noise. Similarly, a noise level, which is considered to be completely unacceptable by one person, may be of little consequence to another even if they are in essentially the same room trying to undertake the same sorts of activities. In this case, the annoyance depends almost entirely on personal preferences, lifestyles and attitudes of the listeners concerned.

In relation to this project, potential noise impacts have been assessed against criteria developed by the World Health Organization (WHO 1999, 2009) that have been established on the basis of the relationship between noise and health impacts, where annoyance and sleep disturbance are of most significance. The predicted noise impacts are those that would be outside of a dwelling. The predicted impacts need to be below the World Health Organization guideline values that are protective of adverse health effects.

7.3 Assessment methodology

Noise criteria considered in this assessment are those from the NSW EPA Industrial Noise Policy (NSW EPA 2017) and related documents.

Other guidance and guidelines used in this assessment include:

- Interim Construction Noise Guideline (NSW DECC 2009)
- NSW Industrial Noise Policy (NSW EPA 2017)
- Assessing Vibration: a technical guideline (NSW DEC 2006a).

The criteria used in NSW policy are in line with those available from the World Health Organisation (WHO 1999, 2011).

For both construction and operations, noise and vibration have been assessed using the following approach:

- Identify relevant locations where people might be present that could be impacted by noise or vibration (i.e. identify sensitive receivers)
- Establish the existing noise/vibration environment at these locations
- Model potential changes in noise or vibration during construction or operations at these locations
- Identify if those potential changes comply with noise/vibration guidelines as determined by government authorities or if mitigation measures are required.

Assessing the potential for impacts on health related to noise and vibration for a project focuses on potential changes in noise or vibration due to the project. It is acknowledged that there is an existing level of noise already present and it is the change in that level that is relevant for this assessment.

NSW guidance indicates what size of change is permissible using the criteria developed by WHO. The assessment also looks at changes in noise levels at different times of the day not just the average over the day or just during daytime.

The assessment has looked at 15 minute average changes in noise as well as changes over a day to determine if noise impacts from the project could impact on community health. Land uses are also considered in the assessment. The modelled noise levels are those for outside of buildings.

Noise modelling takes into account the types of equipment and activities that will be used/occur at a site and models how noise from the project will decrease with distance from the works in the surrounding areas. The noise will decrease as the distance from the noise source increases and it is also affected by the terrain and meteorological conditions.

7.4 Existing noise

Existing noise in the project area has been measured using attended and unattended noise monitoring equipment. Attended noise monitoring occurs when people make use of noise monitoring equipment but they can also observe the changes in noise during monitoring and potentially identify sources of noise – for example, if noise levels increase significantly over a short time the person attending the monitoring can observe that the cause was a plane flying overhead or a large truck passing or loud noise from insects or birds. Unattended noise monitoring is when the equipment is placed in relevant locations and left in place over multiple days and then the recorded sound levels are considered. This type of monitoring does not permit identification of the sources of noise.

Unattended monitoring was undertaken at 2 locations between 15 May and 24 May 2024 and at 4 locations between 15 and 28 November 2024 (AECOM 2025).

The locations are listed in **Table 7.1** and shown in **Figure 7.2**.

Table 7.1: Unattended noise monitoring locations (AECOM 2025)

ID	Location	Measurement period – unattended	Measurement period – attended
NL01	45 Kissing Point Road Dundas	16-27/11/24	15/11/24
NL02	26 Rippon Avenue Dundas	16-27/11/24	15/11/24
NL04	2 Eleanor Street Rosehill	15-24/05/24	15/05/24
NL05	63 Asquith Street Silverwater	15-24/05/24	15/05/24
NL07	9 Comaneci Avenue Newington	16-27/11/24	15/11/24
NL11	13 Meadow Cresent Meadowbank	16-27/11/24	15/11/24

In addition, unattended monitoring data collected for other projects (Sydney Metro West and Parramatta Light Rail) which were in relevant locations for this project have also been considered as shown in **Table 7.2**.

Table 7.2: Other projects – unattended noise monitoring locations (AECOM 2025)

ID	Location	Measurement period – unattended
NL03	5 Hope Street Rosehill	Dec 2021
NL06	10 Carnarvon Street Silverwater	Aug 2019
NL08	286/33 Hill Road Wentworth Point	Dec 2021
NL09	105/16 Hill Road Wentworth Point	Dec 2021
NL10	78 Lancaster Avenue Melrose Park	Dec 2021

Results were determined for the L_{A1}, L_{A10} and L_{A90}. These are the noise levels for 1% of the time during the monitoring period, 10% and 90% of the time. The L_{A1} gives the maximum for the period while the L_{A90} indicates the noise level for most of the monitoring period and L_{Aeq} gives the equivalent value across the whole time period.

Table 7.3 provides the L_{A90} and L_{Aeq} noise levels from all of the unattended monitoring.

Table 7.3: Existing background noise levels (AECOM 2025)

Location	L_{A90} background rating noise level (dB(A))			L_{Aeq} average ambient noise level (dB(A))		
	Day	Evening	Night	Day	Evening	Night
Data collected for this project						
NL01	53	53	34	68	67	63
NL02	39	39	36	53	51	48
NL04	52	50	42	58	57	54
NL05	51	47	45	63	58	57
NL07	39	36	30	55	51	47
NL11	41	37	30	56	53	48
Other projects						
NL03	51	49	40	61	60	57
NL06	46	44	41	60	57	55
NL08	53	51	36	63	63	57
NL09	48	47	38	59	57	51
NL10	37	37	32	55	50	45

Attended monitoring was undertaken for 15 minutes at each location on 15 November 2024 or 15 May 2024 depending on location (AECOM 2025). The same locations were used as were used for the unattended monitoring. **Table 7.4** details the results of the attended monitoring.

Table 7.4: Results for attended noise monitoring (AECOM 2025)

ID	Location	Part of the day	L_{Aeq} dB(A)	L_{A90} dB(A)	Comments
NL01	45 Kissing Point Road Dundas	10.57 am 15/11/24	70	59	Heavy traffic along Kissing Point Road. Car pass-by 74 dB(A). Truck pass-by 84 dB(A). Some minor lulls in traffic but mostly constant. Birds chirping during lulls. Overcast conditions.
NL02	26 Rippon Avenue Dundas	11.22 am 15/11/24	53	41	Quiet street. Some car pass-bys, a very distant plane flyover. Car pass-by on Rippon Avenue 66 dB(A). Bird noise dominant during lulls. Distant hum from main road. Overcast conditions.
NL04	2 Eleanor Street Rosehill	2.42 pm 15/05/24	58	53	Cars and trucks passing by on James Ruse Drive; traffic noise generally between 55-57 dB(A). Some bird noise. Helicopter pass-by. Light wind conditions.
NL05	63 Asquith Street Silverwater	4.08 pm 15/05/24	63	54	Cars passing along Stubbs Street, around 50-60 dB(A). Occasional aircraft noise. Light wind conditions
NL07	9 Comaneci Avenue Newington	10.15 am 15/11/24	53	42	Some very distant hum from main road, but birds mostly dominant. Some local domestic noise sources, wheelie bins being moved around. A few car pass-bys along Comaneci Avenue. Car pass-by on Comaneci Avenue 63 dB(A). Conditions clear, no wind.
NL11	13 Meadow Cresent Meadowbank	12.03 pm 15/11/24	51	44	Car pass-by 59 dB(A), very few pass-bys. Some distant construction and traffic noise, reverse alarms, otherwise birds chirping and leaves rustling dominant. Overcast conditions.

The attended monitoring identified that the sources of noise in the area were traffic, aircraft, birds, people moving things around, leaves rustling and alarms (AECOM 2025). For most of these locations, the existing traffic noise was dominant.

These results show that the existing noise levels are fairly consistent across these locations. The results from the attended noise monitoring ranged from 51-70 dB(A) for the single 15 minute period over which monitoring occurred. For the unattended monitoring, the L_{Aeq} ranged from 51 to 68 dB(A) for the day period (AECOM 2025).

Criteria for noise levels are developed for this project based on this understanding of the existing noise environment in this area. These criteria are developed in accordance with the construction noise guideline and the noise policy for industry using guidance provided by NSW EPA (NSW DECC 2009; NSW EPA 2017, 2020).

The construction noise guidance indicates that the noise management level for a particular project during construction should be limited to the relevant background noise level based on the L_{Aeq} dB(A) results in **Table 7.4** plus 10 dB(A) during standard working hours and plus 5 dB(A) for work conducted outside of standard working hours. It is also acknowledged that on occasion there may be some particularly noisy works. If noise might reach 75 dB(A) or higher, those are the situations where respite may need to be provided and/or additional mitigation measures would be needed. As a result, the noise management level to apply at the most impacted locations around the sites where construction will occur range from 47 to 63 dB(A) (as L_{Aeq},15 min) during standard working hours depending on the existing noise environment. For out of hours work, the noise management levels to apply range from 35 to 50 dB(A) (as L_{Aeq},15 min) during the night, 42 to 58 dB(A) (as L_{Aeq},15 min) for the evening and 42 to 58 dB(A) (as L_{Aeq},15 min) during the day (but outside of standard hours) (AECOM 2025).

The noise policy for industry indicates that noise from any single piece of equipment or activity at an industrial site should not be greatly above the prevailing noise environment already in an area. This means that noise levels at relevant nearby locations should not be greater than the existing noise levels plus 5 dB(A) (as L_{Aeq},15 min). Based on consideration of only those locations where noise was measured and are relevant for the WRRF site and the pumping station (i.e. locations where noise might arise during operation), this means the noise management levels (as an intrusiveness criterion) to apply are 45-50 dB(A) (as L_{Aeq},15 min) for night time, 52-55 dB(A) (as L_{Aeq},15 min) for evenings and 45-50 dB(A) (as L_{Aeq},15 min) during the day (AECOM 2025).

7.5 International guidance on health impacts from noise

7.5.1 General

To further consider the potential for health impacts from noise, consideration has been given to the WHO guidance on noise levels protective for health (WHO 2009). The project specific criteria developed in accordance with the NSW guidance have been compared to the WHO guidance.

7.5.2 Night

The WHO review of night time noise identified the following (WHO 2009):

- there is no sufficient evidence of biological effects that are harmful to health at noise levels below 40 $dB_{Lnight,\ outside}$
- adverse effects, however, have been observed at levels above 40 $dB_{Lnight,\ outside}$ such as self-reported sleep disturbance, environmental insomnia and increased use of drugs that assist with sleep.

It is important to recognise that this value is based on the average noise over an entire night time period. It is also based on the annual average night time noise not just the noise on 1 particular night. So this value is not directly comparable with the criteria discussed above determined for this project in line with NSW guidance.

The NSW guidance provides information on converting the 15 minute based criteria to a value that can be compared with the WHO guidance. Conversion of a noise level from a 15 minute average to a value comparable to the WHO guideline can be made by taking 3 dB(A) from the project criteria (NSW EPA 2017).

The acoustic quality objectives for night time adopted for the project were 45-50 dB(A) (as L_{Aeq},15 min) during operation which convert to 42-47 dB(A) as $L_{Aeq,\ night,\ outside}$.

These values are above the WHO guidance but this is because the existing noise at the targeted locations is already close to or above the WHO guidance for night time. It does not mean that the project will change the existing situation. As a result, the next step in this assessment is to consider the predicted noise levels for the project which will be provided in **Section 7.6**.

7.5.3 Day

During the day, noise guidelines from WHO that are protective of moderate levels of annoyance in outdoor living areas are 50 dB(A) as LA_{eq} (outdoors) and 35 dB(A) (indoors). The indoor value is based on protecting conversations and learning for children (for day or evening periods) (WHO 1999). These values apply to the whole day or the whole day and evening and are considered by WHO as protective for health effects from noise.

As discussed above, conversion of a noise level for a 15 minute average to an average over the whole day can be undertaken by subtracting 3 dB(A) to the $LA_{eq,15\ min}$ value.

The acoustic quality objectives for day and day/evening adopted for the project were 45-55 dB(A) (as L_{Aeq},15 min) during operation which convert to 42-52 dB(A) as $L_{Aeq,\ day,\ outside}$.

These levels are essentially in compliance with the WHO guidelines for outdoors. Further discussion of the predicted noise levels for the project in **Section 7.6**.

7.6 Assessment of health impacts from noise and vibration for the project

7.6.1 Construction – predicted noise

Potential for changes in noise in the area due to the project while construction is occurring has been assessed in line with relevant government guidance. The equipment to be used during construction has been determined and the noise levels of such equipment have been considered. A wide variety of equipment will be used during construction (as is normal for most large construction projects). Such equipment may include large excavators, chainsaws, jackhammers, heavy vehicles, hand tools or generators (AECOM 2025).

Most works during construction are to be conducted during Standard Hours for which standard practices will be adopted to manage potential impacts due to changes in noise or vibration. If works are to be undertaken during the night (or outside standard hours), some activities may require mitigation measures such as acoustic barriers, particularly where they are in proximity to residential receivers (AECOM 2025).

Modelling of noise and vibration from equipment to be used during construction including from traffic was undertaken. Noise modelling was undertaken assuming no noise mitigation measures were in place. Noise modelling also included traffic to and from the site. The modelling was undertaken using the model SOUNDPLAN v8.2 (AECOM 2025).

The modelling determined that without mitigation measures there were a number of locations where small increases in noise due to the project could occur (1-5 dB(A)) and a few places where larger increases might occur. These situations relate mostly to pipeline installation works and the initial setup of the construction compound. These modelled results also relate to the worst case 15 minute average noise levels while equipment or activities were occurring closest to a place where people might be impacted. The modelling has indicated that there is potential for increases in noise during evenings should pipeline construction works at night. Most such works will only occur during the day wherever possible.

As a result, a range of noise mitigation measures will be required for relevant locations and for relevant activities.

7.6.2 Construction - mitigation measures

As is the case for all construction projects, changes in noise or vibration during construction can be difficult to avoid so government guidance includes that such project include mitigation measures to be implemented during works. For this Project, such measures include those listed in **Table 7.5**.

Table 7.5: Mitigation measures during construction

Issue	Mitigation measures
Excessive noise generated during construction	Prepare a Construction Noise and Vibration Management Plan (CNVMP) as part of the project CEMP. This will include: • roles and responsibilities • noise sensitive receiver locations • standard working hours and OOHW processes • reasonable and feasible management measures (including respite consideration) • monitoring methodology • community engagement.

Excessive noise generated during construction	Develop and implement a Community and Stakeholder Engagement Plan (CSEP) that will outline the following:
	• ongoing consultation with landowners, stakeholders, local councils, businesses and other relevant government agencies
	• notification of construction impacts to local areas and how these will be managed
	• project updates to nearby communities, including information on positive impacts and long-term project benefits
	• process for community complaints and response management system
	• a dedicated 1800 toll free number for enquiries
	• a dedicated email address and website for the project
	• resident notifications regarding:
	  o start of construction
	  o significant milestones
	  o major detours, traffic disruptions and controls
	  o after hours work
	• communication of key messages in a range of languages
	• vehicle management signs to communicate traffic changes to road users and communicate traffic management plans.
	
	Specific community engagement should be undertaken with RØDE. This engagement should discuss scheduling of noise and vibration inducing construction works to avoid times of the day when sensitive equipment is being used.
	
	For affected childcare centres and places of worship sensitive receivers (such as childcare centres, places of worship and businesses) (such as Sydney Korean Catholic Church, Western Sydney University (WSU) Early Learning Paramatta and the Sydney Baha'i Centre) specific community engagement should be undertaken to understand noise sensitive times such as child rest times and times of worship services for consideration to avoid high noise generating works during sensitive periods or inclusion of respite periods.

Issue	Mitigation measures
Inefficient operation and maintenance of equipment resulting in noise impacts	Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise, including: • Site managers to periodically check the site and nearby residences for noise problems so that solutions can be quickly applied. • Avoid the overuse of radios or stereos outdoors. When in use outdoors, maintain at respectful volumes. • Avoid the overuse of public address systems. • Avoid shouting and minimise talking loudly and slamming vehicle doors. • Turn off all plant and equipment when not in use. • Maintain and monitor equipment to ensure proper and efficient operation. Aligning with Sydney Water's Noise Management Code of Behaviour (SWEMS0056.01).
Equipment selection during construction generates excessive noise	Select equipment to minimise noise emissions. For example: • Select equipment with lower noise emissions than alternative equipment. • Use electric/ hydraulic equipment where possible. Use the minimum size and power requirement to complete a task.
Inefficient use of construction vehicle reverse beepers	Implement and use non-tonal reversing beepers (or an equivalent mechanism) on all construction vehicles and mobile plant, where possible. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Placement of construction equipment results in noise impacts	Arrange construction equipment to minimise noise to any nearby sensitive receivers. For example: • Maximise the distance between noisy plant and any adjacent sensitive noisy receivers, including directing noise emitting plant away from sensitive receivers. • Throttle down or shut down equipment when not in use. • Where possible shield or enclose stationary noise sources whilst maintaining worker safety. • Where possible place structures or hoarding/noise curtains at particularly noisy compounds to shield residential receivers where possible. Eg compounds where trenchless works will be undertaken for particularly long durations.
Noise during out of hours work (OOHW)	Schedule construction works for standard construction hours, where possible. If it is not possible to restrict the works to the day period, then they are to be completed as early as possible in each work shift. Provide appropriate respite to affected receivers in accordance with the Interim Construction Noise Guideline (ICNG).
OOHW results in sleep disturbance of sensitive receivers	Consult with residents that will be impacted by OOHW about measures to manage impacts in accordance with the ICNG, including considering alternative accommodation.
Vibration from construction equipment results in impacts to structures	Investigate opportunities for using alternatives to vibration generating equipment where vibration impacts have the potential to occur.
Vibration from construction equipment	Undertake in-situ vibration monitoring to confirm vibration levels and assess potential impacts where minimum vibration impact distances cannot be achieved. Where the monitoring identifies

Issue	Mitigation measures
results in impacts to structures	exceedances in the relevant criteria, or where impacts are identified, additional management measures will be identified and implemented to appropriately manage impacts.
Vibration from construction equipment results in impacts to structures	Complete dilapidation and condition surveys on infrastructure and structures at risk from being damaged by vibration during construction, including heritage items.

Impacts on community health from changes in noise or vibration during construction are, therefore, expected to be managed with these mitigation measures included in the project.

7.6.3 Operation – predicted noise

Plant

Modelling of noise and vibration from equipment to be used during operation of this facility was undertaken. Noise modelling was undertaken assuming no noise mitigation measures were in place. Noise modelling also included traffic to and from the site. The modelling was undertaken using the model SOUNDPLAN v8.2 (AECOM 2025).

The types of equipment that are likely to be present at the site that might emit noise during operations are primarily pumps but also include fans and blowers. Information on the noise created by this equipment along with how long they will operate at any time and when during the day or night such operation will occur have been used to inform the model for the site (AECOM 2025).

Noise levels were modelled for various meteorological conditions including the conditions that allow the most adverse situation to occur (low wind and temperature inversion). Changes in noise at the closest off-site locations where people might be present regularly have been modelled and these values have been compared to the project specific acoustic objectives discussed above (AECOM 2025).

The modelling indicates that locations around the WRRF site will not be subject to changes in noise above the criteria discussed above, even under the worst case weather conditions.

The predicted noise levels for all locations apart from the closest one (i.e. proposed Camellia Town Centre) are also in compliance with the WHO noise guidance. This closest location is the edge of the proposed new Camellia Town Centre which is not currently developed or rezoned and the noise at this location relates to the operation of the pumping station rather than the WRRF site. Predicted noise levels range from 33-40 dB(A) as $L_{Aeq,\ night,\ outside}$ under neutral weather conditions and 36-41 dB(A) as $L_{Aeq,\ night,\ outside}$ for adverse weather conditions (i.e. low winds and temperature inversion) – i.e. in compliance with WHO guidance regarding potential for health effects. (AECOM 2025).

Further into the Town Centre precinct, predicted noise levels drop to those compliant with the relevant criteria. The Town Centre is still being planned and rezoned and so this currently existing noise environment can be considered in planning this redevelopment. The new upgrade to the pumping station does not change the existing noise environment (AECOM 2025).

Traffic

Predicted changes in noise due to truck or car movements at the proposed new facility are expected to not change the current noise environment, given that the predicted vehicle movements for the facility will be minimal compared to the existing traffic in the area – particularly on Unwin and Colquhoun Streets. Expected vehicle movements for the WRRF are 14 car movements and 3-4 truck movements per day and for the pumping station less than 1 vehicle per day (AECOM 2025).

7.6.4 Operation – mitigation measures

Recommendations to reduce noise at the pumping station have been identified, should planning authorities require reduction in the existing (and predicted) noise environment, include:

- Replacing a roller door on the western side of the pumping station with an acoustically rated one
- Keeping windows at the pumping station close on the western and northern side (AECOM 2025).

No other recommendations have been identified to ensure appropriate management of noise during operation of the proposed new facility as all other equipment do not generate enough noise to change the existing noise environment. This means predicted noise levels are estimated to be in compliance with project criteria at all relevant locations (AECOM 2025).

7.7 Outcomes of health impact assessment

Table 7.5 presents a summary of the outcomes of the assessment undertaken in relation to the impacts of changes in noise, associated with the proposed project, on community health.

Table 7.5: Summary of health impacts – noise and vibration

Noise and vibration	
Benefits	Provision of sufficient treatment plants to manage wastewater in an urban area is a benefit to the health of the community
Impacts	Potential changes in the noise environment during construction need to be mitigated particularly in areas along the pipeline construction routes. Potential changes in the noise environment during operation are in compliance with the relevant project specific criteria except at 1 location where mitigation may need to be considered depending on the future land use at that location. It is noted, however, that the noise levels for the upgrade of the pumping station are not predicted to be different from the current situation due to operation of the existing layout of the pumping station or the current situation in relation to traffic on James Ruse Drive so the noise environment at this location would need to be considered for the Camellia Town Centre precinct even without this project.
Mitigation	During construction, standard mitigation measures need to be implemented. The project will need to comply with the Sydney Water Noise Management Procedure and have a project specific noise management plan to ensure all staff and contractors are aware of the site requirements and the importance of complying with those site requirements. During operation, the need for mitigation will be considered at the pumping station depending on the land use at the edge of the Camellia Town Centre precinct once the full plans for the area are determined. It is noted that the mitigation measures that might be required include either (or both) installation of a roller door with acoustic rating or ensuring windows remain closed on relevant sides of the pumping station – options that are quite straightforward to implement.

Section 8. Health impacts: Soil – contamination

8.1 Introduction

This section presents a review of impacts on health associated with the potential presence/management of soil contamination relevant to the project.

In the main, this relates to whether there is any existing contamination at the site and, if so, how it will be addressed during construction.

Health impacts associated with contamination have been assessed on the basis of the information within the technical paper:

- GHD (2025a). Soil and Contaminated Land Impact Assessment, Greater Parramatta, Olympic Peninsula Water Cycle Management. Dated 15 September 2025.
- Jacobs (2025b). Detailed Site Investigation – Camellia WRRF. Dated 21 January 2025.
- Jacobs (2025c). Detailed Site Investigation – River Release Pipeline Alignment. Dated 17 April 2025.
- Jacobs (2025d). Detailed Site Investigation – Brine and Influent Pipeline Alignment. Dated 16 June 2025.
- GHD (2025b). Desk Top Study – Camellia Pumping Station to NSOOS Greater Parramatta, Olympic Peninsula Water Cycle Management. DRAFT. Dated 30 September 2025.

Contamination risks are more relevant to the construction phase of the project because exposure to contaminated soil, sediment or groundwater would most likely occur during the construction phase, if such contamination was not appropriately managed. Once construction of the facility has been completed, normal operations of the WRRF should not result in any additional contamination.

8.2 Background/Approach

The approach taken in this assessment for assessing potential for soil contamination is that outlined in national guidance including:

- enHealth Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards (enHealth 2012a)
- enHealth Australian Exposure Factor Guide (enHealth 2012b)
- ASC NEPM National Environmental Protection Measure – Assessment of Site Contamination including:
    - Schedule B1 Investigation Levels for Soil and Groundwater (NEPC 1999 amended 2013c)
    - Schedule B4 Guideline on Site-Specific Health Risk Assessment Methodology (NEPC 1999 amended 2013d)
    - Schedule B7 Guideline on Health-Based Investigation Levels (NEPC 1999 amended 2013b).

These guidance documents explain how to determine if the concentration of a chemical in soil at a site is in compliance with national guidelines (and can, therefore, remain in place) and what to do if such a concentration is above national guidelines including how to undertake more detailed assessment and how to determine if remediation is required.

As discussed in **Section 5.2.2**, a wide variety of chemicals will be present in soil at a site just as they are present in untreated wastewater. It is the difference between what is normally/commonly present in soil at a site compared to what is actually present at a particular site that is the focus of these site investigations.

The specific approaches adopted for the assessment of soil contamination for this project have included:

- Site investigations have been undertaken for the site where the WRRF will be constructed (if approved) (Jacobs 2025b,c&d)
- Desktop review of all available existing information to gain an understanding of the existing environment – this includes specific site investigation reports for this site and those in the immediate vicinity as well as previous environmental reports (where available), published information, selected historical aerial photographs, and NSW EPA public records.
- Site inspection of the pipeline alignment and the WRRF site to ground truth the information gained from the desktop review and the potential contamination within the project footprint and surrounding study area.
- Summary of all the areas of environmental interest (AEIs) that have been selected (GHD 2025a).

8.3 Assessment of contamination

8.3.1 General

The Camellia Peninsula is an area where a wide range of industrial activities have occurred in the past. Since the late 1800s, heavy and light industry have been undertaken in this area including oil refining, chemical manufacturing, manufacturing of building materials, tanneries, meatworks, lumber yards, bitumen and tyre manufacturing, paint formulation and other activities. Management of various waste materials has also been undertaken in this area (GHD 2025a).

8.3.2 WRRF site

At the site of the WRRF specifically, the following is noted about the history of the site:

- This site formed part of the Clyde Refinery which ceased operation in 2012
- This part of the Clyde Refinery site is located within the Western area remediation project for the Clyde Refinery site
- A range of areas within the Western area remediation project have been investigated and remediated (where necessary) and the work has been signed off by a relevant contaminated land auditor – this has included preparation of a site audit statement indicating the site is suitable for commercial/industrial land use for slab on grade structures subject to implementation of relevant long term environmental management plans (LTEMPs)
- The main issues that were identified were that soil was contaminated with petroleum hydrocarbons and there was potential for asbestos to be present
- In relation to petroleum hydrocarbons, the levels that remain on the site could result in odours or discolouration of the soil but levels that might impact on human health were dealt with during the remediation
- The WRRF site has been declared by NSW EPA as no longer significantly contaminated

- Wastes and uncontrolled fill remain present in parts of the WRRF site. Such material is being addressed by the application of appropriate fill material (i.e. excavated natural material and tunnel spoil) across the entire site to a depth of 1.7 m above the current ground level (GHD 2025a).

The image from Google Earth from 2007 (**Figure 8.1**) shows that part of the proposed WRRF site was located within the Clyde refinery site with storage of cars/containers were located on other sections of the site. It appears that this area has been covered in asphalt. The proposed WWRF site is highlighted in the yellow box – but the box is bigger than the proposed site (just for convenience).

Figure 8.1: Historical land uses at proposed WRRF site (approximate area highlighted by yellow box) (photos from 2003 to 2017 are similar)

Parts of the proposed WRRF site requires filling to raise the ground level. Clean fill (i.e. soil meeting the NSW EPA definition for virgin excavated natural materials (VENM)) is to be brought onto the site and compacted to ensure the site has appropriate geotechnical characteristics with the goal of raising ground level 1.7 m above the historical level). This means that any contaminants in existing soil will be covered and not accessible to people during operation of the facility. These works have been assessed and approved under a Review of Environmental Factors for environmental management works and are not part of this EIS (GHD 2025b).

The use of clean fill material to raise the site level (and to be suitably compacted) that is required as part of this project will ensure no person working or visiting the site can have direct contact with the soil at this site once construction has been completed (Jacobs 2025b).

Those undertaking these works during construction may be able to come into contact with the soil at the site. It is assumed that appropriate procedures and personal protective equipment will be required during construction to ensure risks to workers are managed appropriately (Jacobs 2025b).

The use of fill across much of the WRRF site will limit the potential for any leaching to groundwater or impacts from soil vapour for any areas where contamination has been identified (Jacobs 2025b).

Long term environmental management plans have already been prepared and reviewed by the contaminated site auditor to ensure knowledge of the existing contamination levels is retained at Sydney Water and to ensure construction works and any future works at the plant are appropriately designed to not change any potential risks due to the contaminants (Jacobs 2025b).

Potential contaminants at the site could include:

- Petroleum hydrocarbons and PFAS from refinery operations
- Wide range of contaminants that could have been present in fill brought onto the site historically
- Asbestos from historical structures
- Petroleum hydrocarbons or other chemicals from redundant pipelines
- Contaminants from activities at adjoining sites that could travel onto this site (GHD 2025a).

The site investigation evaluated contamination in soil, groundwater and soil vapour.

Concentrations of metals and petroleum hydrocarbons were reported to be present in soil at concentrations above guidelines based on protecting ecosystems in 1 location. Chromium, lead, petroleum hydrocarbons and asbestos were identified in some locations in the north eastern part of the site above guidelines based on protecting people (Jacobs 2025b).

Groundwater may travel through the site in a southerly direction and reach off-site surface water locations (such as Duck River). Surface water samples were also collected showing only copper, zinc and PFOS were above relevant guidelines (Jacobs 2025b).

Petroleum hydrocarbons were reported to be present in soil vapour but no concentrations exceeded any of the relevant guidelines based on protecting people for commercial/industrial sites for all locations at the site apart from SV108. Concentrations at SV108 were in compliance with guidelines for open spaces – the relevant land use for that part of the site (Jacobs 2025b).

While the soil vapour results at SV108 are in compliance with the relevant guidelines for open space areas, these results at SV108 indicate that there is potential for LNAPL (light non-aqueous phase liquid) to be present in the south east corner of the site. As discussed in CRC CARE Technical Report 23 (CRC CARE 2013), soil vapour concentrations can be taken as indicative of LNAPL even if LNAPL is not actually observed in a groundwater well when:

- Benzene is present at concentrations greater than 3-5 mg/L in groundwater
- BTEX is present at concentrations greater than 20 mg/L in groundwater
- TRH is present at concentrations greater than 30 mg/L in groundwater
- PID readings are greater than 500 ppm

- Hexane, cyclohexane and heptane are present in soil vapour at concentrations greater than 100 mg/m^3.

In relation to SV108:

- Benzene concentration is 41 mg/m^3 which meets the listed trigger.
- Sum of the concentrations of hexane, cyclohexane and heptane is 650 mg/m^3 which meets one of these triggers.
- Groundwater data for GW113 and GW114 do not meet the BTEX or TRH triggers, however, the PID reading for this location was >500 ppm which again flags the potential for LNAPL to be present.

Further investigation is recommended for the area around SV108 as this location is quite close to the southern boundary of the site and the contamination in that area may be moving off the site towards Duck River (Jacobs 2025b).

Some chlorinated hydrocarbons were reported to be present in soil vapour above relevant guidelines in some locations. One of these locations appears to be in the footprint of the building housing the reverse osmosis process (SV104) (Jacobs 2025b).

Vapour intrusion modelling has been undertaken in this assessment to demonstrate that vapour intrusion cannot occur to a level of concern. The modelling is presented in **Appendix B**.

Vapour intrusion occurs when volatile chemicals are present in soil vapour within the soil profile which may move towards the ground surface and then through cracks in slabs and penetrations to reach inside a building. Vapour modelling using standard default assumptions and assuming a person might be present in the RO building all day across the work year (or for workers in excavations during construction) results in estimates of risk more than 300-500 times lower than the maximum acceptable value recommended by national health authorities. This means risks due to vapour intrusion into the RO building (or into excavations during construction in the area around the RO building) will be negligible.

It is assumed that this calculation is extremely conservative because people will not be working within this building at all times and because the site will covered by 1.5 m of fill before construction of the WRRF which will further reduce the potential concentrations that might intrude into a building.

As already flagged, long term environmental management plans are in place for various parts of the WRRF site and required by the audit statement to be implemented.

Consequently, risks to community health from contamination at the WRRF site are expected to be negligible as the community will not be able to come into contact with any soil or groundwater at the site as they will not be able to access the site during construction or operation. Duck River is already impacted by contaminated groundwater from many sources in the area including the former refinery adjacent to this site so, while it may be possible that petroleum hydrocarbons etc may move with groundwater from this site into the off-site area, such levels are likely to be similar to those already present in the river due to the entire former refinery site (Jacobs 2025b).

In locations where asbestos containing materials may be found, risks should be managed in accordance with government guidance and the asbestos management plan for these works (Jacobs 2025b).

Mitigation measures relevant in relation to worker protection that may be included in the project will be documented in the construction environmental management plan (Jacobs 2025b).

8.3.3 Brine pipeline and transfer pipeline

The routes of the brine and transfer pipelines have been investigated for potential contamination in soil and groundwater (Jacobs 2025d). The route for these pipelines travels to the north west of the site until they reach the pumping station and then to the north until intersecting with the NSOOS.

The alignment for the brine and transfer pipelines includes the following considerations in relation to site history:

- These pipelines will travel near or through the following sites:
    - Former Clyde refinery
    - Clyde stabling facility (currently under construction for Sydney Metro West)
    - Former James Hardie site
    - Former Akzo Nobel site
    - Existing Camellia pumping station
    - Existing waste facility – Downer
    - Soil treatment facility – Abacus
    - Bitumen site – Emoleum
    - Service Stations
    - Range of other commercial/light industrial sites.
    - Areas of disturbed ground (GHD 2025a).
- In addition, there is potential for acid sulfate soils in the alignment (GHD 2025a).
- While the alignment of the pipelines is near the following site, it does not actually go through areas with contamination at the following sites:
    - Clyde stabling facility (currently under construction for Sydney Metro West)
    - Former James Hardie site
    - Former Akzo Nobel site
    - Existing waste facility – Downer
    - Soil treatment facility – Abacus
    - Bitumen site – Emoleum
    - Service Stations (1 of 2).

  So these have not been considered any further (GHD 2025a).

This long list of sites highlights the industrial history of this part of Sydney (GHD 2025a).

Soil sampling and analysis has indicated that asbestos may be found along parts of the pipeline routes. In locations where asbestos containing materials may be found, risks should be managed in accordance with government guidance and the project asbestos management plan. This will be an important consideration for these works, given that parts of the route travel through or are adjacent to the former James Hardie site where materials containing asbestos were manufactured. There were few other contaminants found in the soil samples or at least none above relevant guidelines for the protection of health (Jacobs 2025d).

Groundwater samples showed levels of some metals, PFAS and some petroleum hydrocarbons at concentrations above relevant guidelines. This means if dewatering of excavations is required during works, the water pumped from the excavations will need to be appropriately managed in line with the project dewatering management plan and legal requirements. Appropriate management of groundwater from excavations along the pipeline route will ensure protection of community health during construction (Jacobs 2025d).

Analysis of soil vapour close to the pipeline route did not report concentrations of volatile chemicals above any relevant guidelines so no further assessment is required. This is supported by the lower concentrations for the volatile chemicals in soil and groundwater (Jacobs 2025d).

Risks to the community due to contamination issues along the pipeline routes are negligible as long as earthworks are undertaken appropriately to manage asbestos containing materials and dewatering of excavations is managed appropriately to ensure the community cannot come into contact with that water (directly or after it is discharged to the stormwater system or into Duck River directly) (Jacobs 2025d).

Consequently, risks to community health from contamination along the route of the brine and transfer pipelines are expected to be negligible as the community will not be able to come into contact with any soil or groundwater at the site once construction is complete. They will also not be able to come into contact with soil or groundwater during construction due to the controls required to be in place for safety reasons related to construction methods. Mitigation measures relevant in relation to worker protection that may be included in the project will be documented in the construction environmental management plan.

8.3.4 River release pipeline

The river release pipeline travels to the southeast of the site through Newington and Wentworth Point through to Meadowbank Park. The pipeline route has been investigated using sampling of soil, groundwater and ground gas (Jacobs 2025c).

The soil samples indicated that asbestos containing materials were present at levels above relevant guidelines in some locations. Other contaminants (petroleum hydrocarbons and some metals) were measured at concentrations above guidelines based on protecting ecosystems but the concentrations of these contaminants were not above guidelines based on protecting people's health (Jacobs 2025c).

In locations where asbestos containing materials may be found, risks should be managed in accordance with government guidance (e.g. keeping the material wet, wrapping it in plastic as soon as possible, engagement of relevantly qualified people to undertake the work). Again, this will be an important matter to consider in the construction environmental management plan to ensure works are undertaken safely (Jacobs 2025c).

Groundwater samples indicated that PFAS, some metals and ammonia may be present at concentrations above guidelines:

- Benzene at GW116 was higher than at any other location although not at concentrations above guidelines for protection of people. This location was in the south eastern corner of the WRRF site – where elevated petroleum hydrocarbons have already been discussed in **Section 8.3.2**.
- PFOS (and some other PFAS) were detected in most groundwater wells at levels in line with ambient concentrations in many urban waterways in Australia. Concentrations for PFOS in surface water and groundwater in urban areas are mostly within the range of 0.01 to 0.05

µg/L where there is no specific contamination source such as an airport or defence base. This range has been based on studies from Victoria, NSW, Western Australia and Queensland. The studies used are those designed to measure levels in normal urban areas (Allinson et al. 2019; Baddiley et al. 2020; Coggan et al. 2019; Richmond 2022; Sardiña et al. 2019; Sharp et al. 2021; Szabo et al. 2018; Thompson et al. 2011).
- Concentrations of nickel, lead and arsenic were measured to have exceeded recreational water guidelines at some locations by small amounts. Recreational water guidelines are based on people recreating in the water every day of the year for a lifetime. This amount of exposure is not possible in relation to groundwater at this site.

Ground gas (i.e. methane etc) may be elevated in areas near former landfills such as the former Silverwater landfill and areas around Sydney Olympic Park as methane may be generated by the breakdown of waste in such facilities for decades after they have been closed. Monitoring of methane levels did find some elevated methane concentrations which may accumulate in excavations (trenches, pits and service pits) during works. It will be important to continue to monitor methane levels in such excavations to ensure appropriate management. Procedures to ensure this occurs should be documented in the construction environmental management plan (Jacobs 2025c).

Soil vapour measurements were only collected on the WRRF site and these have already been discussed and assessed in **Section 8.3.2** (Jacobs 2025c).

Consequently, risks to community health from contamination along the route of the river release pipeline are expected to be negligible as the community will not be able to come into contact with any soil or groundwater at the site once construction is complete. They will also not be able to come into contact with soil or groundwater during construction due to the controls required to be in place for safety reasons related to construction methods. Mitigation measures relevant in relation to worker protection that may be included in the project will be documented in the construction environmental management plan.

8.4 Outcomes of health impact assessment

Table 8.1 presents a summary of the outcomes of the assessment undertaken in relation to the impacts of soil contamination, associated with the proposed project, on community health.

Table 8.1: Summary – soil (including contamination)

Soil (including contamination)	
Benefits	Provision of sufficient treatment plants to manage wastewater in an urban area is a benefit to the health of the community
Impacts	Contamination requiring management during construction may be present in some parts of the WRRF site and along the pipeline routes. Contamination at the WRRF site will need to ensure appropriate management of contaminated groundwater and, where relevant, soil vapour (i.e. contamination with volatile chemicals). Mitigation measures during construction will be required to ensure materials are handled appropriately and to ensure workers are appropriately protected. Asbestos may be found along the pipeline routes and would need to be managed carefully in line with government requirements and the site asbestos management plan. No change in contamination status is expected once the facility is operational and, therefore, risks to community health will be negligible during operations.

Soil (including contamination)	
Mitigation	Mitigation measures such as monitoring, personal protective equipment and appropriate handling of materials (soil and groundwater) will be needed to ensure appropriate management of risks to workers during construction. In addition, contamination by volatile chemicals may result in odours during some works for people particularly sensitive to odours – providing information to workers that risks have been assessed and found to be low would be a useful approach to ensure the presence of such odours does not cause concern for workers. In relation to asbestos containing materials, appropriate controls will be required in line with government requirements and the site asbestos management plan. No other mitigation measures are required in relation to contamination.

Section 9. Health impacts: Safety

9.1 Introduction

This section presents a review of impacts on health associated with safety aspects including:

- use of chemicals during the operation of the facility
- bushfires
- subsidence
- flooding.

Health impacts associated with potential safety issues related to the project have been assessed on the basis of the information within these technical papers:

- GHD (2025c), Greater Parramatta and Olympic Peninsula Water Cycle Management Preliminary Hazard Analysis Report. Dated 5 June 2025.
- Jacobs (2025e) Flood Assessment Report, Greater Parramatta and Olympic Peninsula Water Cycle Management Project. Dated 2 October 2025.
- Stantec (2025a), Greater Parramatta and Olympic Peninsula (GPOP), Water Cycle Management, Traffic and Transport Impact Assessment. Dated 10 October 2025.

9.2 Assessment of health impacts – management of hazardous materials

9.2.1 Approach

Wastewater treatment requires the use of a range of chemicals. To check whether the storage or use of such chemicals requires consideration under State Environment Planning Policy (SEPP) 33, a multi-level assessment has been undertaken (GHD 2025c).

SEPP 33 covers developments that may be hazardous or involve the use of hazardous chemicals. NSW guidance about what constitutes hazardous development and how to evaluate whether a particular development can be classified as hazardous is provided in the following documents:

- NSW Government 2021, *State Environmental Planning Policy (Resilience and Hazards)* (NSW Government 2021)
- NSW Planning 2011b, *Risk Criteria for Land Use Safety Planning, Hazardous Industry Planning Advisory Paper No 4* (NSW Planning 2011c)
- NSW Planning 2011, *Hazardous Industry Planning Advisory Paper No 6, Hazard Analysis* (NSW Planning 2011a)
- National Transport Commission, Australian Dangerous Goods Code[20].

A 'hazardous industry' under SEPP 33 is one which, when all locational, technical, operational and organisational safeguards are employed, continues to pose a significant risk. Often such industries are sites where one or more chemicals that are classified as Dangerous Goods are stored in sufficient quantity that, if an accident were to occur or if some of the control measures were to fail, it could create a situation that could concern the community. Such events might have the potential to cause significant injury (GHD 2025c).

[20] https://www.ntc.gov.au/codes-and-guidelines/australian-dangerous-goods-code

Government guidance provides screening criteria and checklists to determine whether a particular development might need to be assessed in detail under this regulation. Such criteria include the types of materials used at a site and the amounts of such materials that might be stored at a site (GHD 2025c).

The objective of the screening assessment or hazard identification step (HAZID) is to determine if hazardous processes or hazardous materials that may be present on a site in order to undertake relevant activities could potentially have impacts in off-site areas at an unacceptable level (GHD 2025cc).

If a development includes use of materials at levels above the screening criteria then it requires detailed evaluation. The first step in this more detailed process is a preliminary hazard analysis (PHA) (NSW Planning 2011a). The assessment of the suitability of a site to accommodate an existing or proposed development of a potentially hazardous nature must be based on consideration of:

- the nature and quantities of hazardous materials stored and processed on the site
- the type of plant and equipment in use
- the adequacy of proposed technical, operational and organisational safeguards
- the surrounding land uses or likely future land uses
- the interactions of these factors (NSW Planning 2011a).

It involves consideration of the nature of the materials and processes at a development and what, if anything, could go wrong in handling such materials or undertaking such processes (GHD 2025).

The government guidance also provides guidance about how to store and handle such materials to manage the risks posed by such dangerous goods.

9.2.2 Screening (HAZID)

Construction

During construction it is not expected that any dangerous goods will need to be handled on-site at levels above the screening criteria. This will be reviewed during the development of the construction environmental management plan once details of the construction are clearer (GHD 2025c).

Operation

Once the plant is in operation, the following chemicals may need to be managed at the site:

- Carbon dioxide
- Lime
- Ferric chloride
- Sodium hypochlorite
- Ammonium hydroxide
- Sodium bisulfite
- Sodium hydroxide
- Sulfuric acid
- Hydrogen peroxide
- Citric acid
- Sucrose
- Antiscalant

- Biogas (methane and carbon dioxide)
- Biocide
- Liquid polymer emulsion
- Powder polymer (GHD 2025c).

Most of these chemicals/chemical classes will not be stored or used on-site above the government screening criteria. Ferric chloride, sodium hypochlorite, ammonium hydroxide and sodium bisulfite are in the same dangerous goods class and will be stored on-site in total above the screening criteria. Sodium hydroxide, sulfuric acid and hydrogen peroxide are in the same dangerous goods class – different to the one above. These will also be stored/used on-site at levels above the screening criteria. Finally, biogas/methane also will be present at the site above screening criteria – it is produced within the treatment process. These chemicals, therefore, require more detailed assessment. None of the chemicals trigger the screening criteria in relation to transport of the chemicals to or from the site (GHD 2025c).

9.2.3 Preliminary hazard analysis (PHA)

Construction

There were no materials to be used during construction that were highlighted in the screening assessment, so no further assessment is required (GHD 2025c).

Operation

The preliminary hazard analysis looks at the ways in which these materials might be of concern.

The identified potential hazards include:

- Spills of corrosive chemicals within the plant
- Interaction of incompatible chemicals
- Release of brine into to the environment, prior to the intended release point
- Release of treated water from pipe breaks etc (prior to the planned release structure)
- Release of biogas/methane or carbon dioxide
- Release of sulfuric acid
- Explosive gas mix (related to biogas/methane)
- Polymer powder fire (GHD 2025c).

The PHA identified the control measures required to ensure these events have a very low probability of occurring. These measures include:

- Storage and use of corrosive chemicals in line with the relevant Australian Standards (AS3780, AS1657) and government requirements (e.g. bunding, dangerous goods requirements etc)
- Holding safety data sheets for each chemical and ensuring compliance with requirements
- Emergency spill kits held on-site
- Emergency plan for the site (including evacuation plans, training requirements)
- Engineering measures (e.g. leak detection equipment, pressure and vacuum relief valves, appropriate electrical equipment (i.e. spark free))
- Appropriate design of equipment to minimise potential for failure/leaks
- Housekeeping requirements (GHD 2025c).

Further assessment of the potential for issues related to the release of biogas/methane from the digesters (leak or fire) was undertaken. This work included consideration of how much heat could be generated for the type of equipment to be installed at this site if a fire was to occur as well as potential issues related to an explosion, if such could occur for the digesters (GHD 2025c).

Modelling was undertaken assuming either a catastrophic rupture of a digester or a small leak (i.e. failure of a valve or other fitting or a small hole in the vessel) in a digester could occur. Modelling for this work is undertaken using the model PHAST – a commonly used model for such work (GHD 2025c).

The proposed location of the digesters is close to the northern boundary of the site. This means that if a catastrophic failure were to occur, damage could reach the off-site area to the north of the site where a number of industrial properties are located. For a small leak from a digester, no effects are likely to reach off-site areas. Engineering information about how likely a digester is to suffer catastrophic failure indicates that this has a very low likelihood – i.e. 0.000006 chance per year. Given that the site will have 3 digesters, the likelihood of such a failure is 0.000018 per year (GHD 2025c).

The modelling indicates that the site complies with all requirements of the NSW Planning guidance for hazardous facilities (GHD 2025c).

9.2.4 Results

The recommendations from the PHA in relation to this project include:

- All chemicals held on-site should be stored in accordance with relevant Australian Standards, government regulations and Sydney Water requirements.
- All chemicals held on-site should have safety data sheets stored on-site for easy reference and access for emergency services if necessary.
- Safe work procedures for transfer, storage, spill prevention and spill cleanup should be in place at the facility and complied with by all staff.
- Design of the facility should ensure chemical storage is in compliance with relevant Australian Standards, government regulations and Sydney Water requirements.

9.3 Assessment of health impacts – bushfires

The project is not located within an area that could be prone to bushfires as the site is located within the heavily urbanised areas of Sydney. Therefore, no assessment has been undertaken in relation to potential risks due to bushfires.

9.4 Assessment of health impacts – subsidence

The project is not located within an area that is prone to subsidence due to mining or natural geology. Therefore, no assessment has been undertaken in relation to potential for subsidence.

9.5 Assessment of health impacts – flooding

A flood assessment has been undertaken (Jacobs 2025e). The project is not expected to significantly alter flooding conditions.

The Camellia-Rosehill WRRF has been designed to be above the projected 1% annual exceedance probability (AEP) event (with the consideration of future climate change). Flooding impacts resulting from the operation of the project are generally predicted to be minor across all flood events, including the Probable Maximum Flood (PMF) and 1% Annual Exceedance Probability (AEP) events under climate change scenarios (Jacobs 2025e).

There is potential for changes to flooding behaviour in Charity Creek and Smalls Creek in Meadowbank Park as a result of the proposed aerial crossings over both waterways. Sydney Water would continue to refine the design of the aerial crossings to prevent impacts from flooding in these waterways (Jacobs 2025e).

Flooding impacts during construction are expected to be minor. Some construction compounds are located in high flood hazard areas. These risks would be managed through site-specific flood mitigation measures and during detailed construction planning (Jacobs 2025e).

A flood management plan will be prepared to ensure construction occurs appropriately (Jacobs 2025e).

9.6 Assessment of health impacts – pedestrian safety

Pedestrian safety (and other aspects of active transport) has been evaluated in the Traffic report:

- Stantec (2025a), Greater Parramatta and Olympic Peninsula (GPOP), Water Cycle Management, Traffic and Transport Impact Assessment. Dated 10 October 2025.

The WRRF site will not be accessible to the general public. Existing pedestrian access to areas around the WRRF site is limited as the area has numerous industrial sites where access for the general public is discouraged. The WRRF part of this project will not change this situation. Other projects in the area such as the Duck River Trail and the Light Rail project will address relevant infrastructure in areas where the general public may visit (Stantec 2025a).

Pedestrian access and safety may be impacted during construction of the various pipelines for this project but, once construction of the pipelines is completed, no impacts would be expected (Stantec 2025a).

9.7 Outcomes of health impact assessment

Table 9.1 presents a summary of the outcomes of the assessment undertaken in relation to the potential issues relating to safety (including pedestrian safety, use/storage of hazardous chemicals, bushfires or subsidence), associated with the proposed project, on community health.

Table 9.1: Summary of health impacts – safety

Safety	
Benefits	Provision of sufficient treatment plants to manage wastewater in an urban area is a benefit to the health of the community
Impacts	Based on the available data and information, potential impacts on the health of the community in relation to handling and use of dangerous goods, pedestrian safety or changes in flooding potential during storm events have been assessed and determined to be negligible when managed in accordance with government requirements (i.e. legal requirements). Given that this project is not located in an area where subsidence or bushfires are likely, no assessment of these aspects has been undertaken. The location of this new facility and the related pipelines already ensures that any change in risk to community health related to this project for risks from bushfires or subsidence is negligible/zero.

Safety	
Mitigation	Existing legal requirements for the storage and transport of hazardous substances must be complied with at the new facility. Particular control measures recommended for this facility include: ▪ All chemicals held on-site should be stored in accordance with relevant Australian Standards, government regulations and Sydney Water requirements. ▪ All chemicals held on-site should have safety data sheets stored on-site for easy reference and access for emergency services if necessary. ▪ Safe work procedures for transfer, storage, spill prevention and spill cleanup should be in place at the facility and complied with by all staff. ▪ Design of the facility should ensure chemical storage is in compliance with relevant Australian Standards, government regulations and Sydney Water requirements.

Section 10. Health impacts: Transport and traffic

10.1 Introduction

This section presents a review of impacts on health associated with any changes in transport and traffic issues arising from the project. Health impacts associated with changes in traffic due to the project have been assessed on the basis of the information within the technical paper:

- Stantec (2025a), Greater Parramatta and Olympic Peninsula (GPOP), Water Cycle Management, Traffic and Transport Impact Assessment. Dated 10 October 2025.

10.2 Background/Approach

The potential for impacts due to changes in transport and traffic during construction or operation of the wastewater treatment plant or along the routes of the pipelines has been assessed (Stantec 2025a).

It is important to consider changes in traffic in relation to public health as congested traffic has the potential to impact on health in a number of ways. Increased anxiety, reduced air quality, increased noise, and poor perceptions of an area due to safety issues could be possible if traffic changes are significant or if a project is located in an area that already has significant traffic issues. Another aspect that is important to consider for a project in relation to public health is whether that project has potential to change access to active transport – i.e. cycling routes or pedestrian access – or public transport.

The assessment of changes in traffic included the following steps:

- Use historical traffic data to understand existing traffic conditions on the surrounding road network.
- Undertake additional traffic surveys to assist in understanding existing traffic conditions on the surrounding road network and to form an existing and future baseline for the assessment.
- Consider traffic related to other large projects in the area including Parramatta Light Rail and Sydney Metro West and the timing of those projects in relation to this one.
- Undertake intersection modelling using SIDRA INTERSECTION for the following intersections to assess the level of impact using modelling parameters such as Degree of Saturation (DoS) and Level of Service (LoS):
    - Hassall St/Grand Ave/James Ruse Dr
    - Grand Ave/Colquhoun St
    - Wentworth St/Parramatta Rd.
- Develop mitigation measures where required.
- Develop a framework construction traffic management plan (Stantec 2025a).

10.3 Other major projects

10.3.1 Parramatta Light Rail

Stage 1 has been completed and is now operational. This Stage connects Parramatta with Westmead and Carlingford as well as Camellia. Stage 2 for this project is commencing construction later in 2025 and will take a number of years to complete. Traffic related to Stage 2 of the light rail project will be relevant for consideration from 2025[21] (Stantec 2025a).

10.3.2 Sydney Metro West

This project is currently under construction with a projected operational date in 2032[22]. Initial tunnelling was recently completed[23]. The peak period for construction-related vehicle traffic across the Sydney Metro West project will be second half of 2026 through to end of 2027. Traffic due to this project will be lessening somewhat as the proposed GPOP project (if approved) commences construction (Stantec 2025a).

10.3.3 Duck River Trail

Currently works on forming a trail along both sides of Duck River for public recreation are underway. The work is proposed to occur in 3 stages with the first stage due for completion in September 2025. Traffic related to this project will be much less than for the projects discussed above (Stantec 2025a).

10.3.4 Redevelopment of former industrial sites

The Camellia Rosehill Place Strategy covers the renewal of many of the former industrial sites in this area over the next 20 years[24]. The plan covers the development of a mixed use precinct – i.e. includes housing, retail, employment activities and public spaces. The new housing developments in this area and in other nearby areas are the reason that additional wastewater infrastructure is required (Stantec 2025a).

10.4 Assessment of health impacts

10.4.1 Construction

The assessment has considered the current traffic situation in the area (i.e. 2025) along with the baseline expected for 2028 with expected growth in the area (i.e. 1.5% growth between 2025 and 2028) as well as the situation in 2028 with this project added into the system.

The assessment has assumed that heavy vehicles will only travel along the designated routes. This ensures such vehicles stick to major roads for as long as possible. Some of the relevant intersections are already quite delayed under existing conditions during both the morning and evening peak times. The addition of this project will not add noticeably to the delays experienced at these intersections. The relevant ones are Hassall St/Grand Ave/James Ruse Dr and Wentworth Street/Parramatta Road. The other major intersection relevant for this project is Grand Avenue/Colquhoun Street. This one is in good condition and that will not change if this project is added into the traffic at this location.

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[21] https://www.nsw.gov.au/driving-boating-and-transport/projects/parramatta-light-rail
[22] https://www.sydneymetro.info/west/project-overview
[23] https://www.smh.com.au/national/nsw/tunnelling-on-metro-west-nears-completion-but-don-t-expect-new-lines-any-time-soon-20250915-p5mv0x.html
[24] https://www.planningportal.nsw.gov.au/camellia-rosehill-place-strategy

Impacts on traffic are expected in areas relevant for pipeline construction for short times during trenching or during installation using trenchless techniques. This is because actual construction activities will be occurring close to roads. This may require:

- Road closures or lane restrictions
- Traffic diversions
- Diversions for other types of transport from standard routes (movement of bus stops or adjustment of routes)
- Access restrictions to footpaths or cycleways
- Adjustment of parking availability or access routes for certain venues (e.g. URBNSURF)
- Need for traffic controllers to be used to manage traffic at relevant locations where works occur close to roadways
- Impacts to driveway access for some properties along pipeline routes (Stantec 2025a).

These impacts will occur for short time periods in each area as they would only occur while works are underway for that specific segment of pipeline (Stantec 2025a).

In relation to active transport (walking or cycling) or public transport, few impacts are expected in relation to construction of the WRRF. However, there may be short term changes in access for bikes or walking or changes in routes for public transport while construction of the pipelines is occurring (Stantec 2025a).

10.4.2 Mitigation measures – construction

Mitigation measures will be needed, where practicable, to allow traffic in the area to be appropriately managed during the construction of this project. Such measures might include:

- Scheduling deliveries outside of peak times
- Controlling how construction related vehicles use the most impacted intersections (such as only allowing such vehicles to turn left at such intersections)
- Ensuring works do not impact on special event management in the area by liaising with all relevant organisations and scheduling works/vehicle movements, where possible, outside of days when large special events are scheduled at Sydney Olympic Park.
- Effective and timely communication with the local community will also be critical
- Programming of construction will need to be coordinated with the other major projects in this area, especially Sydney Metro West and Parramatta Light Rail Stage 2 to ensure cumulative impacts on traffic flow are managed appropriately (Stantec 2025a).

In relation to active transport and public transport, where bus stops, bus routes, ferry routes, on-street parking, footpaths, cycle paths or access to specific roads might be impacted temporarily during construction of the various pipeline segments, liaison with councils, government agencies and other stakeholders (including Western Sydney University) will be necessary to establish acceptable temporary solutions.

10.4.3 Operations

Much fewer vehicle movements will be required during operation of the proposed new facility. The number of vehicle movements will be around 28/day for light vehicles and 18/day for heavy vehicles. Given the industrial nature of the area and the existing traffic environment, this level of traffic will make a negligible changes to the existing situation and needs no further assessment. In addition, sufficient on-site parking will be provided for people working at the facility to ensure staff do not need to park on the street. Impacts to active transport (walking and cycling) and public transport are also expected to be negligible, given the location of the facility and the limited number of people and vehicles accessing the site (Stantec 2025a).

10.5 Outcomes of health impact assessment

Table 10.1 presents a summary of the outcomes of the assessment undertaken in relation to the impacts of changes in traffic associated with the proposed project, on community health.

Table 10.1: Summary of health impacts – traffic

Traffic	
Benefits	Provision of sufficient treatment plants to manage wastewater in an urban area is a benefit to the health of the community
Impacts	Changes in traffic (including active transport and public transport) may occur during the construction phase of the project. These will need to be managed in accordance with standard Council and state government requirements. Changes in traffic during operation of the WRRF will be negligible. No impacts on community health due to changes in traffic are expected for this project as long as appropriate mitigation measures are implemented during the construction phase.
Mitigation	Mitigation measures during construction may include actions such as: ▪ Scheduling deliveries outside of peak times ▪ Controlling how construction related vehicles use the most impacted intersections (such as only allowing such vehicles to turn left at such intersections) ▪ Ensuring works do not impact on special event management in the area by liaising with all relevant organisations and scheduling works/vehicle movements, where possible, outside of days when large special events are scheduled at Sydney Olympic Park. ▪ Effective and timely communication with the local community will also be critical ▪ Programming of construction will need to be coordinated with the other major projects in this area, especially Sydney Metro West and Parramatta Light Rail Stage 2 to ensure cumulative impacts on traffic flow are managed appropriately (Stantec 2025a). In relation to active and public transport, where bus stops, bus routes, ferry routes, on-street parking, footpaths, cycle paths or access to specific roads might be impacted temporarily during construction of the various pipeline segments, liaison with councils, government agencies and other stakeholders will be necessary to establish acceptable temporary solutions. A primary measure to ensure changes in traffic do not cause undue stress in the area will be timely and effective communication. Such communication should start early in the project, be updated frequently and regularly and be easily accessed by local residents and business.

Section 11. Conclusions

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by Sydney Water to prepare a Health Impact Assessment (HIA) for the “Greater Parramatta and Olympic Peninsula Water Cycle Management” Project (GPOP WCM).

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 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.

An environmental impact statement (EIS) is being prepared for this project and this HIA addresses the potential risks and benefits to human health posed by this project.

Based on the assessment undertaken in relation to this facility and the potential for changes to community health that could arise, the following has been concluded:

- Water quality

With consideration of the water quality guidance adopted, the design of the proposed new facility and the assessment of potential changes in water quality arising due to this proposed facility, there will be no changes in water quality that could impact on community health in Parramatta River or Duck River where the facility and pipelines are designed to meet the specifications identified.

- Air quality

With consideration of the air quality guidance adopted and the assessment of potential changes in air quality arising due to this proposed facility, there will be no changes in air quality that could impact on community health in the area around the proposed facility where the facility is designed to meet the specifications identified.

- Noise

With consideration of the noise limits adopted and the assessment of potential changes in noise levels for the project, where the project is designed to meet the noise specifications identified (i.e.

predicted levels), and where the identified noise mitigation measures are implemented, there will be no changes in noise sufficient to cause changes in community health for the off-site community.

- Other matters (soil contamination, transport, dangerous goods/chemical hazards, subsidence, bushfire)

Based on the evaluations provided and ensuring that government regulations about storage and transport of hazardous chemicals are followed, there are no changes in handling/storage of dangerous goods, soil contamination or transport/traffic related to the project that would be sufficient to cause changes in community health for the off-site community. The project is located in an area which is not subject to subsidence, bushfire or flooding so these matters did not require detailed assessment.

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Appendix A Fishing restrictions in Sydney Harbour fact sheet

Department of Primary Industries

Sydney Harbour and northern beaches Recreational Fishing Guide

Fisheries Compliance Unit

November 2021

Fishing is a fun, outdoor activity for the whole family. Fishing rules help ensure healthy and sustainable fisheries for future generations.

Sydney Harbour (Port Jackson) and surrounding waterway's provide a wide range of fishing opportunities from beach or jetty fishing to the more adventurous rock and boat fishing. This guide provides essential information on fishing, including any closures and restrictions, which apply within Sydney Harbour and Sydney's northern beaches.

DPI fisheries officers routinely patrol waterways, boat ramps and foreshores to advise anglers about responsible fishing practices and to ensure compliance with NSW fishing regulations.

Information on bag and size limits and legal fishing gear can be obtained at www.dpi.nsw.gov.au/fisheries or by visiting your local DPI fisheries office.

To report suspected illegal fishing activity, call the Fishers Watch phone line on **1800 043 536** (free call) or on-line at: www.dpi.nsw.gov.au/fisheries/compliance/report-illegal-activity. All calls will be treated as confidential and you can remain anonymous.

RECREATIONAL FISHING FEE

When fishing in NSW waters, both freshwater and saltwater, you are required by law to pay the NSW recreational fishing fee and carry a receipt showing the payment of the fee. This applies when spear fishing, hand lining, hand gathering, trapping, bait collecting and prawn netting or when in possession of fishing gear in, on or adjacent to waters.

All money raised by the NSW recreational fishing fee is spent on improving recreational fishing in NSW. Projects include:

- building artificial reefs to create new fishing locations;
- fish aggregating devices (FADs) to enhance fishing for dolphinfish and even tuna and marlin;
- creation of recreational fishing havens;
- angler facilities such as fish cleaning tables and fishing platforms;
- stocking of freshwater fish in dams and rivers;
- essential research on popular recreational fish species;
- restoring important fish habitat;
- marine stocking of prawns in estuaries;
- angler education and advisory programs such as the Fishcare Volunteer program, fishing workshops, Get Hooked it's fun to fish primary schools education and fishing guides.

Much more information is available at www.dpi.nsw.gov.au/fisheries.

You can pay the NSW recreational fishing fee at www.onegov.nsw.gov.au or by calling 1300 369 365 or at many outlets throughout NSW, such as most fishing tackle stores, caravan parks, local shops, service stations and many Kmart stores.

Some exemptions apply to paying the fishing fee, including people under the age of 18, holders of pensioner concession cards and Aboriginal people. For further information on exemptions go to www.dpi.nsw.gov.au or call (02) 4424 7499.

You may not need to pay the NSW recreational fishing fee if you are fishing on a charter boat, hire boat or under the supervision of a fishing guide. Please check with the charter/hire boat operator, or guide, before you go fishing. If they do not hold a recreational fishing fee exemption certificate you will need to pay the NSW recreational fishing fee.

SYDNEY HARBOUR RECREATIONAL FISHING AND DIOXON CONTAMINATION

Test results have revealed elevated levels of dioxins in fish and crustaceans throughout Sydney Harbour, including Parramatta River and other connected tidal waterways. A ban has been placed on commercial fishing as a precautionary measure.

Recreational fishing in Sydney Harbour has not been banned, but fishers are urged to follow dietary advice on the consumption of seafood taken from Sydney Harbour. Fishers can also continue to practice catch and release.

An expert panel has recommended that fish and crustaceans caught west of the Sydney Harbour Bridge should not be eaten. You should release your catch.

For fish caught east of the Sydney Harbour Bridge, you should generally not eat more than 150 grams of fish per month. Higher amounts of some fish and crustacean species may be eaten. For more information, see Table1.

Note. This advice is provided if one single species is being eaten. For example eating 150g of bream and 600g of prawns in one month would exceed the recommended intake. Eating 300g prawns, 300g sand whiting and 300g yellowtail scad in one month would equal the recommended maximum intake.

For further information visit NSW Food Authority website www.foodauthority.nsw.gov.au or phone 1300 552 406 for more information.

Recreational harvest of shellfish

Shellfish are filter feeders and they sometimes accumulate harmful substances from the water during feeding.

Shellfish collected by recreational fishers should never be eaten raw. This is because recreationally harvested shellfish are not subject to the same strict food safety controls as commercially harvested shellfish.

Consequently the NSW Food Authority recommends eating only shellfish harvested under a recognised program.

For more information check the DPI Recreational Fishing Guide or www.foodauthority.nsw.gov.au or phone 1300 552 406.

Table 1. ***Recommended maximum intake based on eating a single species caught east of the Sydney Harbour bridge.***

Seafood	Number of 150g serves	Amount per month
Prawns	4 per month	600g
Crabs	5 per month	750g
Bream	1 per month	150g
Dusky Flathead	12 per month	1800g
Fanbelly Leatherjacket	24 per month	3600g
Flounder	12 per month	1800g
Kingfish	12 per month	1800g
Luderick	12 per month	1800g
Sand Whiting	8 per month	1200g
Sea Mullet	1 every 3 months	50g
Silver Biddy	1 per month	150g
Silver Trevally	5 per month	750g
Tailor	1 per month	150g
Trumpeter Whiting	12 per month	1800g
Yellowtail Scad	8 per month	1200g
Squid	4 per month	600g

RECREATIONAL FISHING CLOSURES

A number of fishing closures exist in Sydney Harbour and surrounding waterway's. These exist for a variety of reasons, from public health and safety to preserving unique aquatic environments. The majority of these closures are signposted and penalties apply for not complying with fisheries rules and regulations.

Shellfish Closures

Shellfish (Figure 1). Sydney Harbour (Port Jackson) and all its tributaries are closed to the taking of any species of shellfish (eg. Pipis, cockles, mussels, snails, whelks, oysters and abalone).

Total fishing closures

All methods of fishing are prohibited in the following waters.

Duck River and Homebush Bay (Figure 2). The whole of the waters of Duck River and Homebush Bay (including Haslams and Powells Creeks) located in the upper reaches of the Parramatta River.

Figure 1. Sydney Harbour Shellfish & Intertidal Protected Area

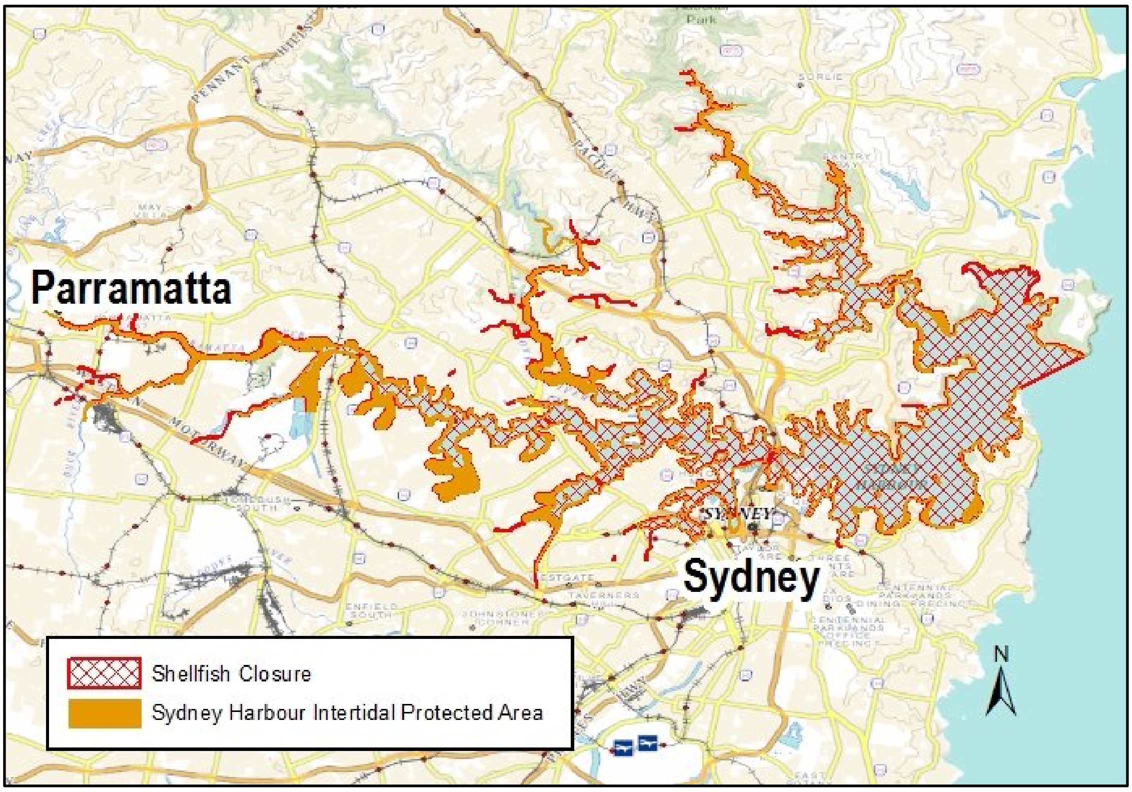
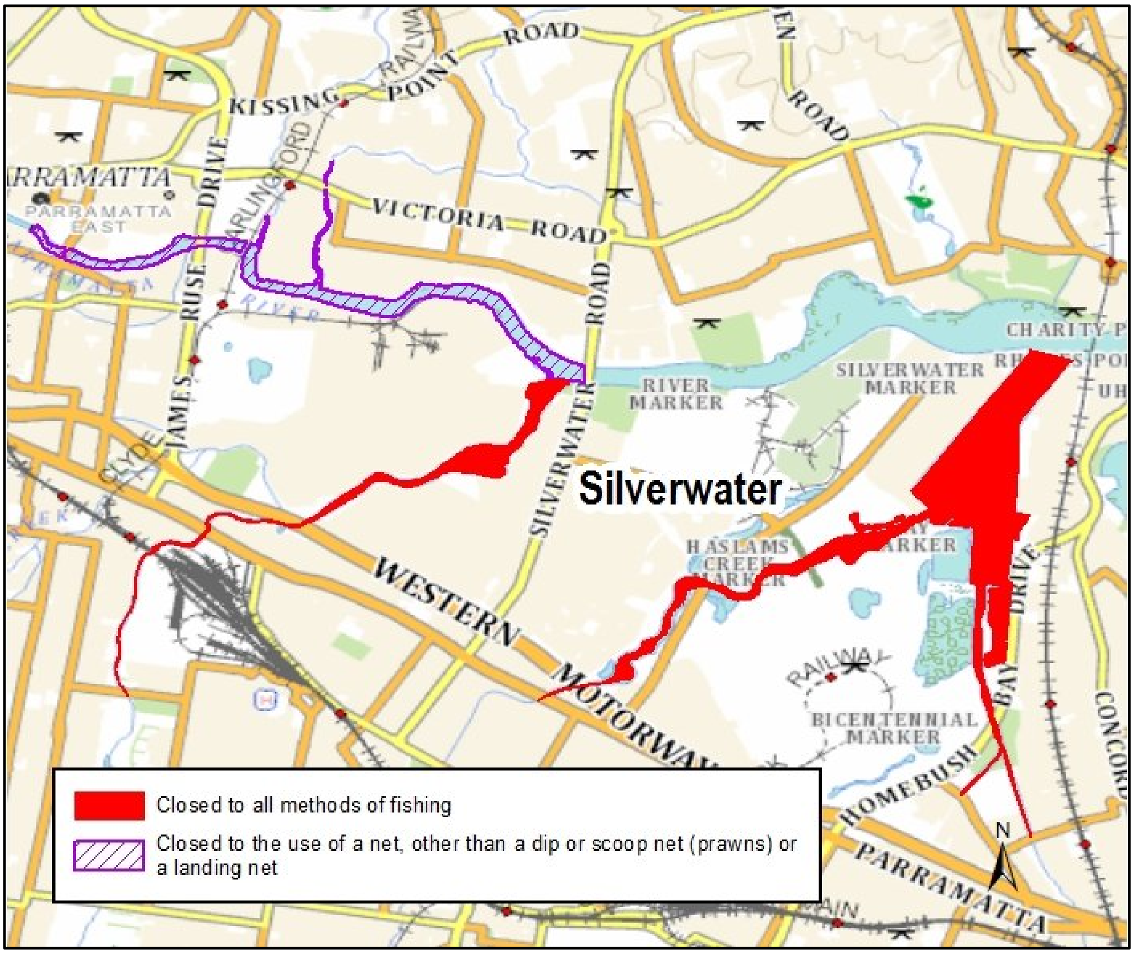


Figure 2. Duck River, Homebush Bay and Parramatta River



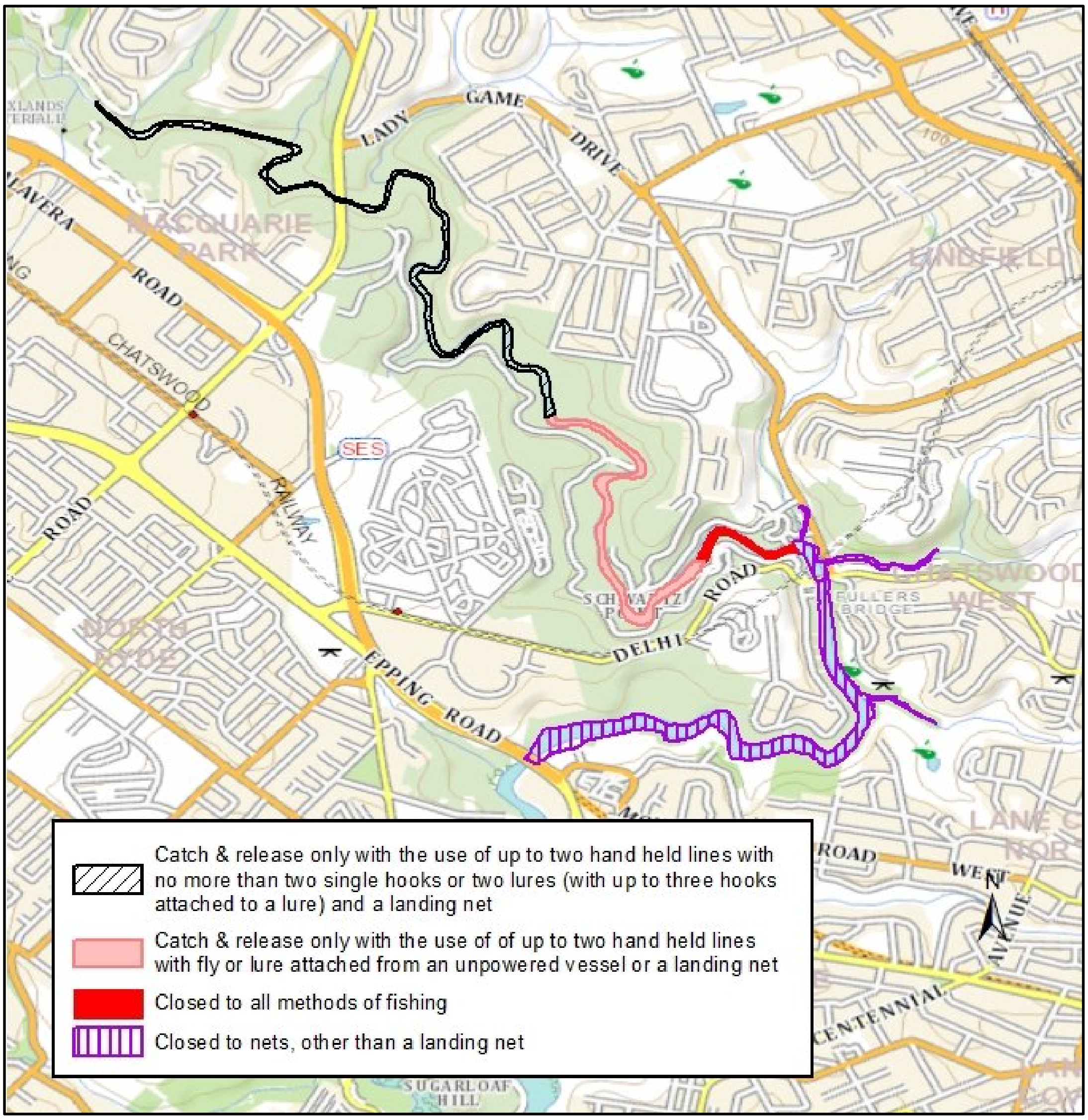
Cabbage Tree Bay Aquatic Reserve (Figure 11).

Lane Cover River (Little Blue Gum Creek to Boatshed) (Figure 3). The whole of the waters of Lane Cove River and its tributaries, from a line drawn between two posts on opposite banks of the river at the junction of Little Blue Gum Creek, approximately 50 metres downstream from the weir, upstream to a line drawn from a post at the boatshed to a post on the opposite bank.

Little Penguin Critical Habitat Areas (Figure 4). From sunset to sunrise 1 July to 28 February (inclusive). For more information visit

www.environment.nsw.gov.au/animals/TheLittlePenguin.htm

Figure 3. Lane Cove River

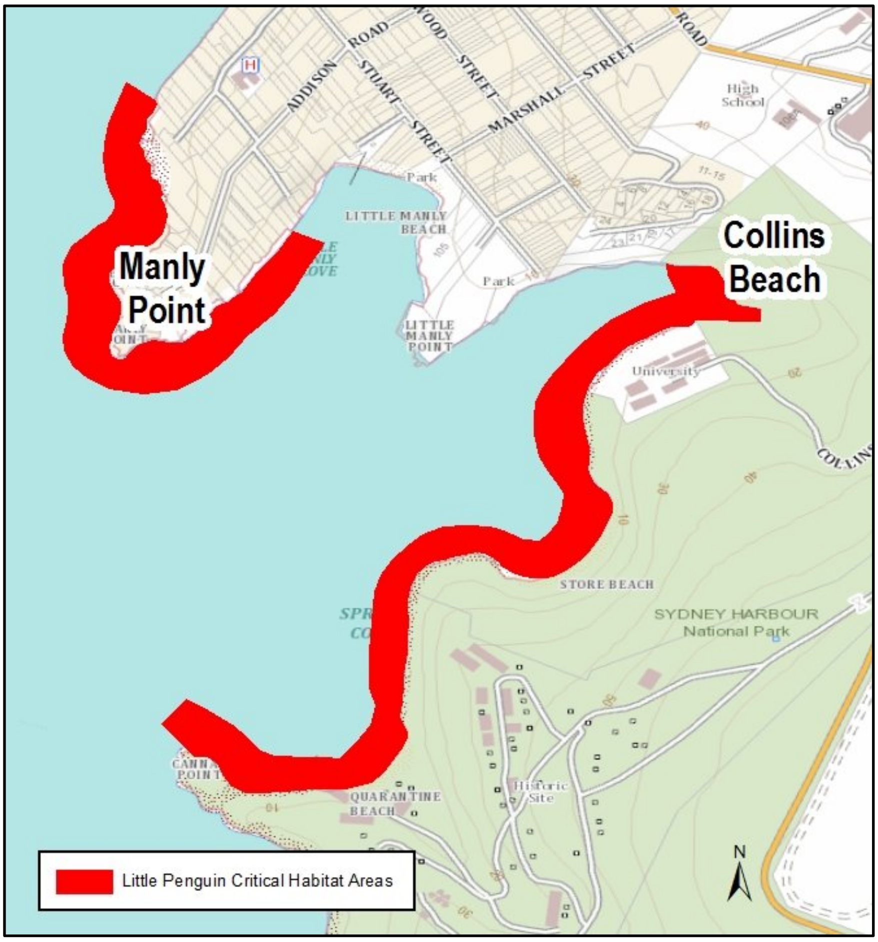


General fishing closures

All NSW waters. During the period May to August (inclusive) each year Australian Bass and Estuary Perch can only be taken by catch and release fishing in any NSW waters except impoundments and the waters of rivers above impoundments.

Recreational netting and trapping

Figure 4. Little Penguin Critical Habitat Areas



Darling Harbour and bays (Figure 5). The following waters are closed to any method involving the use of a net, other than a landing net: the whole of the waters of Darling Harbour, Johnston's Bay, White Bay, Rozelle Bay, and Blackwattle Bay, south of a line drawn from the NSW Maritime tower, to Darling Street ferry wharf.

Lane Cover River (Epping Highway bridge to Little Blue Gum Creek) (Figure 3). The following waters are closed to any method involving the use of a net other than a landing net: that part of Lane Cove River and its tributaries, from the Epping Highway bridge, upstream to a line drawn between two posts on opposite sides of the river at Little Blue Gum Creek.

Lane Cove River (Boatshed to Fern Valley) (Figure 3). The following waters are closed to all methods of fishing with the exception of a landing net, or the use of up to two hand held lines with fly or lure attached from an unpowered vessel (eg; kayak, canoe). All fish caught must be released alive and fishing from the riverbank is prohibited: the waters of Lane Cove River from a line drawn from a post at the boatshed to a post on the opposite bank upstream to a line drawn across the river between two posts on opposite sides of the river, at picnic area number 20 (Fern Valley).

Lane Cove River (Upstream from Fern Valley) (Figure 3). The following waters are closed to all methods of fishing other than a landing net and the use of up to two hand held lines with no more than two single hooks or two lures (with up to three hooks attached to a lure). All fish caught must be released alive in all waters upstream from Fern Valley from a line drawn across the river between two posts on opposite sides of the river.

Parramatta River (Silverwater to Parramatta Weir) (Figure 2). The following waters are closed to the use of a net, other than a dip or scoop net (prawns) or a landing net: all tidal waters of Parramatta River and its tributaries, from the Silverwater Road bridge upstream to Parramatta Weir (excluding the waters of Duck River).

Middle Harbour. The whole of waters of Middle Harbour and its tributaries, upstream from the Roseville Bridge (Warringah Road) are closed to any method involving the use of a net, other than a landing net.

Figure 5. Darling Harbour and bays

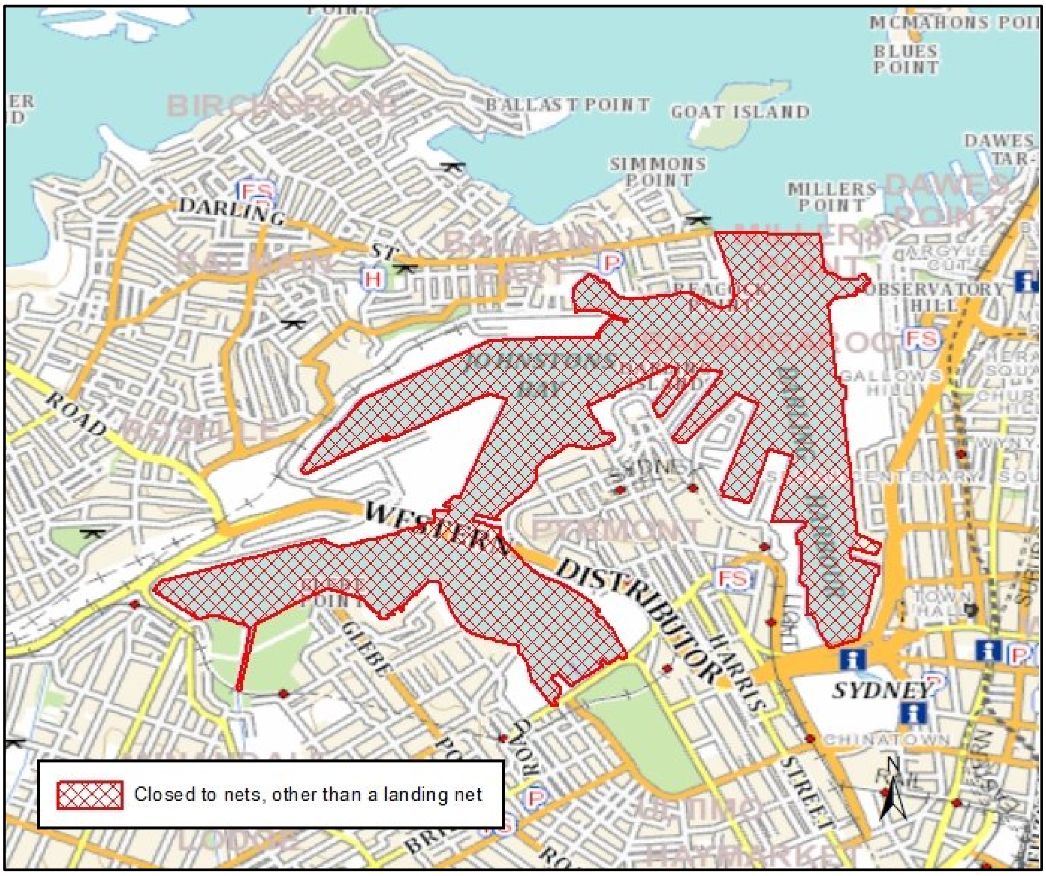
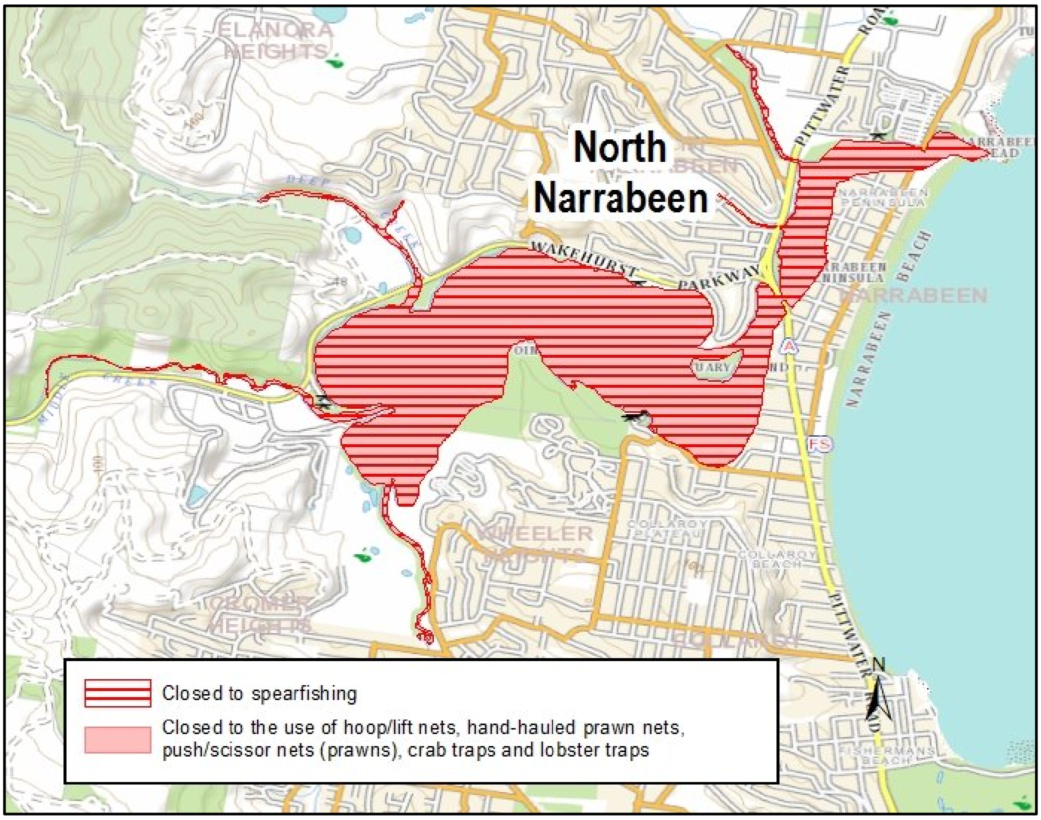


Figure 6. Narrabeen Lake



Hunters Bay (Figure 12). The following waters are closed to the use of all nets other than a landing net from October to March (inclusive) each year: the waters of Hunters Bay, Middle Harbour, enclosed by a line drawn generally southeasterly from Wyargine Point to the western end of Cobblers Beach.

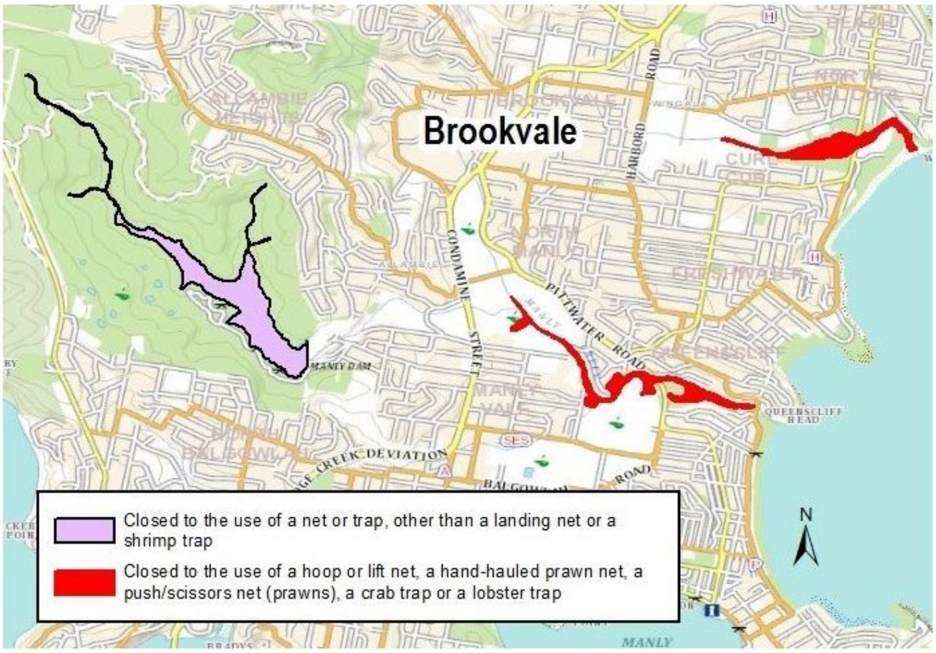
North Harbour (Figure 12). The following waters are closed to the use of nets or traps, other than a landing net, lobster trap or bait trap: all waters north of a line drawn on a bearing of 115 from the eastern extremity of Forty Baskets Beach, to the southern extremity of Manly Point, northern boundary of North Harbour Aquatic Reserve.

Careel Bay, Pittwater caulerpa closure (Figure 8). The following waters are closed to the use of all nets, other than a landing net: all waters east of a line drawn from the western most point of Barrenjoey Head south to the western most port marker off Observation Point and then south to the northern most point of Stokes Point.

Narrabeen Lake (Figure 6), Curl Curl Lagoon and Manly Lagoon (Figure 7), Dee Why Lagoon (Figure 10). All waters and tributaries are closed to any method involving the use of a hoop or lift net, a hand hauled prawn net, push or scissor net (prawns), a crab trap or lobster trap.

Manly Dam (Figure 7). All waters of Manly Dam and its tributaries are closed to the use of a net or trap, other than a landing net or a shrimp trap.

Figure 7. Manly and Curl Curl Lagoons and Manly Dam



AQUATIC RESERVES

There are four aquatic reserves along Sydney's northern beaches: Barrenjoey Head, Narrabeen Head, Long Reef and Cabbage Tree Bay. North Harbour aquatic reserve is located within Sydney Harbour.

These aquatic reserves have been established to protect marine life and habitats. They conserve important habitat and nursery areas for protected species and are valuable areas for research and education. For more information visit www.dpi.nsw.gov.au/fisheries/habitat/protecting-habitats/mpa.

The boundaries of the aquatic reserves extend 100m seaward from mean low water mark, except for Cabbage Tree Bay and North Harbour aquatic reserves. Fishing restrictions vary between aquatic reserves.

Barrenjoey Head Aquatic Reserve (Figure 8). Includes the rocky platform around Barrenjoey Head from the northern end of Station Beach to the northern end of Palm Beach. Within the aquatic reserve, you can line fish and spearfish (subject to normal restrictions) and collect rock lobster, sea lettuce and bait weed. It is prohibited to collect cunjevoi and all invertebrates (dead or alive) including anemones, barnacles, chitons, cockles, crabs, mussels, octopus, pipis, sea urchins, starfish, snails and worms, and empty shells. **Note:** This includes a prohibition on the killing of cunjevoi or invertebrates to feed fish.

Narrabeen Head Aquatic Reserve (Figure 9). Includes the whole foreshore from the south end of Turimetta Beach to the rock baths at Narrabeen Head. Within the aquatic reserve, you can line fish and spearfish (subject to normal restrictions) and collect rock lobster, sea lettuce and bait weed. It is prohibited to collect cunjevoi and all invertebrates (dead or alive) including anemones, barnacles, chitons, cockles, crabs, mussels, octopus, pipis, sea urchins, starfish, snails and worms, and empty shells. **Note:** This includes a prohibition on the killing of cunjevoi or invertebrates to feed fish.

Figure 8. Barrenjoey Head Aquatic Reserve & Pittwater

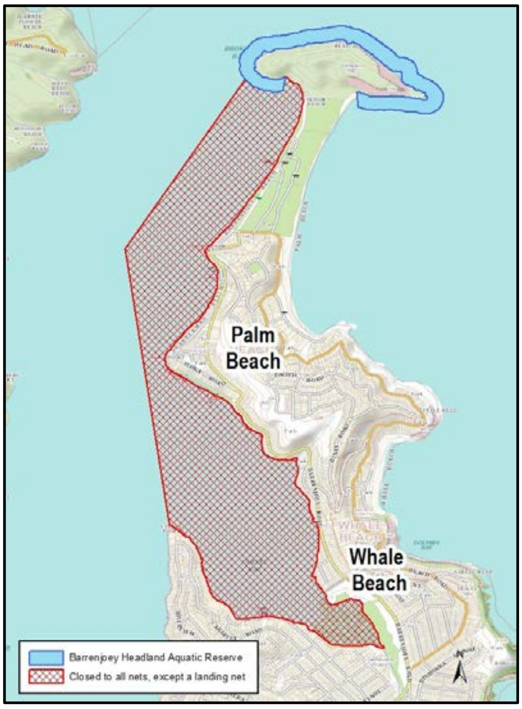
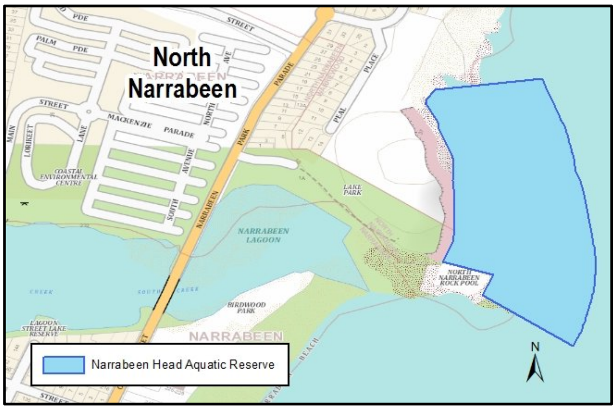


Figure 9. Narrabeen Head Aquatic Reserve

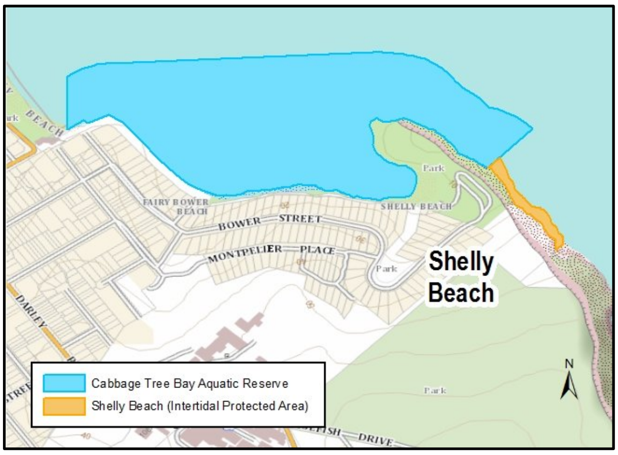


Long Reef Aquatic Reserve (Figure 10). Extends from Collaroy rock baths south to Long Reef surf lifesaving club. Fin fish can be taken by line or spear only but you must bring your own bait. With the exception of fin fish, you cannot collect or harm any other marine plants or animals, whether alive or dead. **Note:** This includes a prohibition on the killing of cunjevoi or invertebrates to feed fish.

Cabbage Tree Bay Aquatic Reserve (Figure 11). Includes the whole foreshore of the bay from Manly Surf Life Saving Club to the northern end of Shelly Beach Headland, and encompasses all of Cabbage Tree Bay. This is a 'no-take' aquatic reserve, which means you are not permitted to fish by any method, destroy, injure or interfere with any fish or marine vegetation (whether dead or alive). **Note:** This includes a prohibition on feeding fish or the use of burley to attract fish.

Figure 10. Long Reef Aquatic Reserve & Dee Why Lagoon

Figure 11. Cabbage Tree Bay Aquatic Reserve & Shelly Beach IPA



North Harbour Aquatic Reserve (Figure 12). Boundaries are formed by a line between headlands at North Head and Grotto Point, and another line joining Little Manly Point, Manly Point and Forty Baskets Beach and extends from the seabed at these outer boundaries up to the mean high water mark. Within the reserve, you are permitted to take fin fish by hand held line only and must bring your own bait. With the exception of fin fish you cannot take, gather, destroy, injure or interfere with any fish or marine vegetation (whether dead or alive). **Note:** This includes a prohibition on the killing of cunjevoi or invertebrates to feed fish.

Figure 12. North Harbour Aquatic Reserve, North Harbour & Hunters Bay

Bronte-Coogee Aquatic Reserve (Figure 13). Includes the whole foreshore from the southern end of Bronte Beach to the rock baths at Coogee Beach – 4000 meters of coastline - and extends 100 metres seaward from mean low water. Within the aquatic reserve, you can line fish and spearfish (subject to normal restrictions) and collect rock lobster, sea lettuce and bait weed. It is prohibited to collect cunjevoi and all invertebrates (dead or alive) including anemones, barnacles, chitons, cockles, crabs, mussels, octopus, pipis, sea urchins, starfish, snails and worms, and empty shells. **Note:** This includes a prohibition on the killing of cunjevoi or invertebrates to feed fish.

Figure 13. Bronte-Coogee Aquatic Reserve & Clovelly & Gordons Bay

INTERTIDAL PROTECTED AREAS

Intertidal protected areas preserve and protect intertidal animals and habitat as well as acting as reservoirs to re-populate other areas.

The collection of all invertebrates and cunjevoi is prohibited from all Intertidal protected areas from the mean high water mark to 10 meters seaward from the mean low water mark.

They are located at **Bungan Head (Figure 14), Mona Vale Headland (Figure 14), Dee Why Headland (Figure 15), Shelly Beach Headland (Figure 11), Bondi (Mackenzies Point) (Figure 16)** and the entire shoreline of **Sydney Harbour (Figure 1)** and its tributaries, including the Parramatta and Lane Cove Rivers and Middle Harbour excluding the shoreline of North Harbour from Manly Point to the southern end of Forty Baskets Beach.

Fishing is allowed in these areas but taking, gathering or collecting seashore animals including crabs, snails, worms, octopus, sea urchins, anemones, pipis, cockles, mussels, oysters, saltwater nippers and cunjevoi is prohibited. Exempt invertebrates that may be taken are Abalone and the Eastern and Southern Rock Lobster.

Figure 14. Bungan Head & Mona Vale Headland IPA

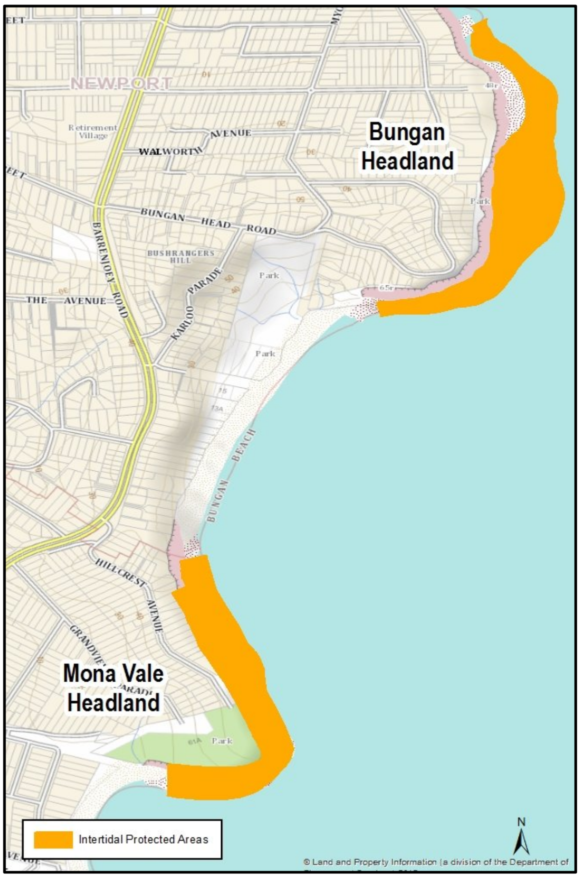


Figure 15. Dee Why Headland IPA

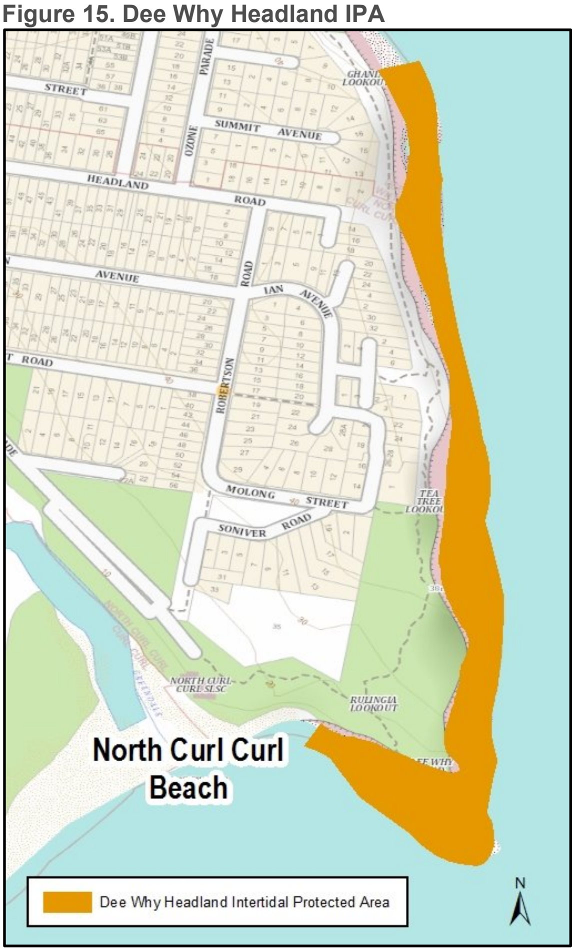
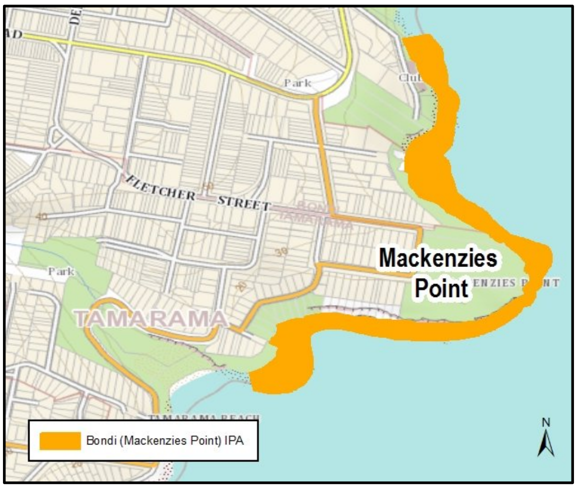


Figure 16. Bondi (Mackenzies Point) IPA



Spearfishing and diving

Spearfishing in NSW is a popular form of recreational fishing and has been recognised for its selective fishing practices. Spearfishers and divers are permitted to use:

- a snorkel when taking fish;
- SCUBA and hookah apparatus for scallops and sea urchins only; and
- bare/gloved hand only when taking lobsters.

Spearfishers and divers are ***not*** permitted to use:

- a light with a spear/spear-gun;
- a spear/spear-gun to take blue, brown or red groper or any protected fish;
- powerheads and/or explosive devices.

Spearfishing is prohibited in freshwater as well as many entrances, coastal lagoons and other tidal waters.

The following areas covered by this guide are closed to spearfishing:

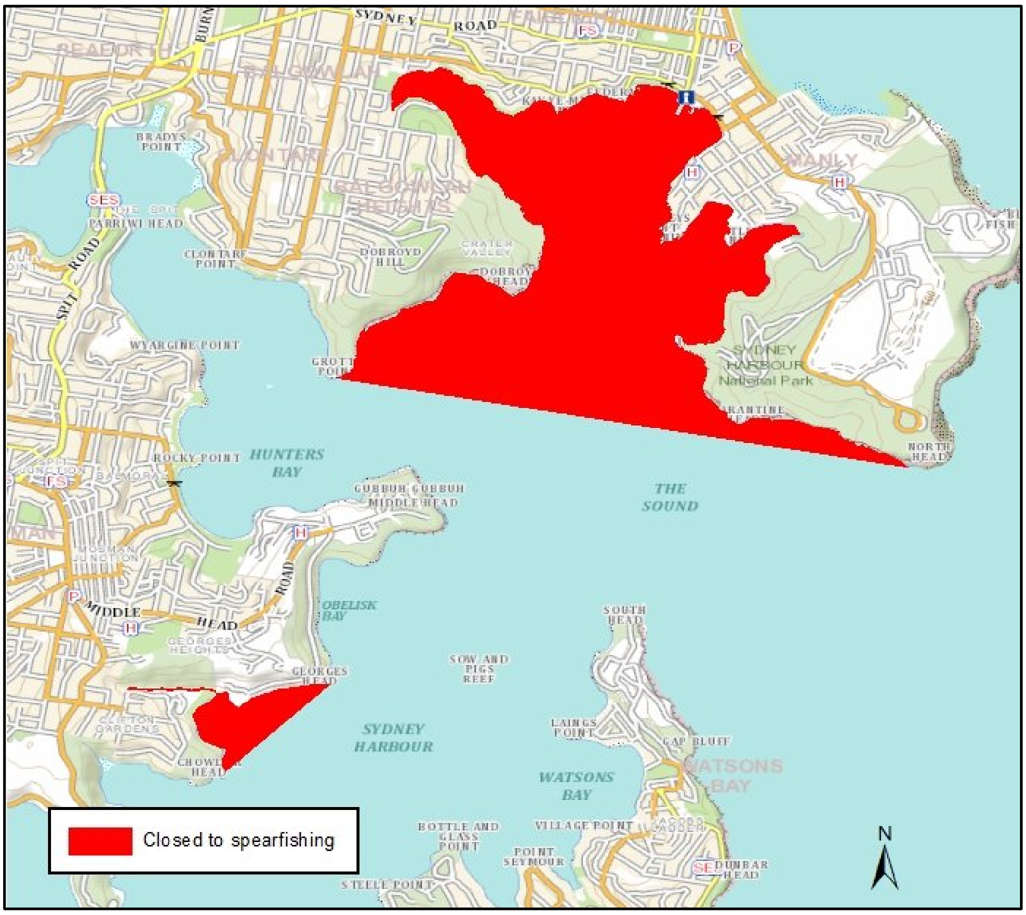
All NSW ocean beaches, excluding the last 20m at each end of the beach.

Clovelly & Gordons Bay (Figure 13). The waters of Clovelly Bay and Gordons Bay including waters encompassed by a line commencing at the southeastern extremity of Shark Point, extending southeasterly for 100 metres to a point 33 54.950 S, 151 16.300 E, then generally southwesterly to a point 33 55.100 S, 151 15.800 E, then 100 metres northwesterly to the easternmost point of the southern headland of Gordons (or Thompsons) Bay, then by the mean high water mark to the point of commencement. **Note:** It is prohibited to take any species of eastern blue groper, blue groper, brown groper and red groper in these waters.

Narrabeen Lake (Figure 6). The waters of Narrabeen Lake and its tributaries.

Port Jackson (Figure 17). The waters of North Harbour, Manly Cove, Little Manly Cove and Spring Cove and their tributaries, north of a line drawn between Grotto Point and outer North Head and those waters of Chowder Bay west of a line drawn from the easternmost extremity of Chowder Head, to the foreshore of the southeastern most extremity of Georges Head on the eastern side of the Army Maritime School.

Figure 17. Port Jackson - spearfishing



GENERAL RECREATIONAL FISHING RULES

- It is illegal for recreational fishers to sell their catch.
- Leave all commercial fishing gear in place and do not disturb commercial fishers going about their lawful business.
- You must not alter the length of fish by filleting and/or removing the head until you are well away from the water. This rule does not apply at areas normally used for cleaning fish, such as boat ramp cleaning tables, if the fish are for immediate consumption or immediate use as bait, or for fish that do not have a legal length. You may clean fish by gilling and gutting only.
- It is an offence to interfere with any oyster lease. Please ensure that your vessel, your vessel's wash or your tackle does not interfere with any part of an oyster lease, including the oysters.
- Abalone gut is prohibited for use as bait in NSW waters to prevent the spread of abalone viral ganglioneuritis (AVG).
- Collecting pipis by recreational fishers for human consumption is prohibited in NSW. A maximum of 50 pipis is permitted to be collected for bait and within 50m of the high tide mark. Pipis and cockles may contain toxins due to natural algal blooms. The blooms are not always visible.

- Intertidal invertebrates must not be shucked except for immediate use as bait.
- It is illegal to jag/foul hook fish other than through the mouth.

Fishing safely

Fishing is fun, but remember to take care and exercise caution. Rock fishing can be particularly dangerous due to the unpredictable nature of the ocean. Follow these basic safety tips at all times when rock fishing:

- Always wear a life jacket
- Stay alert to the weather conditions
- Plan an escape route in case you are washed in
- Never turn your back on the ocean
- Wear appropriate non-slip footwear and light clothing
- Do not jump in if someone is washed in - wait for assistance
- Never fish alone

For more information go to www.safefishing.com.au

Responsible fishing

- Reduce wildlife injuries by attending your lines and avoid bird feeding areas.
- Only catch sufficient fish for your immediate needs. Release all others using best practice catch and release techniques. Remember all fish, including scavengers, are important to the ecosystem.
- If you retain your catch, dispatch all fish and invertebrates swiftly and humanely.
- Dispose of all litter and fish waste responsibly.
- Be considerate of others and keep noise to a minimum, especially in residential areas.
- Reduce wildlife injuries by attending your lines and avoid bird feeding areas.
- Use environmentally friendly fishing tackle such as lead alternative sinkers, biodegradable line, and non-stainless hooks where possible.
- Act responsibly when you have reached your bag limit and you remain in the fishing grounds.
- Do not interfere with commercial fishing activities or commercial fishing gear.

Penalties

Penalties apply to persons who take or possess fish (including invertebrates, shells, etc.) taken in contravention of fishing closures, including aquatic reserves and intertidal protected areas.

Fish Aggregating Devices – FADs

NSW Department of Primary Industries deploy a series of fish aggregating devices (FADs) each year along the NSW coast between the months of September and June. The FADs are funded by the Recreational Fishing Trust and are installed to provide improved fishing for recreational fishers.

FADS in the Sydney north district are located offshore of Port Jackson; for exact GPS locations please check the website www.dpi.nsw.gov.au/fisheries/recreational/saltwater/fads.

For more information on this program funded by the Recreational Fishing Trust or to report a lost or damaged FAD please contact the program coordinator at DPI on (02) 4424 7421.
Email: fisheries.FADs@dpi.nsw.gov.au.

Artificial Reefs

Artificial reefs are used extensively around the world to create fish habitat, and new high quality fishing opportunities for anglers. NSW DPI has deployed specially designed artificial reefs in both estuarine and offshore waters aimed at providing new high quality fishing opportunities for recreational fishers.

DPI deployed the State's first offshore recreational fishing reef approximately 1.2km east of 'The Gap' (South Head) in 38m of water. The reefs GPS coordinates (WGS84) are 33 50.797'S 151 17.988'E. For more information on artificial reefs go to www.dpi.nsw.gov.au/fisheries/recreational/saltwater/artificial-reefs.

Further information

For more information about fishing restrictions that apply to Sydney Harbour waterways and beaches, please contact the;

Sydney North Fisheries Office

12 Shirley Road

Wollstonecraft NSW 2065

Postal address: PO Box 1305

Crows Nest NSW 1585

Phone: (02) 8437 4903

Mobile: 0419 185 363

Fax: (02) 9966 0663

Web: www.dpi.nsw.gov.au/fisheries

Check for updates of this Recreational Fishing Guide at: www.dpi.nsw.gov.au/fishing/recreational/resources

Published by the NSW Department of Primary Industries.

INT15/103621

Appendix B Soil vapour/vapour intrusion modelling

B1 Quantification of inhalation exposures

B1.1 General

As discussed in **Section 8.3.2**, petroleum hydrocarbons were reported to be present in soil vapour but no concentrations exceeded any of the relevant guidelines based on protecting people. Some chlorinated hydrocarbons were reported to be present in soil vapour above relevant guidelines in some locations. One of these locations appears to be in the footprint of the building housing the reverse osmosis process (SV104) (Jacobs 2025b).

Vapour intrusion modelling has been undertaken (documented in this appendix) to demonstrate that vapour intrusion cannot occur to a level of concern.

Vapour intrusion occurs when volatile chemicals are present in soil vapour within the soil profile which may move towards the ground surface and then through cracks in slabs and penetrations to reach inside a building. When chemicals are present in soil vapour in the subsurface where buildings will not be located, vapour intrusion at the ground surface is not usually sufficient to pose a risk to people's health as outdoor air is rapidly diluted by wind at most times.

B1.2 Screening assessment

B1.2.1 Approach

A screening assessment has been provided in **Table B1**. This assessment has identified which chemicals need to be included in the detailed vapour intrusion modelling for the WRRF site.

This section presents a summary of the maximum concentrations reported in soil vapour beneath the site. These vapour concentrations have been compared against screening criteria. For each analyte detected in soil vapour, the concentrations have been reviewed to identify key chemicals that require further assessment.

Screening of the soil vapour data has been undertaken using the following relevant Tier 1 screening level guidelines. The guidelines include (as relevant):

- **ASC NEPM Health Based Screening Levels (NEPC 1999 amended 2013c).** The ASC NEPM provides risk-based Interim HILs (iHILs) for chlorinated compounds and Health Screening Levels (HSLs) for petroleum hydrocarbons in soil vapour. Different levels are provided for a variety of exposure settings including residential, open-space/ parks/ recreational and commercial/industrial land uses. For this assessment, commercial/industrial (iHIL-D/HSL-D) have been used as recommended in the ASC NEPM for commerical/industrial sites.

Where there are chemicals detected for which there no Australian soil vapour guidelines available, it is possible to use conservative Tier 1 ambient air guidelines and convert those to values relevant for soil vapour.

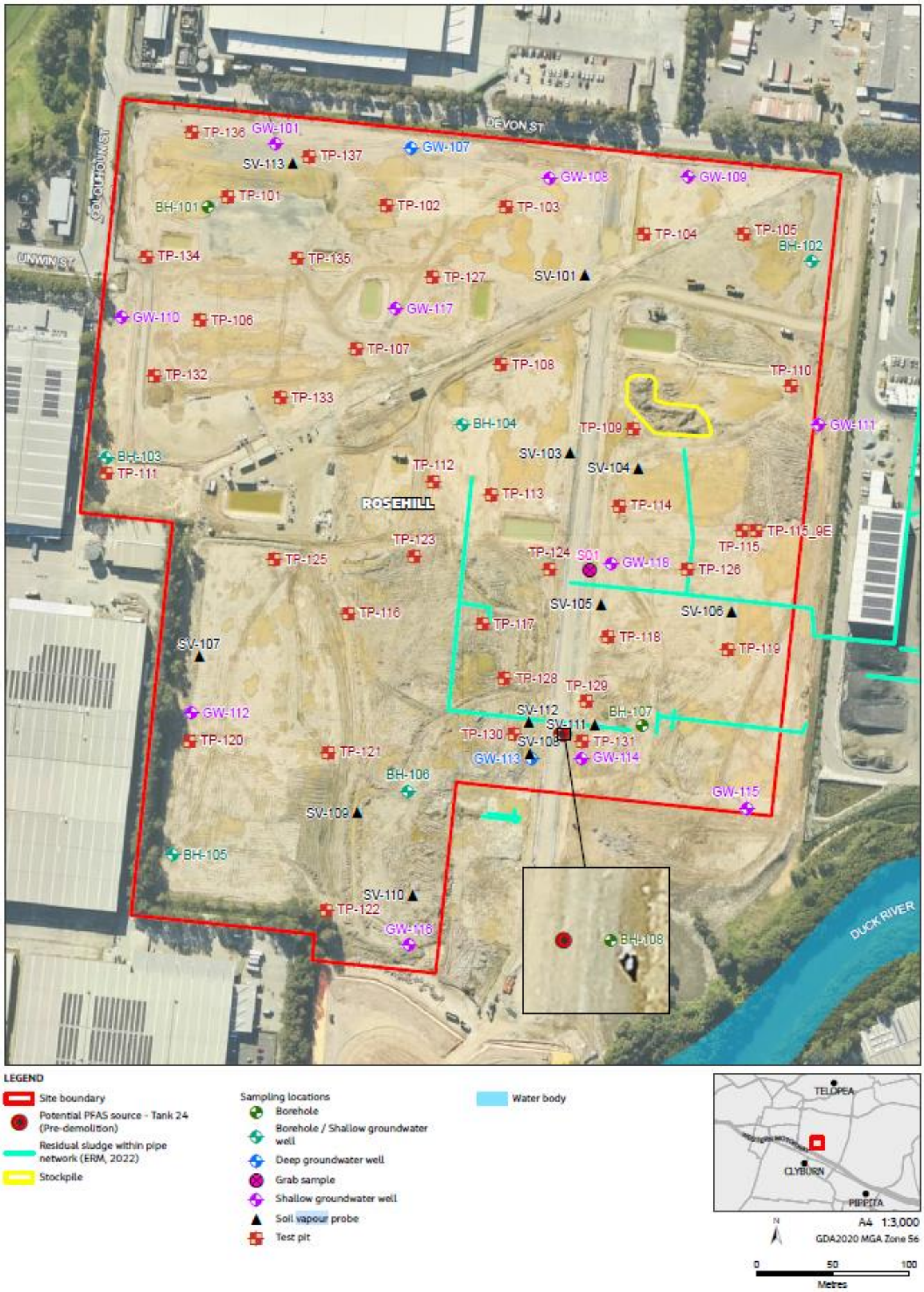


Figure 4.a: Investigation sampling locations

Data Sources: Department of Customer Service (2024); Imagery Sources: Aerometrex 2024
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Figure B1 Fig 4a from WRRF Jacobs report

The measurement of soil vapour is not a measure of an exposure concentration in indoor air. Volatiles present in soil vapour need to migrate upwards through overlying soils, concrete (where present) and into the ambient or indoor air before being inhaled. During these processes, the soil vapour is subject to diffusion, degradation, mixing and dispersion (dilution) resulting in lower concentrations being present indoors or outdoors than are present in soil vapour at the source/depth.

An attenuation factor is the ratio of the indoor (or outdoor) air concentration to the soil vapour concentration. Due to the lower potential for mixing and dispersion, vapour concentrations are higher indoors than outdoors. Hence for the purpose of this assessment, an attenuation factor has been applied to the ambient air guidelines based on a soil vapour to indoor air attenuation factor of 0.1 for both petroleum hydrocarbon related chemicals and chlorinated hydrocarbons.

The ASC NEPM uses an attenuation factor of 0.005 for petroleum hydrocarbons and 0.1 for chlorinated hydrocarbons (CRC CARE 2011; NEPC 1999 amended 2013b). Applying an attenuation factor of 0.005 to an ambient air guideline means multiplying that guideline by 200 and, applying an attenuation factor of 0.1 means multiplying that guideline by 10. Using a factor of 0.1 is conservative for both chemical groups relevant here so only this factor has been used in this assessment.

The relevant Tier 1 ambient air guidelines used as the basis for soil vapour guidelines adopted for the purpose of screening are derived from the following sources:

- **USEPA Regional Screening Levels (USEPA RSLs) (USEPA 2024).** Where no guideline value was available from the above sources, the USEPA RSLs (based on target HI of 1 and target carcinogenic risk of $1x10^{-5}$) have been used. For this review, air guidelines for workers have been considered.
- **CRC CARE (CRC CARE 2013).** Appendix C of the Petroleum Hydrocarbon Vapour Intrusion Guidance provides details of ambient air guidelines for a range of petroleum hydrocarbons not covered by the HSLs.
- **World Health Organisation (WHO 2004)**. The WHO has also developed ambient air guidelines based on the protection of human health (associated with a lifetime exposure). These guidelines are based on consideration of incremental lifetime risk (for non-threshold carcinogenic effects) and threshold toxicity data, protective of other health effects. Where no guideline value was available from the above sources, guidelines from relevant WHO documents have been used. The WHO review of the toxicity of chloroform provides a relevant ambient air guideline.
- **OEHHA (OEHHA 1999).** The Office of Environmental Health Hazard Assessment in California has evaluated the toxicity of ethanol from its used in petrol. A guideline for ethanol in air is available in this document.

The adopted screening guideline for soil vapour data is either the direct soil vapour guideline from the ASC NEPM for chemicals which have such guidelines or the ambient air guideline to which the relevant attenuation factor has been applied.

B1.2.2 Screening assessment

The maximum concentration for each chemical at any location other than SV108 as well as SV108 separately has been compared to the relevant screening guidelines to identify key chemicals and this assessment is shown in **Table B1**. The guidelines adopted for screening are considered appropriate for the identification of contaminants that may require a detailed assessment for impacts to people.

Table B1: Screening risk assessment – soil vapour – human health

Detected chemicals	Maximum concentration (µg/m^3)	Sampling location	Ambient air screening guideline (µg/m^3)	Adopted screening guideline – soil vapour (µg/m^3)
SV108				
Trichloroethene (TCE)	<LOR	--	--	80[N2]
Tetrachloroethene (PCE)	<LOR	--	--	8,000[N2]
Chloroform	<LOR	--	140[W]	1,400
Chlorobenzene	1,900	SV108		
Benzene	41,000	SV108	--	4,000[N1]
Toluene	10,000	SV108	--	4,800,000[N1]
Ethylbenzene	29,000	SV108	--	1,300,000[N1]
Xylenes	14,000	SV108	--	840,000[N1]
Naphthalene	5,100	SV108	--	6,000[N1]
Cyclohexane	160,000	SV108	6,000[C]	1,200,000
Hexane	320,000	SV108	700[C]	140,000
Heptane	170,000	SV108	26,000[C]	52,000,000
1,2,4-Trimethylbenzene	1,800	SV108	--	Covered by TRH F1 and F2
1,3,5-Trimethylbenzene	3,600	SV108		
1-Methyl-4-ethylbenzene	2,200	SV108		
2,2,4-Trimethylpentene	770,000	SV108		
Propene	10,000	SV108		
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	3,200	SV108		
TRH F1	4,930,000	SV108	--	1,300,000[N1]
TRH F2	37,000	SV108	--	1,200,000[N1]
All other locations				
Trichloroethene (TCE)	2,500	SV110	--	80[N2]
Tetrachloroethene (PCE)	34	SV110	--	8,000[N2]
1,1-Dichloroethene	61	SV110	17[U]	170
cis-1,2-Dichloroethene	1,700	SV104	--	300[N2]
trans-1,2-Dichloroethene	150	SV104		
Vinyl chloride	2,100	SV104		100[N2]
Chloroform	1,000	SV101	140[W]	1,400
Benzene	37	SV109	--	4,000[N1]
Toluene	51	SV109	--	4,800,000[N1]
Ethylbenzene	120	SV110	--	1,300,000[N1]
Xylenes	73	SV104	--	840,000[N1]
Cyclohexane	8,300	SV109	6,000[C]	1,200,000
Hexane	1,100	SV109	700[C]	7,000
Heptane	440	SV109	26,000[C]	260,000
Ethanol	82	SV113	--	Covered by TRH F1 and F2
1,2,4-Trimethylbenzene	48	SV104		
1,3,5-Trimethylbenzene	31	SV109		
1-Methyl-4-ethylbenzene	23	SV104		
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	16	SV104		
Acetone	640	SV101		
TRH F1	1,150,000	SV109	--	1,300,000[N1]

Detected chemicals	Maximum concentration (µg/m^3)	Sampling location	Ambient air screening guideline (µg/m^3)	Adopted screening guideline – soil vapour (µg/m^3)
TRH F2	71,000	SV109	--	1,200,000^{N1}

Notes:

N1 = NEPM HSL for commercial/industrial land uses (NEPC 1999 amended 2013c)

N2 = NEPM i-HIL for commercial/industrial land uses (NEPC 1999 amended 2013c)

U = USEPA RSLs – worker air (USEPA 2024)

C = CRC CARE Technical Report 23 (Australian PVI Guidance Table C1) (CRC CARE 2013)

W = WHO CICAD for Chloroform (WHO 2004)

The concentrations of petroleum hydrocarbons are elevated above some guideline values at SV108. This location is in the southern part of the site which will remain grassed with no buildings. As a result, the more appropriate guidelines for screening are those for public open space (i.e. HSL-C). None of the concentrations reported in soil vapour at SV108 exceed the HSL-C values so no further consideration of the risks due to vapour intrusion is needed. It is noted (as already discussed in **Section 8.3.2**) that this location has characteristics indicating the potential for LNAPL to be present. Additional investigations in relation to the presence of LNAPL in an area close to the southern site boundary may be required.

The concentrations of trichloroethene and some other chlorinated hydrocarbons at SV104 and SV110 (see **Figure B1**) were elevated. SV104 appears to be in the footprint for the building that will house the RO unit. Other locations with elevated chlorinated hydrocarbons in soil vapour including SV110 are all in areas of the site which will remain outdoors – areas that will remain grassed, in particular.

Therefore, vapour intrusion modelling has focused on the potential for vapours to accumulate in the RO unit building based on the concentrations at SV104 and SV108 (i.e. that they are all present at the same location – which is conservative).

B2 Vapour Modelling

B2.1 General

Vapour intrusion modelling is undertaken where there is an unsaturated zone beneath the slab at the base of a building. This type of modelling predicts the movement of the vapours through the unsaturated soil profile up to just beneath the slab and then through the slab (via cracks and penetrations) to reach inside a basement or the ground floor where construction occurs as slab on grade.

The Johnson & Ettinger (J&E) model as outlined by the USEPA has been used to estimate potential vapour intrusion in the building (USEPA 2004). This model was identified as a suitable model for use in Australia for these purposes (CRC CARE 2009).

B2.2 Slab on grade building

The equations relevant for the quantification of these exposures using this modelling approach are provided in **Section B3**. The modelling assumptions about the site and the proposed building are outlined in **Table B2**. Calculations undertaken (and relevant equations) (spreadsheet images) are presented in **Appendix B4**.

Table B2: Parameters adopted in vapour intrusion modelling

Parameter	Value	Comment/Reference
Building Parameters		
Depth to source	2 m below ground level	Depth of SV104 – current site (i.e. without additional fill layer to be added in the future)
Soil Characteristics	Bulk density: 1.625 g/mL Moisture content: 8%	Parameters relevant for sand/fill (CRC CARE 2011)
Size	15 m x 10 m	Default size of footprint for building based on ASC NEPM default assumptions
Proportion of slab above source	100%	Maximum possible
Internal building height	3 m	Expected height for these types of spaces
Air exchange rate	0.83 per hour	Default value for commercial/industrial buildings from CRC CARE (2011).
Slab thickness	0.15	Minimum from Building Code of Australia for commercial/retail spaces and multi-storey buildings
Fraction of cracks in slab	0.001	Based on default for building as per USEPA 2004
Advective vapour migration	Qs = Qbuilding*0.001	Calculations have been undertaken on the basis of advection occurring for a multi storey building with basements as per (CRC CARE 2011) – it is acknowledged that the buildings on this site are not expected to have multiple stories but this is a conservative assumption so has been retained here.
Soil vapour data	Maximum concentrations in soil vapour at SV104	

This vapour modelling has used standard default assumptions and assumes a person might be present in the RO building all day across the work year.

Once the concentrations inside the building have been modelled, intakes via inhalation have been assessed on the basis of the inhalation guidance available from the USEPA and recommended for use in the ASC NEPM and supporting CRC CARE guidance (CRC CARE 2011; NEPC 1999 amended 2013b; USEPA 2009).

This guidance requires the calculation of an exposure concentration which is based on the concentration in air and the time/duration spent in the area of impact.

The following equation outlines the calculation of an exposure concentration:

$$Exposure\ concentration = C_a * \frac{ET*EF*ED}{AT} \quad (mg/m^3)$$

where:

Ca = Concentration of chemical in air (mg/m^3)
ET = Exposure time (dependant on activity) (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
AT = Averaging time for threshold (=ED x 365 x 24) and non-threshold exposures (=70 years x 365 x 24) (hours)

Table B3 presents a summary of the parameters adopted for the quantification of inhalation exposures by workers (during construction or operation).

Table B3: Exposure parameter values

Exposure	Plant operator	Intrusive/Construction Worker
Exposure Frequency	240 days per year (NEPC 1999 amended 2013b)	240 days (NEPC 1999 amended 2013b)
Exposure Duration	30 years (NEPC 1999 amended 2013b)	1 year (professional judgement)
Averaging Time (carcinogenic)	70 years or 25550 days (613200 hours) as per USEPA (2009)	
Averaging Time (non-carcinogenic)	ED x 365 days (ED x 365 days x 24 hour) as per USEPA (2009)	
Exposure Time	8 hours per day (NEPC 1999 amended 2013b)	8 hours per day (NEPC 1999 amended 2013b)
Air Concentration	Modelled from soil vapour concentrations	Modelled from soil vapour concentrations

B2.3 Excavations

There are a number of ways to model vapour concentrations that might be present in an excavation as discussed in **Appendix C**. It is important to assess the potential for workers in such excavations to be exposed to volatile chemicals from soil vapour where these are present at a site. For this site, it has been assumed that workers could be in an excavation for services etc in the SV104 area which may have vapours from soil vapour. The details of the calculations are provided in **Section B3**.

B2.4 Findings

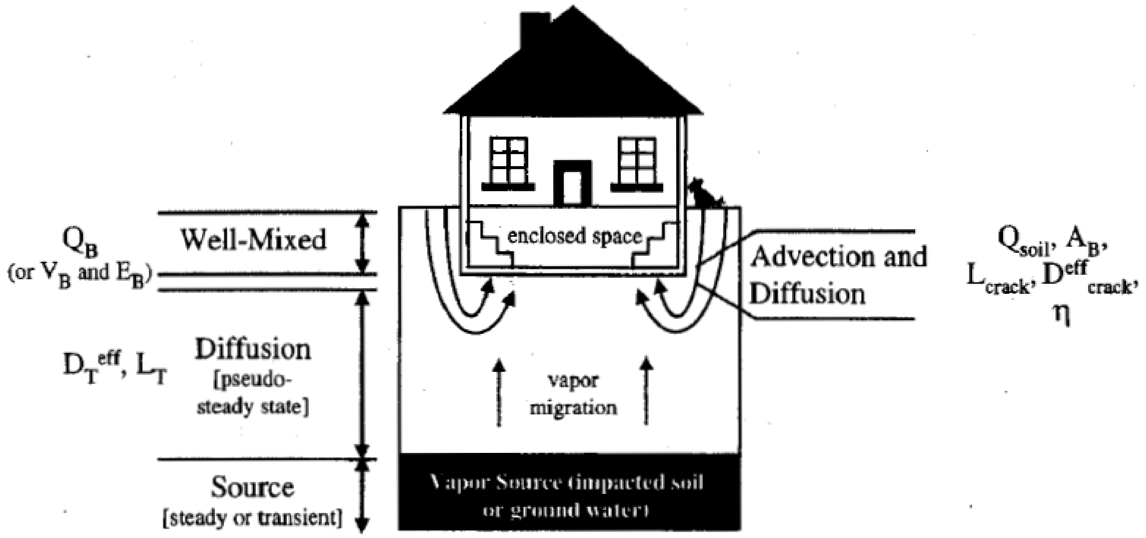
This modelling results in estimates of risk more than 300 times lower than the maximum acceptable value recommended by national health authorities. This means risks due to vapour intrusion into the RO building (or into excavations during construction in the area around the RO building will be negligible.

It is assumed that this calculation is extremely conservative because people will not be working within this building at all times and because the site will covered by 1.5 m of fill before construction of the WRRF which will further reduce the potential concentrations that might intrude into a building.

B3 Background information on vapour modelling

B3.1 Introduction

The assessment of vapour migration and vapour intrusion into buildings on the site has been undertaken using Johnson & Ettinger equations as presented by USEPA and the outdoor model as presented by ASTM (ASTM 2002; USEPA 2004). This requires estimation of the partitioning from a source concentration in soil or groundwater to vapour phase (directly above the source), or use of measured soil vapour concentrations. Once soil vapour concentrations have been determined then diffusion is a key mechanism governing changes in soil vapour concentrations as the vapours move toward the surface of the ground and then either diffusion or advection governs transport of the vapours into a building depending on building type.



(from Johnson and Ettinger 1991)

The following discussion presents the equations used to estimate the vapour phase concentration directly above the source and diffusion through overlying soils (Abreu & Johnson 2005; Johnson, Paul C. 2005; Johnson, P.C. & Ettinger 1991; Johnson, P.C. et al. 1990).

B3.2 Vapour Phase-Partitioning

Soil Vapour Source

Where soil vapour has been characterised, it is taken to be representative of the vapour phase concentration at the point of measurement.

$$C_{source} = C_{soilgas}$$ (g/cm^3) …Equation VS1

Groundwater Source

For a groundwater source, it is assumed that the vapour phase concentration directly above the groundwater is in equilibrium with the groundwater and the concentration is related to the groundwater concentration by Henry's Law:

$$C_{source} = C_{water} \bullet HL$$ (g/cm^3) …Equation VS2

Where:
Cwater = concentration in water (at top of groundwater, g/cm^3)
HL = Henry's Law constant (unitless)

The concentration within the vapour phase will increase proportionally with the concentration in groundwater (at the top of the groundwater table), until it reaches saturation. At some point the saturated vapour phase concentration will be reached, which is an upper limit of the vapour phase concentration.

The saturated vapour phase concentration is estimated using the following relationship:

$$SVPC = \frac{VP \bullet MW}{T \bullet 62361}$$ (g/cm^3) …Equation VS3

Where:
VP = vapour pressure of the contaminant (mmHg)
MW = molecular weight (g/mol)
T = soil temperature (K)
62361 = conversion (mmHg/K* cm^3/mol)

Soil Source

For a soil source, it is assumed that the vapour phase concentration directly above the soil is in equilibrium with the source and the concentration is related to the soil concentration by the following:

$$C_{source} = \frac{C_{soil} \bullet H' \bullet \rho_S}{\theta_{ws} + k_d \bullet \rho_S + H' \bullet \theta_{as}} \quad (g/cm^3) \quad \text{...Equation VS4}$$

where:

Csoil	= Concentration in soil source zone (g/g)
H'	= Henry's Law constant (unitless)
ρ_S	= Soil bulk density (g soil/cm^3 soil)
θ_{ws}	= Volumetric water content in soil source zone (cm^3 water/cm^3 soil)
θ_{as}	= Volumetric air content in soil source zone (cm^3 air/cm^3 soil)
K_d	= Soil-water partition coefficient (cm^3 air/g soil) = K_{oc} x f_{oc}
Koc	= Soil organic carbon partition coefficient, chemical specific (cm^3/g)
f_{oc}	= Soil organic carbon fraction (unitless)

The equilibrium vapour phase concentration is proportional to the soil concentration up to the soil saturation limit (C_{sat}), which is calculated using the following (with the saturated vapour phase calculated using Equation VS2 below):

$$C_{sat} = \frac{S}{\rho_s} \bullet [H' \bullet \theta_{as} + \theta_{ws} + K_d \bullet \rho_s] \quad (mg/kg) \quad \text{...Equation VS5}$$

where:

S = Pure component solubility in water (mg/L)

The concentration within the vapour phase will increase proportionally with the concentration in soil, until it reaches saturation. At some point the saturated vapour phase concentration will be reached, which is an upper limit of the vapour phase concentration.

The saturated vapour phase concentration is estimated using the following relationship:

$$SVPC = \frac{VP \bullet MW}{T \bullet 62361} \quad (g/cm^3) \quad \text{...Equation VS6}$$

Where:
VP = vapour pressure of the contaminant (mmHg)
MW = molecular weight (g/mol)
T = soil temperature (K)
62361 = conversion (mmHg/K* cm^3/mol)

When residual free phase is present, the vapour concentration is independent of the soil concentration but proportional to the mole fraction of the individual components of the residual phase mixture as below.

Vapour Phase above Free Phase (NAPL)

Where free phase or NAPL is present at the top of the groundwater or within a soil profile, the concentration of vapour directly above the NAPL is estimated using Raoult's Law:

$$C_{NAPL\ source} = \frac{x_i \bullet P_i(T_S) \bullet MW}{1000 \bullet R \bullet T_S} \quad \text{...Equation VS7}$$

where:

xi = mole fraction of chemical in NAPL (mol/mol)
Pi(TS) = vapour pressure of chemical at average soil temperature (atm)
Mw = molecular weight (g/mol)
R = Universal Gas Constant, 0.08206 L (atm)$mol^{-1}K^{-1}$
TS = Average soil temperature (^oK)
1000 = Units conversion factor (L/ml).

B3.3 Effective Diffusion

The total overall effective diffusion coefficient can be calculated for n different soil layers between the source and the enclosed floor (including the capillary fringe where relevant). This is estimated using Equation D1.

$$D_T^{eff} = \frac{L_T}{\sum_{i=1}^{n} L_i / D_i^{eff}} \quad \text{...Equation D1}$$

L_T = separation distance between the source and the building (cm)
L_i = thickness of the soil layer i (cm)
D_i^{eff} = effective diffusion coefficient across soil layer i (cm^2/s) – refer to Equation D2

$$D_i^{eff} = D_a \bullet \left[\frac{\theta_{ai}^{3.33}}{n_i^2}\right] + \left[\frac{D_w}{H'}\right] \bullet \left[\frac{\theta_{wi}^{3.33}}{n_i^2}\right] \quad \text{...Equation D2}$$

D_a = diffusivity in air, chemical specific (cm^2/s)
θ_{ai} = soil air-filled volume of layer i (cm^3/cm^3)
n_i = soil total porosity of layer i (cm^3/cm^3)
= $1-\rho_b/\rho_s$
ρ_b = soil dry bulk density, (g/cm^3)
ρ_s = soil particle density, (g/cm^3) - typically 2.65
D_w = diffusivity in water, chemical specific (cm^2/s)
θ_{wi} = soil water-filled volume of layer i, (cm^3/cm^3)

B3.4 Vapour Intrusion

The steady-state vapour-phase concentration of a contaminant inside a building ($C_{building}$) is calculated by applying the Johnson and Ettinger model assuming a steady-state mass transfer (i.e., infinite). This is calculated using Equation JE1.

$$C_{indoor} = C_{source} \bullet \alpha \qquad \text{...Equation JE1}$$

Where

C_{indoor} = the steady-state vapor-phase concentration of a contaminant inside a building (µg/m^3)

α = attenuation coefficient [unitless], refer to Equation JE2

C_{source} = vapour concentration at the source (µg/m^3), refer to equations VS1 to VS5 (as relevant).

The attenuation factor is calculated using the following:

$$\alpha = \frac{\left[\frac{D_T^{eff} \bullet A_B}{Q_{building} \bullet L_T}\right] \bullet \exp\left[\frac{Q_{soil} \bullet L_{crack}}{D^{crack} \bullet A_{crack}}\right]}{\left[\exp\left[\frac{Q_{soil} \bullet L_{crack}}{D^{crack} \bullet A_{crack}}\right] + \left[\frac{D_T^{eff} \bullet A_B}{Q_{building} \bullet L_T}\right] + \left[\frac{D_T^{eff} \bullet A_B}{Q_{soil} \bullet L_T}\right] \bullet \exp\left[\frac{Q_{soil} \bullet L_{crack}}{D^{crack} \bullet A_{crack}}\right]^{-1}\right]} \qquad \text{Equation JE2}$$

Where:

D_T^{eff}. = total overall effective diffusion coefficient. Refer to Equations D1 and D2.

A_B = area of the enclosed space below the ground level which will vary depending on whether the building has a basement below the ground or not (cm^2).

$Q_{building}$. = building ventilation rate which is calculated using building parameters and air exchange rate (cm^3/s). Refer to Equation JE3.

L_T = separation distance between the source or soil vapour measurement and the building (cm).

Q_{soil}. = volumetric flowrate of soil vapour into the enclosed space. This represents the convective flow of vapours into a building though cracks in the floor and walls. It incorporates pressure driven flows and a default value of 5 L/min is recommended (2003), however it can be calculated using Equation JE5.

L_{crack} = enclosed space foundation or slab thickness (cm).

D^{crack} = effective diffusion coefficient through the cracks (cm^2/s).

A_{crack} = area of total cracks which varies depending on whether there is a basement or not (cm^2), refer to Equation JE4.

The building ventilation rate is calculated using Equation JE3 for the building dimensions representing the living space of the building. It assumes that the total air volume entering the structure is mixed and that the vapour entering the structure is instantaneously and homogeneously distributed.

$$Q_{building} = \frac{(L_B \bullet W_B \bullet H_B \bullet ER)}{3600} \qquad \text{...Equation JE3}$$

Where:

L_B = length of building, (cm)

W_B = width of building, (cm)

H_B = height of building, (cm)

ER = air exchange rate, (per hour)

3600 = conversion from hours to seconds

$$A_{crack} = n \bullet AB$$
$$AB = L_B \bullet W_B + (2 \bullet L_B \bullet L_h + 2 \bullet W_B \bullet L_h)$$

…Equation JE4

Where:

AB	= area of enclosed space below ground, (cm^2)
n	= ratio of crack area to total area (unitless)
A_{crack}	= total crack area, (cm^2)
L_h	= depth below ground, (cm)

The volumetric flow rate of soil vapour into the building is calculated using Equation JE5. This represents the advective/convective flow rate of contaminant vapours in soil surrounding the building via the cracks in the building floor and walls. It incorporates pressure driven flows into the building that may be associated with wind effects on the structure, stack effects due to heating or an unbalanced mechanical ventilation. This is of particular importance where a basement is present and where heating /ventilation effects are of significance.

Tracer testing of buildings where advection is the primary mechanism for intrusion into the building suggested a typical range for Qsoil from 1 to 10 L/min, with 5 L/min selected as a default by the USEPA (USEPA 2004). The equation represents potential openings for soil vapour entry into a building. These openings include floor/wall joints associated with floating concrete slabs or a perimeter drain /sump system. The soil vapour permeability used is that for the type of material immediately under the slab.

$$Q_{soil} = \frac{2 \bullet \pi \bullet P \bullet k_v \bullet X_{crack}}{\mu \bullet \ln\left[2 \bullet \frac{Z_{crack}}{r_{crack}}\right]}$$

…Equation JE5

Where:

P	= pressure differential between the soil surface and the enclosed space, ($g/cm.s^2$) which may range from negligible (0.001-20 Pa, or 0.0001 to 2 $g/cm.s^2$)
k_v	= soil vapour permeability, (cm^2), calculated based on soil type beneath slab (USEPA 2004)
X_{crack}	= floor-wall seam perimeter, (cm)
μ	= viscosity of air, (g/cm.s)
Z_{crack}	= crack depth below ground level, (cm)
r_{crack}	= equivalent crack radius, (cm) (USEPA 2004)

However, for buildings constructed as slab-on-grade in climates where the potential for pressure differences to be driven by long term heating or unbalanced ventilation systems, the potential for pressure driven flows (advection) is considered negligible, consistent with the approach adopted in the ASTM guidance (ASTM 2002). This results in Qsoil being essentially negligible and hence the attenuation factor is simplified and can be calculated using the following (as per ASTM 2002):

$$\alpha = \frac{\left[\dfrac{D_T^{eff} / L_T}{ER \bullet L_B}\right]}{\left[1 + \left[\dfrac{D_T^{eff} / L_T}{ER \bullet L_B}\right] + \left[\dfrac{D_T^{eff} / L_T}{(D^{crack} / L^{crack}) \bullet \eta}\right]\right]}$$

Equation JE6

Where:

D_T^{eff}. = total overall effective diffusion coefficient. Refer to Equations D1 and D2.
L_B = enclosed-space volume: infiltration area ratio (cm).
ER = enclosed-space air exchange rate (1/sec).
L_T = separation distance between the source or soil vapour measurement and the building (cm).
L_{crack} = enclosed space foundation or slab thickness (cm).
D^{crack} = effective diffusion coefficient through the cracks (cm^2/s).

Where there is no foundation, and diffusion is the primary mechanism by which vapours may migrate from the subsurface into a space (crawl-space, sub-slab ventilation system or indoors [where there is no slab or timber floor]), the attenuation is equal to the following (Abreu & Johnson 2005):

$$\alpha_S = A = \frac{D_T^{eff}}{\left[\dfrac{Q_V}{A_B} \bullet L_T\right]}$$

Equation JE7

Where:

D_T^{eff}. = total overall effective diffusion coefficient. Refer to Equations D1 and D2.
QV = volumetric ventilation rate of space (cm^3/s)
= VAER x V_S
VAER = air exchange rate of space (1/sec)
Vs = volume of space (cm^3)
= AB x PVH
PVH = height of the space
A_B = area of the enclosed space below the ground level which will vary depending on whether the building has a basement below the ground or not (cm^2).
L_T = separation distance between the source or soil vapour measurement and the building (cm).

The vapour attenuation coefficient between vapours immediately beneath a foundation and indoor air, provided diffusion through the foundation is the dominant transport mechanism can be calculated using the following:

$$\alpha_F = \frac{A_B \bullet D_{crack}^{eff} \bullet n}{Q_B \bullet L_{crack}}$$

Equation JE8

Where:

$Q_{building}$.	= building ventilation rate which is calculated using building parameters and air exchange rate (cm^3/s). Refer to Equation JE3.
D_{crack}^{eff}.	= total overall effective diffusion coefficient through cracks in foundation. Refer to Equations D1 and D2.
n	= fraction of cracks in foundation (unitless)
A_B	= area of the enclosed space below the ground level which will vary depending on whether the building has a basement below the ground or not (cm^2).
L_{crack}	= enclosed space foundation or slab thickness (cm).
	= AB x PVH

B3.5 Outdoor/Excavation Model

There are a number of models available for estimating potential concentrations of chemicals within the outdoor air environment associated with the migration from a subsurface source. Limited guidance is available for the estimation of concentrations in an excavation, hence the outdoor model adopted has also been utilised for calculations of concentrations within an excavation. The estimation of concentrations in outdoor air can be undertaken using two different methodologies outlined in the Soil Screening Guidelines (USEPA 1996) and the Risk Based Corrective Action at Petroleum Release Sites (ASTM 2002).

The relevant equations associated with the estimation of outdoor air concentrations based on the approach outlined in the USEPA document "Soil Screening Guidance" (1996 and Supplement 2001 Exhibit D-3) (USEPA 1996). This model uses air dispersion models to provide an estimate of potential dispersion of emissions above the ground as presented below.

$$C_o = \frac{J_S}{Q/C \bullet 10^{-9}}$$ …Equation O1

Where:

C_o	= Outdoor air concentration ($\mu g/m^3$)
J_S	= Contaminant flux from the surface of the ground (measured) ($g/s/m^2$)
Q/C	= Dispersion term calculated for area ($g/s/m^2$ per kg/m^3)
10^{-9}	= Units conversion to from kg/m^3 to $\mu g/m^3$

$$Q/C = 11.91 \bullet \exp\left(\frac{(\ln(Acres) - 18.4385)^2}{209.7845}\right)$$ …Equation O2

Where:

Q/C	= Dispersion term calculated for area ($g/s/m^2$ per kg/m^3) based on climates similar to Los Angeles which is considered relevant for much of Australia, however, for other areas, relevant parameters are selected.
Acres	= Area of the source outside (acres)

A simpler approach more commonly used for small subsurface sources is the outdoor model presented in the ASTM (2002) guidance. Outdoor air concentrations have been estimated using a simple box model, which accounts for some atmospheric mixing. The concentration of volatile contaminants within the breathing zone of outdoor air has been estimated using Equation O3.

$$C_{outdoor} = C_S \bullet VF$$ (mg/m³) …Equation O3

Where:
C_s = concentration at the source (mg/m^3)
VF = volatilisation factor calculated for emissions from the source to air, refer to Equation O4.

As noted with the indoor air model, the vapour phase concentration at the source can be estimated using the following relationships:

- Where soil vapour data is available and relevant to the quantification of vapour migration, the measured soil vapour concentration is considered to be the concentration at the source, with migration modelled through overlying soils (from point of measurement to the surface); and
- Where no soil vapour data is available, the concentration at the source is based on theoretical partitioning from the groundwater or soil source, as presented in Equations VS1 to VS5 (as required).

The volatilisation factor is calculated using the following:

$$VF = \frac{D_s^{eff} \bullet W}{U_{air} \bullet \delta \bullet L_{GW}}$$ ....Equation O4

where:
U_{air} = Wind speed above the ground surface in the ambient mixing zone (cm/s)
δ_{air} = Ambient air mixing zone height (cm)
L_{GW} = Depth to groundwater (= height of capillary zone, h_{cap}, + height of unsaturated zone, h_v) (cm)
W = Width of source area parallel to wind or groundwater flow direction (cm) (i.e. width and breadth of breathing zone)
D_{ws}^{eff} = Effective diffusion coefficient between the groundwater and soil surface (cm^2/s), refer to Equations D1 and D2.

ASTM (2002) also provides equations for estimating emissions to outdoor air from sources that are close to or at the surface of the ground.

Volatile COPC have the potential to accumulate within trenches or excavations in areas where excavations intersect or are located directly above contaminated soil or groundwater. Workers have the potential to be exposed to these COPC when working in or near the trench or excavation. It is unlikely that workers would spend an entire workday within any excavation or trench, and any exposure near the trench or excavation would result in exposure to significantly lower concentrations due to dilution.

Concentrations within an excavation have been estimated using the ASTM (2002) outdoor air model presented above, however the depth to the source is adjusted to reflect to depth from the base of the excavation to the source, the dimensions of the excavation are used and the wind speed is adjusted to reflect a more confined space scenario. A typical excavation is estimated as 1 m x 10 m x 1 to 1.5 m depth (ANZECC and Safe Work Australia note that the depth of most services is between 1 and 2 m bgl (ANZECC 1992; Safe Work Australia 2015)). A wind speed considered representative of a more confined space within an excavation is 10% of the average outdoor wind-speed.

B3.6 Model Assumptions

The following represent the major assumptions/limitations of the J&E Model.

- Contaminant vapours enter the structure primarily through cracks and openings in the walls and foundation.
- Convective transport occurs primarily within the building zone of influence and vapour velocities decrease rapidly with increasing distance from the structure.
- Diffusion dominates vapour transport between the source of contamination and the building zone of influence.
- All vapours originating from below the building will enter the building unless the floors and walls are perfect vapour barriers.
- All soil properties in any horizontal plane are homogeneous.
- The contaminant is homogeneously distributed within the zone of contamination.
- The aerial extent of contamination is greater than that of the building floor in contact with the soil.
- Vapour transport occurs in the absence of convective water movement within the soil column (i.e., evaporation or infiltration), and in the absence of mechanical dispersion.
- The model does not account for transformation processes (e.g., biodegradation, hydrolysis, etc.).
- The soil layer in contact with the structure floor and walls is isotropic with respect to permeability.
- Both the building ventilation rate and the difference in dynamic pressure between the interior of the structure and the soil surface are constant values.

Use of the J&E Model as a first-tier screening tool to identify sites needing further assessment requires careful evaluation of the assumptions listed in the previous section to determine whether any conditions exist that would render the J&E Model inappropriate for the site. If the model is deemed applicable at the site, care must be taken to ensure reasonably conservative and self-consistent model parameters are used as input to the model. Considering the limited site data typically available in preliminary site assessments, the J&E Model can be expected to predict only whether or not a risk-based exposure level will be exceeded at the site. Precise prediction of concentration levels is not possible with this approach.

B4 Risk calculations

The spreadsheet images for these calculations are provided below.

VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOIL AND GROUNDWATER SOURCE
Using Johnson & Ettinger Model (USEPA 2004) for VI and ASTM (2002) for Outdoors and Excavations

Site

Site Specific Physical Input Parameters	Units	Abbrev.	Value	Comments
General Parameters				
Depth to groundwater (unsaturated)	[m]	vd	0	Depth from groundwater to slab
Depth to soil impacts	[m]	sg1	0	Depth from soil impacts to slab
Depth to soil vapour impacts	[m]	svg1	2	Depth from soil vapour measurement to slab
Top Layer (unsaturated zone)				***Sand/Sandy Clay/Fill***
Depth of top layer (groundwater source)	[m]	vd1	**0**	Site-specific
Depth of top layer (soil source)	[m]	vd1s	**0**	Assume impacts or SV remains beneath the slab
Thickness of contaminated soil	[m]	thicks	**0**	Default as per CRC CARE 2011
Depth of top layer (soil vapour source)	[m]	vd1sv	**2**	Assume impacts or SV remains beneath the slab
Moisture Content	[ml/g]	mocon	**0.08**	Default for sand, sandy clay and fill (CRC CARE 2011)
Fraction of Organic Carbon	-	foc1	**0.003**	Default (CRC CARE 2011)
Soil Bulk Density	[g/ml]	rhob	**1.625**	Default for sand, sandy clay and fill (CRC CARE 2011)
Density of Solids	[g/ml]	sd	2.65	Default
Total Soil Porosity	[ml/ml]	theta	0.39	Calculated (1 - (rhob/sd))
Volumetric Water Content	[ml/ml]	wacon	0.130	Calculated (mocon*rhob)
Volumetric Air Content	[ml/ml]	acon	0.257	Calculated (theta-wacon)

Receptor Specific Input Parameters	Units	Abbrev.	Value	Comments
Building Characteristics				
Exposure duration	[years]	ED	**35**	Relevant to residential use
Depth of Basement	[m]	basement	**0**	No basement
Width of Building	[m]	bwidth	**10**	Relevant to building size
Length of Building	[m]	blength	**15**	Relevant to building size
Area of Emission - Building Area	[m^2]	emarea	150.0	Calculated based on building dimensions
Foundation/wall thickness	[m]	fthick	0.15	Minimum default from BCA
Height of Room	[m]	boxh	**3**	Ceiling height of lower ground floor or basement premises
Hourly Volume Exchange of Fresh Air	[exch/hr]	exchanges	**0.83**	Default for commercial/industrial premises (conservative)
Fraction of Cracks in Walls and foundation	-	cracks	**0.001**	Default Value for type of building, USEPA 2004
Qbuilding	[cm^3/s]	Qb	103750.0	Calculated, USEPA 2004
Is advective vapour flow significant?	-	Adv	no	Based on building type/assumptions adopted
Qsoil	[cm^3/s]	Qs	0.0	default low value
Acrack	[cm^2]	Ac	1500	Calculated from building area and crack ratio, USEPA 2004
Volumetric Water Content in foundation/wall cracks	[ml/ml]	fwacon	0.12	Default Value
Volumetric Air Content in foundation/wall cracks	[ml/ml]	facon	0.260	Default Value
Outdoor Air Characteristics				
Depth of Excavation	[m]	exdepth	**1.0**	Assumed depth of excavation
Length of Contaminated Area	[m]	length	**20**	Assumed area outdoors contributing to outdoor concentration
Width of Contaminated Area	[m]	width	**20**	Assumed area outdoors contributing to outdoor concentration
Length of Excavation	[m]	exlength	**10**	Assumed for excavation
Wind Speed Outdoors	[m/s]	wspd	**3.7**	Average 9am and 3pm winds from Sydney Olympic Park Met Station
Wind Speed in Excavation	[m/s]	exwspd	**0.4**	Low wind speed in excavation, 10% of outdoor windspeed
Height of Outdoor Mixing Zone	[m]	outboxh	2	Default Value relevant for excavations

Chemical Specific Parameters	Water Solubility (mg/L)	Koc (cm^3/g)	MW (g/mol)	Air Diffusion Coefficient (cm^2/s)	Water Diffusion Coefficient (cm^2/s)	Vapour Pressure (mmHg)	Henry's Law Constant (unitless)
Trichloroethene	1.28E+03	6.07E+01	1.31E+02	6.87E-02	1.02E-05	6.90E+01	4.03E-01
Tetrachloroethene	2.06E+02	9.49E+01	1.66E+02	5.05E-02	9.46E-06	1.85E+01	7.24E-01
cis-1,2-Dichloroethene	6.41E+03	3.96E+01	9.69E+01	8.84E-02	1.13E-05	2.00E+02	1.67E-01
trans-1,2-Dichloroethene	4.52E+03	3.96E+01	9.69E+01	8.76E-02	1.12E-05	3.31E+02	3.83E-01
Vinyl chloride	8.80E+03	2.17E+01	6.25E+01	1.07E-01	1.20E-05	2.98E+03	1.14E+00
1,1-Dichloroethene	2.42E+03	3.18E+01	9.69E+01	8.63E-02	1.10E-05	6.00E+02	1.07E+00
Chloroform	7.95E+03	3.18E+01	1.19E+02	7.69E-02	1.09E-05	1.97E+02	1.50E-01

Note: Physical/chemical properties sourced from RAIS website (March 2024) (Default/SSL values and then EPI Exp. values adopted where available)

Vapour Transport Calculations	Deff Layer 1 (cm^2/s)	Deff Layer 2 (cm^2/s)	Deff Layer 3 (cm^2/s)	Deff Foundations and Cracks (cm^2/s)	Deff Capillary Fringe (cm^2/s)
Trichloroethene	4.94E-3	4.94E-3	4.94E-3	5.15E-3	1.40E-5
Tetrachloroethene	3.63E-3	3.63E-3	3.63E-3	3.78E-3	9.19E-6
cis-1,2-Dichloroethene	6.36E-3	6.36E-3	6.36E-3	6.63E-3	2.50E-5
trans-1,2-Dichloroethene	6.30E-3	6.30E-3	6.30E-3	6.57E-3	1.72E-5
Vinyl chloride	7.71E-3	7.71E-3	7.71E-3	8.03E-3	1.61E-5
1,1-Dichloroethene	6.21E-3	6.21E-3	6.21E-3	6.47E-3	1.33E-5
Chloroform	5.53E-3	5.53E-3	5.53E-3	5.77E-3	2.45E-5

Vapour Transport Calculations	Total Effective Diffusion (Soil to Foundation) (cm^2/s)	Total Effective Diffusion (Soil to excavation) (cm^2/s)	Total Effective Diffusion (GW to foundation) (cm^2/s)	Total Effective Diffusion (GW to excavation) (cm^2/s)	Total Effective Diffusion (SV to foundation) (cm^2/s)	Total Effective Diffusion (SV to excavation) (cm^2/s)
Trichloroethene	#DIV/0!	4.94E-03	1.40E-05	1.39E-05	4.94E-03	4.94E-03
Tetrachloroethene	#DIV/0!	3.63E-03	9.19E-06	9.15E-06	3.63E-03	3.63E-03
cis-1,2-Dichloroethene	#DIV/0!	6.36E-03	2.50E-05	2.48E-05	6.36E-03	6.36E-03
trans-1,2-Dichloroethene	#DIV/0!	6.30E-03	1.72E-05	1.72E-05	6.30E-03	6.30E-03
Vinyl chloride	#DIV/0!	7.71E-03	1.61E-05	1.60E-05	7.71E-03	7.71E-03
1,1-Dichloroethene	#DIV/0!	6.02E-03	2.01E-05	2.00E-05	6.02E-03	6.02E-03
Chloroform	#DIV/0!	5.53E-03	2.45E-05	2.42E-05	5.53E-03	5.53E-03

Modelled Air Concentrations from Soil Vapour Source

Intermediate Calculations	A	B	C	Pe	Key VI Mechanism
Trichloroethene	3.6E-04	1.9E-04	9.6E-10	1.00E+0	diffusion dominated
Tetrachloroethene	2.6E-04	2.6E-04	9.6E-10	1.00E+0	diffusion dominated
cis-1,2-Dichloroethene	4.6E-04	1.5E-04	9.6E-10	1.00E+0	diffusion dominated
trans-1,2-Dichloroethene	4.6E-04	1.5E-04	9.6E-10	1.00E+0	diffusion dominated
Vinyl chloride	5.6E-04	1.2E-04	9.6E-10	1.00E+0	diffusion dominated
1,1-Dichloroethene	4.4E-04	1.6E-04	9.6E-10	1.00E+0	diffusion dominated
Chloroform	4.4E-04	1.7E-04	9.6E-10	1.00E+0	diffusion dominated

Calculated Air Concentrations	Soil Vapour Concentration (mg/m^3)	JE Attenuation Coefficient (unitless)	Ground Floor Air Concentration (mg/m^3)	Outdoor Air Concentration (mg/m^3)	Excavation Air Concentration (mg/m^3)
Trichloroethene	**2.5**	4.9E-06	**1.2E-05**	**1.7E-06**	**1.7E-05**
Tetrachloroethene	**0.034**	3.6E-06	**1.2E-07**	**1.7E-08**	**1.7E-07**
cis-1,2-Dichloroethene	**1.7**	6.3E-06	**1.1E-05**	**1.5E-06**	**1.5E-05**
trans-1,2-Dichloroethene	**0.15**	6.2E-06	**9.4E-07**	**1.3E-07**	**1.3E-06**
Vinyl chloride	**2.1**	7.6E-06	**1.6E-05**	**2.2E-06**	**2.2E-05**
1,1-Dichloroethene	**0.034**	6.2E-06	**2.1E-07**	**2.8E-08**	**2.8E-07**
Chloroform	**1**	5.5E-06	**5.5E-06**	**7.5E-07**	**7.5E-06**

Inhalation of volatiles

$$\text{Inhalation exposure concentration} = C_a \times \frac{ET \times FI \times EF \times ED}{AT} \ (mg/m^3)$$

Parameters relevant to quantification of exposure by commercial workers		
Exposure Time Indoors (ET, hr/day)	8	As per NEPM (1999 amended 2013)
Fraction Inhaled from Contaminated Source (FI, unitless)	1	Assume all of building above source
Exposure Frequency (EF, days/yr)	240	Days at work, as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	262800	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk $(mg/m^3)^{-1}$	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air (Ca) (mg/m^3)	Inhalation Exposure Concentration - NonThreshold (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Trichloroethene	4.0E-03	2.0E-03	10%	1.8E-03	1.2E-05	1.1E-06	2.7E-06	4.6E-9	1%	0.00149	80%
Tetrachloroethene		2.0E-01	10%	1.8E-01	1.2E-07	1.1E-08	2.7E-08	--		0.000000149	0%
cis-1,2-Dichloroethene		7.0E-03	5%	6.7E-03	1.1E-05	1.0E-06	2.3E-06	--		0.000353	19%
trans-1,2-Dichloroethene		7.0E-02	5%	6.7E-02	9.4E-07	8.8E-08	2.1E-07	--		0.00000309	0%
Vinyl chloride	8.8E-03				1.6E-05	1.5E-06	3.5E-06	1.3E-8	2%	--	
1,1-Dichloroethene		4.0E-03	5%	3.8E-03	2.1E-07	2.0E-08	4.6E-08	--		0.0000121	1%
							TOTAL	7.2E-07		0.00186	

Inhalation of volatiles in excavation

$$\text{Inhalation exposure concentration} = C_a \times \frac{ET \times FI \times EF \times ED}{AT} \ (mg/m^3)$$

Parameters relevant to quantification of exposures by construction workers		
Exposure Time Indoors (ET, hr/day)	8	As per NEPM (1999 amended 2013)
Fraction Inhaled from Contaminated Source (FI, unitless)	1	Assume all of excavation above source
Exposure Frequency (EF, days/yr)	240	Days at work, as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	1	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	8760	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk $(mg/m^3)^{-1}$	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air (Ca) (mg/m^3)	Inhalation Exposure Concentration - NonThreshold (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Trichloroethene	4.0E-03	2.0E-03	10%	1.8E-03	1.7E-05	5.2E-08	3.7E-06	2.1E-10	26%	0.00203	78%
Tetrachloroethene		2.0E-01	10%	1.8E-01	1.7E-07	5.2E-10	3.7E-08	--		0.000000203	0%
cis-1,2-Dichloroethene		7.0E-03	5%	6.7E-03	1.5E-05	4.6E-08	3.2E-06	--		0.000482	18%
trans-1,2-Dichloroethene		7.0E-02	5%	6.7E-02	1.3E-06	4.0E-09	2.8E-07	--		0.00000421	0%
Vinyl chloride	8.8E-03				2.2E-05	6.8E-08	4.8E-06	6.0E-10	74%	--	
1,1-Dichloroethene		4.0E-03	5%	3.8E-03	2.8E-07	8.7E-10	6.1E-08	--		0.0000159	1%
Chloroform		1.4E-01	5%	1.3E-01	4.5E-05	1.4E-07	9.9E-06	--		0.0000744	3%
							TOTAL	**8.1E-10**		**0.00261**	