Roads and Maritime Services/Sydney Airport Corporation Limited

Sydney Gateway Road Project

Environmental Impact Statement/ Preliminary Draft Major Development Plan

Technical Working Paper 8

Surface Water

November 2019

Roads and Maritime Services

Sydney Gateway Road Project

Technical Working Paper 8 – Surface Water

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Glossary

Acid sulfate soils	Naturally occurring soils, sediments or organic substrates (eg peat) that are formed under waterlogged conditions. These soils contain iron sulfide minerals (predominantly as the mineral pyrite) or their oxidation products. In an undisturbed state below the water table, acid sulfate soils are benign. However, if the soils are drained, excavated or exposed to air by a lowering of the water table, the sulfides react with oxygen to form sulfuric acid.
AHD	Australian height datum
Annual Exceedance Probability (AEP)	An indicator used to describe the frequency of floods. Annual exceedance probability is the probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.
Australia and New Zealand Guidelines for Fresh and Marine Water Quality (2000)	A set of guidelines prepared to provide authoritative guidance on the management of water quality in Australia and New Zealand.
Alignment	The geometric layout (e.g. of a road or railway) in plan (horizontal) and elevation (vertical).
Aquifer	A groundwater bearing formation sufficiently permeable to transmit and yield groundwater or water bearing rock.
Average recurrence interval (ARI)	An indicator used to describe the frequency of floods. The average period in years between occurrences of a flood of a particular magnitude or greater. Floods generated by runoff from the study catchments are referred to in terms of their ARI, for example the 100-year ARI flood. The 100-year ARI flood has a one per cent chance (i.e. a one-in-100 chance) of occurrence in any one year.
The Blue Book	The Managing Urban Stormwater – Soils and Construction (Landcom, 2004) series of handbooks which provide guidelines, principles and recommended minimum design standards for good management practice for soils and water during construction of projects.
BOM	Bureau of Meteorology
Botany rail line	A dedicated freight rail line that forms part of the Sydney Freight Network. The line extends from near Marrickville Station to Port Botany.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
Construction	Includes all physical work required to construct the project.
Construction ancillary facilities	Temporary facilities during construction that include construction work areas, sediment basins, pre-cast yards and material stockpiles, laydown areas, parking, maintenance workshops and offices, and construction compounds.
Construction environmental management plan	Site specific plan developed for the construction phase of the project to ensure that all contractors and sub-contractors comply with the environmental conditions of approval for the project and that environmental risks are properly managed.
Cumulative impacts	Impacts that, when considered together, have different and/or more substantial impacts than a single impact assessed on its own.
Detailed design	The stage of design where project elements are designed in detail, suitable for construction.

Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second. Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving (eg metres per second).
Drainage	Natural or artificial means for the interception and removal of surface or subsurface water.
Drawdown	Reduction in the height of the water table caused by changes in the local environment.
Earthworks	All operations involved in loosening, excavating, placing, shaping and compacting soil or rock.
Electrical conductivity	The measure of a material's ability to accommodate the transport of an electric charge.
Embankment	An earthen structure where the road (or other infrastructure) subgrade level is above the natural surface.
Erosion	Natural process where wind or water detaches a soil particle and provides energy to move the particle.
Exceedances per Year (EY)	An indicator used to describe the frequency of floods. Exceedances per year is the number of times that a given rainfall total accumulated over a given duration will be exceeded in any one year.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
Flood storage area	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and location of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation.
Grade	The rate of longitudinal rise (or fall) with respect to the horizontal expressed as a percentage or ratio.
Groundwater	Water that is held in rocks and soil beneath the earth's surface.
Gross Pollutant Trap (GPT)	Filter that catches stormwater pollution before it has a chance to enter waterways.
Humeceptor	A proprietary hydrodynamic separator product, specifically designed to remove hydrocarbons and suspended solids from stormwater runoff.
Hydraulic conductivity	A characteristic of soil that describes how easily water moves through it. Low hydraulic conductivity would indicate poor water transmitting properties.
Hydrology	The study of rainfall and surface water runoff processes.
Impact	Influence or effect exerted by a project or activity on the natural, built or community environment.
Infiltration	The downward movement of water into soil and rock. It is largely governed by the structural condition of the soil, the nature of the soil surface (including presence of vegetation) and the antecedent moisture content of the soil.
Leachate	Liquid that 'leaches' (drains) from a landfill or stockpile.
Localised flooding	Localised flooding occurs when components of the drainage system are undersized or blocked and cannot accommodate the incoming overland surface flows, resulting in the flooding of a localised area.

Major Development Plan	A plan that may be required as a result of the proposed development of types of infrastructure listed in Section 89 of the *Airports Act 1996* ('major airport development'). Development cannot occur before an approval of a plan lodged with the Commonwealth Minister for Infrastructure.
Metres AHD	Metres Australian Height Datum
mg/L	Milligrams per litre
MUSIC	The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) is a computer software decision support tool for stormwater management. It helps with the planning and conceptual design of stormwater management systems.
NA	Not applicable
New M5	A component of the WestConnex program of works. The project is located between Kingsgrove and St Peters interchange (under construction).
M4-M5 Link	A component of the WestConnex program of works. The project is a new inner western bypass of the Sydney central business district connecting the M4 and M5. It is located between Haberfield and St Peters interchange (under construction).
Pavement	The portion of a carriageway placed above the subgrade for the support of, and to form a running surface for, vehicular traffic.
PFAS	Per-and poly-fluoroalkyl substances, which are manufactured chemicals used in products that resist heat, oil, stains and water. There are many types of PFAS, with the best-known examples being perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), which were used in some fire-fighting foams.
Pollutant	Any measured concentration of solid or liquid matter that is not naturally present in the environment.
Probability	A statistical measure of the expected chance or likelihood of occurrence.
Project	The construction and operation of the Sydney Gateway road project.
Project site	Includes the area that would be directly affected by construction (also known as the construction footprint) as well as the location of the construction storage areas/compounds and the location of operational project infrastructure.
Risk	Chance of something happening that will potentially have an undesirable effect. It is measured in terms of consequence and likelihood.
Roads and Maritime	NSW Roads and Maritime Services
Runoff	The amount of rainfall that ends up as streamflow, also known as rainfall excess.
Secretary's Environmental Assessment Requirements (SEARs)	Requirements and specifications for an environmental assessment prepared by the Secretary of the Department of Planning and Environment under section 115Y of the *Environmental Planning and Assessment Act 1979* (NSW).
Sensitive receivers	Land uses, landscape features and activities that are sensitive to changes in the environment such as water quality and quantity, noise, vibration, air and visual impacts. Sensitive receivers may include aquatic ecosystems, aquaculture areas, residential dwellings, schools and recreation areas.
Soil and Water Management Plan (SWMP)	A plan which describes how to manage obligations and performance with regards to aspects and potential impacts associated with soil and water during construction of the project.

Spoil	Material generated by excavation.
St Peters interchange	A component of the New M5 project, located at the former Alexandria Landfill site at St Peters. In its ultimate configuration, it would connect the New M5, the M4–M5 Link and the Sydney Gateway road project with Euston Road and Gardeners Road.
Stockpile	Temporary stored materials such as soil, sand, gravel and spoil/waste.
Study area	The study area is defined as the wider area including and surrounding the project site, with the potential to be directly or indirectly affected by the project (eg by noise and vibration, visual or traffic impacts). The actual size and extent of the study area varies according to the nature and requirements of each assessment and the relative potential for impacts.
Surface water	Water flowing or held in streams, rivers and other wetlands in the landscape.
Sydney Gateway	A NSW Government initiative to respond to the forecast growth of Sydney Airport and Port Botany. Sydney Gateway comprises a road and rail component, consisting of: ▪ Road connections to Sydney Airport's domestic and international airport terminals from the Sydney motorway network at St Peters interchange (being delivered by Roads and Maritime Services) ▪ Duplication of a three-kilometre long section of the Botany rail line (being delivered by ARTC).
Total Nitrogen	The sum of total Kjeldahl nitrogen (ammonia, organic and reduced nitrogen) and nitrate-nitrite. It can be derived by monitoring for organic nitrogen compounds, free-ammonia, and nitrate-nitrite individually and adding the components together.
Total Phosphorus	An essential nutrient of plants, animals and humans. In water, it exists primarily as orthophosphate (PO_4^{3-}) or in organic compounds. The parameter total phosphorus (TP) defines the sum of all phosphorus compounds that occur in various forms.
Total suspended solids	Total suspended solids is the dry-weight of suspended particles in a sample of water that can be trapped by a filter and analysed using a filtration apparatus.
Trigger Values	Guideline trigger values are concentrations in waterways that, if exceeded, would indicate a potential environmental problem, and so 'trigger' an investigation and/or further management response, e.g. additional controls.
Waterway	Any flowing stream of water, whether natural or artificially regulated (not necessarily permanent).
WestConnex	WestConnex is a 33-kilometre-long, predominantly underground, motorway currently under construction in Sydney. The WestConnex program of works includes widening and extension of the M4 Western Motorway (M4 Widening); construction of two tunnels connecting Homebush Bay Drive with Wattle Street and Parramatta Road at Haberfield (M4 East); a new section of the M5 South Western Motorway including a new interchange at St Peters (New M5); and a new inner western bypass of the Sydney central business district connecting the M4 and M5 (M4–M5 Link).

1. Introduction

1.1 Overview

1.1.1 Sydney Gateway and the project

Sydney Kingsford Smith Airport (Sydney Airport) and Port Botany are two of Australia's most important infrastructure assets, providing essential domestic and international connectivity for people and goods. Together they form a strategic centre, which is set to grow significantly over the next 20 years. To support this growth, employees, residents, visitors and businesses need reliable access to the airport and port, and efficient connections to Sydney's other strategic centres.

The NSW and Australian governments are making major investments in the transport network to achieve this vision. New road and freight rail options are being investigated to cater for the forecast growth in passengers and freight through Sydney Airport and Port Botany. Part of this solution is Sydney Gateway, which comprises the following road and rail projects:

- Sydney Gateway road project (the subject of this assessment)
- Botany Rail Duplication.

Sydney Gateway will expand and improve the road and freight rail networks to Sydney Airport and Port Botany to keep Sydney moving and growing. The Sydney Gateway road project forms part of the NSW Government's long-term strategy to invest in an integrated transport network and make journeys easier, safer and faster.

Roads and Maritime and Sydney Airport Corporation propose the Sydney Gateway road project (the project). The project comprises new direct high capacity road connections linking the Sydney motorway network at St Peters interchange with Sydney Airport's terminals and beyond. It involves constructing and operating new and upgraded sections of road connecting to the airport terminals, four new bridges over Alexandra Canal, and other operational infrastructure and road connections. The project and its location is shown on Figure 1-1.

1.1.2 Overview of approval requirements

The project is subject to approval under NSW and Commonwealth legislation. Parts of the project located on Commonwealth-owned land leased to Sydney Airport (Sydney Airport land) are subject to the Commonwealth *Airports Act 1996* (the Airports Act). In accordance with the Airports Act, these parts of the project are major airport development. A major development plan (MDP), approved by the Australian Minister for Infrastructure, Transport and Regional Development, is required before a major airport development can be undertaken at a leased airport.

Parts of the project located on other land are State significant infrastructure in accordance with the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). As State significant infrastructure, these parts of the project require approval from the NSW Minister for Planning and Public Spaces. An environmental impact statement (EIS) is required to support the application for approval for State significant infrastructure under the EP&A Act.

A combined EIS and preliminary draft MDP is being prepared to:

- Support the application for approval of the project in accordance with NSW and Commonwealth legislative requirements
- Address the environmental assessment requirements of the Secretary of the Department of Planning and Environment (the SEARs), issued on 15 February 2019
- Address the MDP requirements defined by section 91 of the Airports Act
- This report was prepared on behalf of Roads and Maritime and Sydney Airport Corporation to support the combined EIS/preliminary draft MDP.

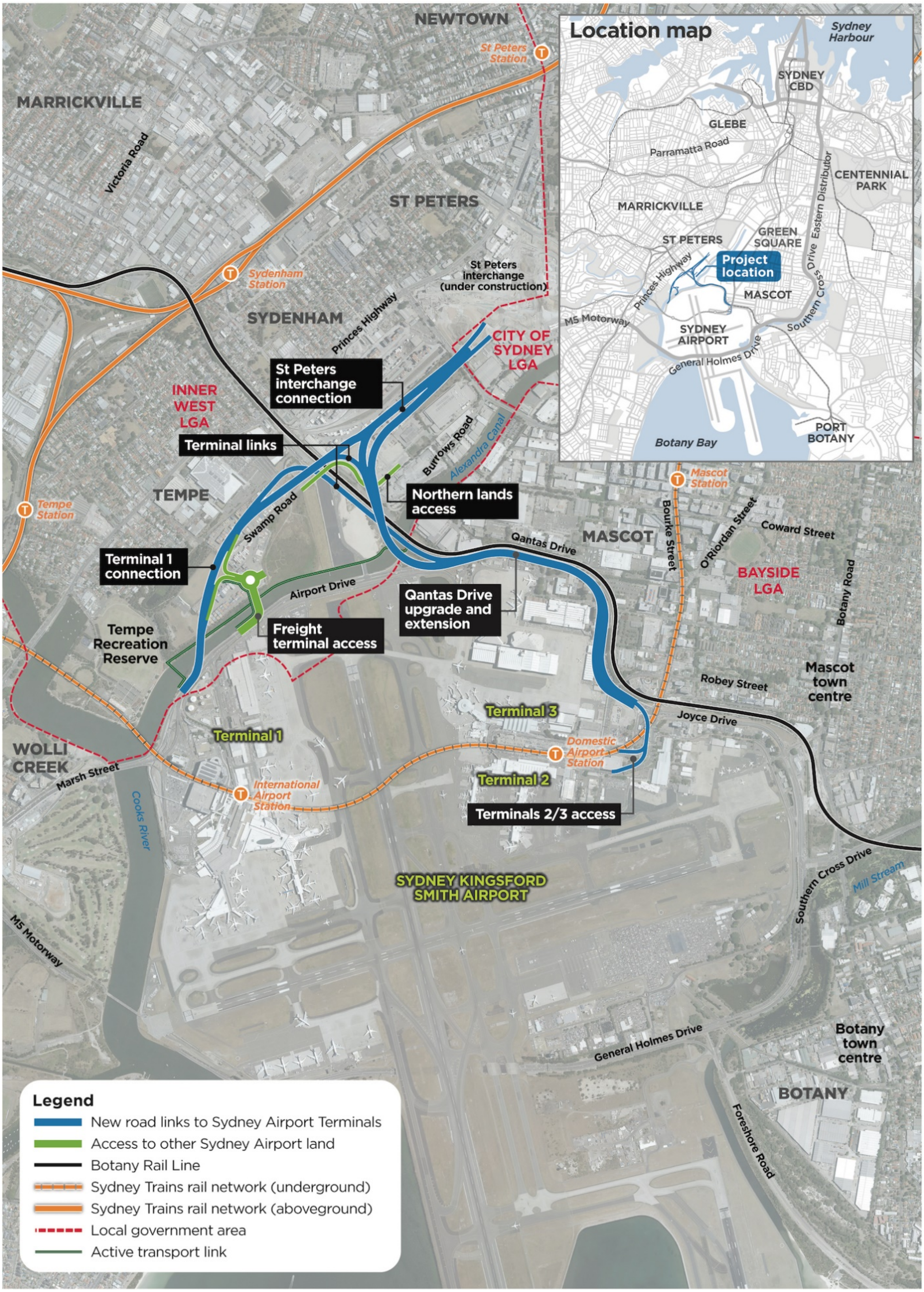

Figure 1-1 The Project

1.2 Purpose and scope of this report

The project involves upgrades of existing roads and construction of new roads and bridges in areas that are currently mixed industrial, commercial and open space. This alteration of catchment conditions may change surface water flow and quality characteristics around the project area during both project construction and operation. For example, increasing the area of impervious road surfaces will result in more stormwater flow and pollutants discharging into nearby waterways. If this impact is not managed, there is potential to increase the quantity and reduce the quality of water entering the environment and surrounding waterways.

The purpose of this report is to assess the potential surface water impacts from constructing and operating the project. It will be used to inform project design, environmental assessment, regulators, stakeholders and community about potential impacts on water quality and to identify recommended mitigation and management measures.

This report:

- Describes the existing catchments and waterways, including their environmental values and relevant regulatory framework
- Describes the methods used to model impacts on flow and water quality
- Assesses the impacts of the project on flow and water quality during construction and operation
- Recommends measures to mitigate potential adverse impacts during both construction and operation.

This assessment addresses the relevant SEARs as identified in Table 1-1, and the MDP requirements under the Airports Act as outlined in Table 1-2.

Table 1-1 SEARs relevant to this assessment

Requirements	Where addressed in this report
10. Water – Hydrology	
1. The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project, including rivers, streams, estuaries and wetlands as described in the BAM.	Section 4.1 and section 4.6 Technical Working Paper 6 – Flooding Technical Working Paper 7 – Groundwater
2. The Proponent must prepare a detailed water balance for ground and surface water including the proposed intake from all water supply options and discharge locations (including figures showing these locations), volume, frequency, duration and proposed water conservation measures for both the construction and operation of the project.	Section 5.2.8 and section 6.3 and Figure 7-1 Technical Working Paper 7 – Groundwater
3. The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including:	
a) natural processes within rivers, wetlands, estuaries, marine waters and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge;	Section 4, section 5 and section 6 Technical Working Paper 7 – Groundwater Technical Working Paper 6 – Flooding Technical Working Paper 14 – Biodiversity Development Assessment Report

Requirements	Where addressed in this report
b) impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement;	Section 5.2.4 and section 5.2.8 Technical Working Paper 7 – Groundwater Technical Working Paper 14 – Biodiversity Development Assessment Report
c) changes to environmental water availability and flows, both regulated/licensed and unregulated/rules-based sources;	Section 5.2.8 and section 6.3
d) direct or indirect increases in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses;	Section 5.2 and section 6.5
e) minimising the effects of proposed stormwater and wastewater management during construction and operation on natural hydrological attributes (such as volumes, flow rates, management methods and re-use options) and on the conveyance capacity of existing stormwater systems where discharges are proposed through such systems; and	Section 5.2, section 6 and section 8 Technical Working Paper 6 – Flooding
f) water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction and operation.	Section 5.2.8 and section 6.3 Technical Working Paper 7 – Groundwater
4. The proponent must identify any requirements for baseline monitoring of hydrological attributes	Section 8.3
5. The assessment must include details of proposed surface and groundwater monitoring.	Section 8.3 Technical Working Paper 7 – Groundwater
11. Water Quality	
1. The Proponent must: a) Describe the background conditions for any surface and groundwater resources likely to be affected by the proposal including leachate from Tempe Tip;	Section 4 Technical Working Paper 7 – Groundwater Technical Working Paper 5 – Contamination and Soils Technical Working Paper 16 – Landfill Assessment
b) state the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the project, including the indicators and associated trigger values or criteria for the identified environmental values;	Section 3.4
c) identify and estimate the quality and quantity of all pollutants that may be introduced into the water cycle by source and discharge point and describe the nature and degree of impact that any discharge(s) may have on the receiving environment, including consideration of all pollutants (including contaminated groundwater) that pose a risk of non-trivial harm to human health and the environment;	Sections 5.2.4 to 5.2.8 and sections 6.2 to 6.4 Technical Working Paper 5 – Contamination and Soils Technical Working Paper 7 – Groundwater
d) assess the impacts of leachate generation from project related activities on the Tempe Tip Site and proposed measures for managing potential impacts during construction and operation;	Section 5.2.5, section 5.2.8 and section 8.1.2 Technical Working Paper 16 – Landfill Assessment
e) describe the proposed measures for treating and disposing of construction and operational wastewater flows;	Section 5.2.8 Technical Working Paper 16 – Landfill Assessment

Requirements	Where addressed in this report
f) identify the rainfall event that the water quality protection measures will be designed to cope with;	Section 6.4.1
g) assess the significance of any identified impacts including consideration of the relevant ambient water quality outcomes;	Section 5.1 and section 6.1
h) demonstrate how construction and operation of the project will, to the extent that the project can influence, ensure that: i) where the NSW WQOs for receiving waters are currently being met they will continue to be protected; and ii) where the NSW WQOs are not currently being met, activities will work toward their achievement over time;	Section 3.4, section 5.2, section 6.4 and section 8.3
i) justify, if required, why the WQOs cannot be maintained or achieved over time;	Section 3.4, section 5.2, section 6.4 and section 8.3
j) demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented;	Section 8
k) identify sensitive receiving environments (which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments; and	Section 4.6 and section 8
l) identify proposed monitoring locations, monitoring frequency and indicators of surface and groundwater quality.	Section 8.3 Technical Working Paper 7 – Groundwater
2. The assessment should consider the results of any current water quality studies, as available, for the catchment areas traversed by the proposal.	Section 4.7
Soils	
1. The Proponent must verify if the proposal is on land marked as Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map or within 500 m of adjacent Class 2, 3 or 4 land that is below 5 m Australian Height Datum (AHD) and where the proposal is likely to lower the water table in this adjacent land below 1 m AHD.	Technical Working Paper 5 – Contamination and Soils Technical Working Paper 7 – Groundwater
2. The Proponent must assess the impact of the proposal on acid sulfate soils (including the impacts of acidic runoff offsite) in accordance with the current guidelines.	Section 5.2 and section 5.3 Technical Working Paper 5 – Contamination and Soils
3. The Proponent must assess whether salinity is likely to be an issue and if so, determine the presence, extent and severity of soil salinity within the proposal area.	Technical Working Paper 5 – Contamination and Soils
4. The Proponent must assess the impacts of the proposal on soil salinity and how it may affect groundwater resources and hydrology.	Technical Working Paper 5 – Contamination and Soils Technical Working Paper 7 – Groundwater
5. The Proponent must assess the impacts on soil and land resources (including erosion risk or hazard). Particular attention must be given to soil erosion and sediment transport consistent with the practices and principles in the current guidelines.	Section 5.2, section 6.2 and section 6.5

Table 1-2 MDP requirements relevant to this assessment

MDP Key issues	Requirements	Where addressed in this report
Assessment of environmental impacts	(d) if a final master plan for the airport is in force—whether or not the development is consistent with the final master plan;	Section 5.4 and section 6.7
Assessment of environmental impacts	(h) the airport-lessee company's assessment of the environmental impacts (surface water quality) that might reasonably be expected to be associated with the development.	Section 5.2.8 and section 6.7
Plans for dealing with environmental impacts	(j) the airport-lessee company's plans for dealing with the environmental impacts (surface water quality) mentioned in paragraph (h) (including plans for ameliorating or preventing environmental impacts).	Section 8

1.3 The project

1.3.1 Location

The project is located about eight kilometres south of Sydney's central business district and to the north of Sydney Airport on both sides of Alexandra Canal. The northern extent of the project is located at St Peters interchange, which is currently being constructed to the north of Canal Road in St Peters. The western extent of the project is located near the entrance to Sydney Airport Terminal 1 on Airport Drive, to the north of the Giovanni Brunetti Bridge and south-west of Link Road. The eastern extent of the project is located near the intersection of Joyce Drive, Qantas Drive, O'Riordan Street and Sir Reginald Ansett Drive.

The project is located mainly on government owned land in the suburbs of Tempe, St Peters and Mascot, in the Inner West, City of Sydney and Bayside local government areas.

1.3.2 Key design features

The project provides a number of linked road connections to facilitate the movement of traffic between the Sydney motorway network, Sydney Airport Terminal 1 (Terminal 1) and Sydney Airport Terminals 2 and 3 (Terminals 2/3). The project would connect Terminal 1 and Terminals 2/3 with each other and with the Sydney motorway network. The project would also facilitate the movement of traffic towards Port Botany via General Holmes Drive. It would provide three main routes for traffic:

- Between the Sydney motorway network and Terminal 1, and towards M5 motorway and Princes Highway
- Between the Sydney motorway network and Terminals 2/3, and towards General Holmes Drive, Port Botany and Southern Cross Drive
- Between Terminal 1 and Terminals 2/3.

The key features of the project include:

- Road links to provide access between the Sydney motorway network and Sydney Airport's terminals, consisting of the following components:
  - St Peters interchange connection – a new elevated section of road extending from St Peters interchange to the Botany Rail Line, including an overpass over Canal Road
  - Terminal 1 connection – a new section of road connecting Terminal 1 with the St Peters interchange connection, including a bridge over Alexandra Canal and an overpass over the Botany Rail Line
  - Qantas Drive upgrade and extension – widening and upgrading Qantas Drive to connect Terminals 2/3 with the St Peters interchange connection, including a high-level bridge over Alexandra Canal

- Terminal links – two new sections of road connecting Terminal 1 and Terminals 2/3, including a bridge over Alexandra Canal
- Terminals 2/3 access – a new elevated viaduct and overpass connecting Terminals 2/3 with the upgraded Qantas Drive

- Road links to provide access to Sydney Airport land:
  - A new section of road and an overpass connecting Sydney Airport's northern lands either side of the Botany Rail line (the northern lands access)
  - A new section of road, including a signalised intersection with the Terminal 1 connection and a bridge connecting Sydney Airport's existing and proposed freight facility either side of Alexandra Canal (the freight terminal access)
- An active transport link approximately 1.3 kilometres in length along the western side of Alexandra Canal to maintain connections between Sydney Airport, Mascot and the Sydney central business district
- Intersection upgrades or modifications
- Provision of operational ancillary infrastructure including maintenance bays, new and upgraded drainage infrastructure, signage and lighting, retaining walls, noise barriers, flood mitigation basin, utility works and landscaping.

1.3.3 Construction overview

A conceptual construction methodology has been developed based on the preliminary project design to be used as a basis for the environmental assessment process. Detailed construction planning, including programming, work methodologies, staging and work sequencing would be undertaken once construction contractor(s) have been engaged.

1.3.3.1 Timing and work phases

Construction of the project would involve four main phases of work. The indicative construction activities within each phase are outlined below.

Table 1-3 Construction work phases

Phase	Indicative construction activities
Enabling works	▪ Construction of the temporary active transport link ▪ Modification of various road intersections to facilitate main construction works.
Site establishment	▪ Installing site fencing, hoarding and signage ▪ Establishing construction compounds, work areas and site access routes.
Main construction works	▪ Clearing/ trimming of vegetation ▪ Removal (or partial removal) of a number of buildings and other existing infrastructure eg concrete hardstand areas, drainage infrastructure, sheds, advertising structures, containers, etc ▪ Roadworks, including bridge and viaduct construction and drainage works ▪ Utility works.
Finishing works	▪ Erecting lighting, signage and street furniture, landscaping works and site demobilisation and rehabilitation in all areas.

Specific construction issues which will require careful planning and management and close co-ordination with relevant stakeholders include:

- Works within the prescribed airspace of Sydney Airport
- Works interfacing with the Botany Rail Line
- Piling in the vicinity of the T8 Airport and South line underground rail tunnels
- Works within the former Tempe landfill and Alexandra Canal which are subject to remediation orders and specific management plans
- Excavation, storage and handling of contaminated soils generally within the project site and contaminated groundwater from the Botany Sands aquifer.

Construction is planned to start in mid 2020, subject to approval of the project, and is expected to take about three and a half years to complete. Further information on construction is provided in Chapter 8 (Construction) of the EIS.

The project would include work undertaken during recommended standard hours as defined by the *Interim Construction Noise Guideline* (DECC, 2009):

- Monday to Friday: 7am to 6pm
- Saturday: 8am to 1pm
- Sundays and public holidays: no work.

It would also include work outside these hours (out-of-hours work) to minimise the potential for aviation and rail safety hazards.

1.3.3.2 Construction footprint

The land required to construct the project (the construction footprint) is shown on Figure 1-2. The construction footprint includes the land needed to construct the proposed roadways, bridges and ancillary infrastructure and land required for the proposed construction compounds. Utility works to support the project would generally occur within the construction footprint; however, some works (such as connections to existing infrastructure) may be required outside the footprint.

1.3.3.3 Compounds, access and resources

Construction would be supported by five construction compounds located to support the main construction works (shown on Figure 1-2). Construction compounds would include site offices, staff amenities, storage and laydown areas, workshops and workforce parking areas.

Materials would be transported to and from work areas via construction haul routes, which have been selected to convey vehicles directly to the nearest arterial road.

The construction workforce requirements would vary over the construction period based the activities underway and the number of active work areas. The workforce is expected to peak at about 1,000 workers for a period of about 13 months, indicatively from the fourth quarter of 2021. Either side of this peak, workforce numbers are expected to reduce to about two thirds.

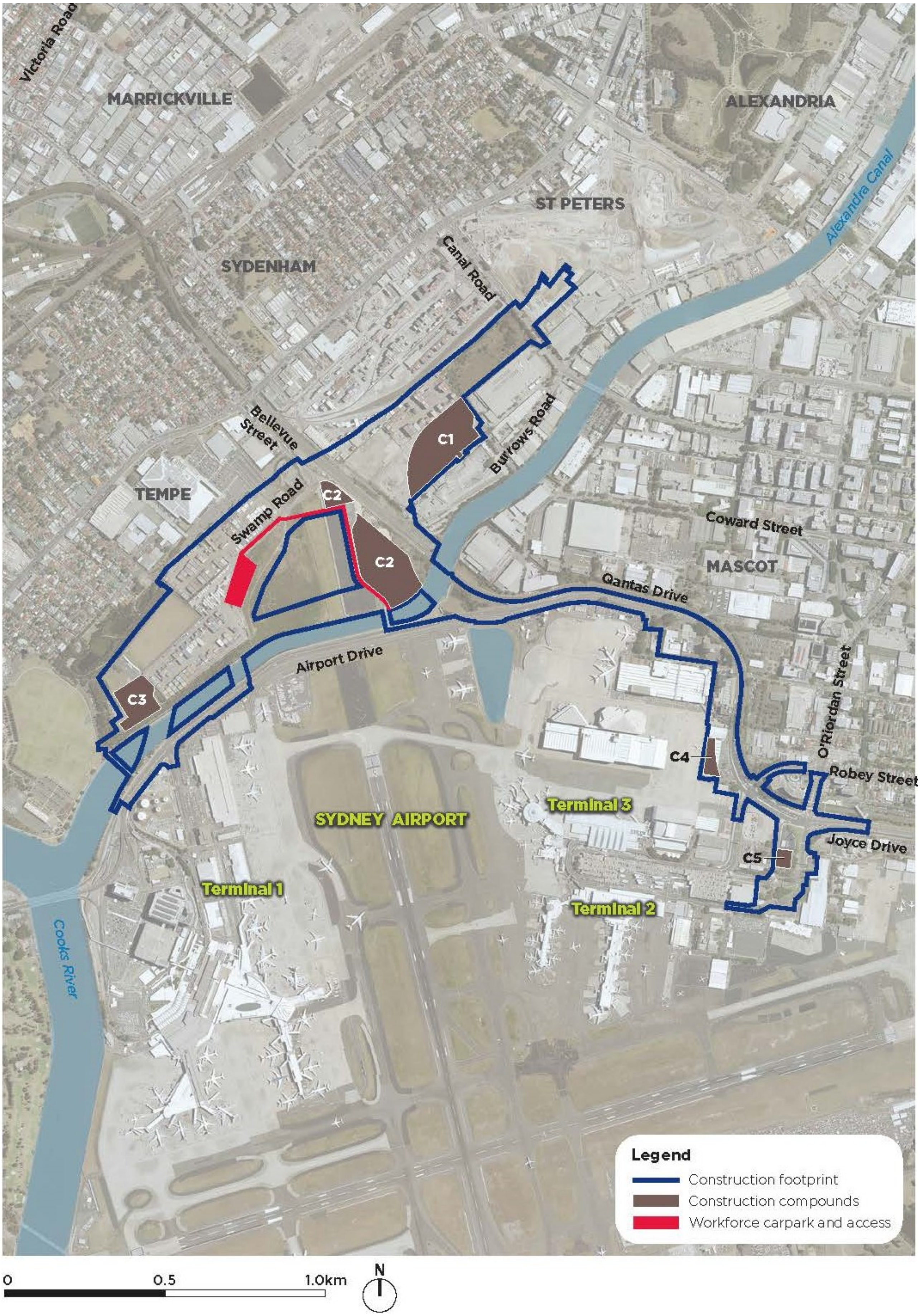

Figure 1-2 Construction footprint and facilities

1.4 Structure of this report

This report is structured as follows:

- **Section 1 – Introduction –** Provides an overview of the project
- **Section 2 – Legislative and policy context** – Describes the legislative framework governing the assessment of water quality impacts in NSW, including on land owned by the Australian Government (Commonwealth land)
- **Section 3 – Methodology** – Describes the methods and assessment criteria adopted in this report to characterise and assess potential impacts on surface water quality
- **Section 4 – Existing environment** – Describes the existing surface water environment including catchment characteristics, groundwater, geomorphology, climate, water quality conditions and sensitive receptors
- **Section 5 – Assessment of construction impacts** – Identifies and assesses potential water quality impacts from construction of the project
- **Section 6 – Assessment of operational impacts** – Identifies and assesses potential water quality impacts from operation of the project
- **Section 7 – Cumulative impacts** – Details combined impacts from construction and operation of the project as well as other infrastructure projects occurring in the surrounding area
- **Section 8 – Recommended mitigation measures and monitoring program** – Details recommended mitigation and management measures to reduce water quality impacts and, where possible, the anticipated effect of nominated mitigation measures on reducing impacts. Includes a proposed monitoring program to assess the emergence of impacts
- **Section 9 – Conclusion** – Overview of the key findings of the report.

2. Legislative and policy context

2.1 Commonwealth legislation

2.1.1 Airports Act 1996 and associated legislation

The project site includes areas of Commonwealth-owned land leased by Sydney Airport Corporation. The *Airports Act 1996* (the Airports Act) and associated regulations provide the assessment and approval process for development on Commonwealth-owned land for the operation of Sydney Airport.

Section 70 of the Airports Act requires there to be a final master plan for the airport that has been approved by the Australian Minister for Infrastructure and Transport.

Part 5 of the Act also requires that each airport develop an environment strategy which is included in its master plan. Once approved, Sydney Airport and all persons who carry out activities at the airport are obliged to take all reasonable steps to ensure compliance with the environment strategy.

Section 89 of the Airports Act specifies types of development that constitute 'major airport development'. A major development plan (MDP), approved by the Australian Minister for Infrastructure and Transport, is required before major airport development can be undertaken at a leased airport.

The consistency of this project with the Airports Act and associated master plan and environment strategy is discussed in section 5.4 and section 6.7 of this report.

2.1.2 Airports (Environment Protection) Regulations 1997

The objective of the Airports (Environment Protection) Regulations 1997 (the regulations) is to establish a system of regulation for activities at airports that generate or have potential to generate pollution or excessive noise. The regulations impose a general duty to prevent or minimise environmental pollution and have as one of their objects the promotion of improved environmental management practices at Commonwealth-leased airports. The regulations contain detailed provisions setting out:

- Definitions, acceptable limits and objectives for air, water and soil pollution, and offensive noise
- General duties to prevent or minimise pollution, preserve significant habitat and cultural areas, and prevent offensive noise
- Monitoring and reporting requirements for existing pollution.

Part 2 of the regulations defines pollution in relation to air (including odour), water, soil and offensive noise. Schedule 2 of the regulations provide the acceptable limits of pollutants toxicants (see Appendix A). These regulations, in conjunction with other national environment protection measures, provide the system of environmental regulation at airports.

The limits for marine waters provided in Schedule 2 are shown in Appendix A.

2.1.3 Sydney Airport Master Plan 2039

As part of the planning framework established by the Airports Act, airport operators are required to prepare a master plan for the coordinated development of their airport. Sydney Airport Master Plan 2039 (Master Plan 2039) outlines the strategic direction for Sydney Airport's operations and development over the next 20 years. It acknowledges that the continued growth of Sydney Airport is vital to achieving local, state and national employment, tourism and development objectives. In accordance with the requirements of the Airports Act, Master Plan 2039:

- Establishes the strategic direction for efficient and economic development at Sydney Airport over the planning period
- Provides for the development of additional uses of the Sydney Airport site
- Indicates to the public the intended uses of the Sydney Airport site
- Reduces potential conflicts between uses of the Sydney Airport site and the areas surrounding the airport
- Ensures that operations at Sydney Airport are undertaken in accordance with relevant environmental legislation and standards
- Establishes a framework for assessing compliance with relevant environmental legislation and standards
- Promotes continual improvement of environmental management at Sydney Airport.

Master Plan 2039 outlines Sydney Airport Corporation's plan for the operation and development of Sydney Airport for the period to 2033. The plan acknowledges that various activities on the airport have the potential to impact on water quality such as spills, construction activities, maintenance activities and hazardous material storage.

The Master Plan 2039 identifies that Sydney Airport Corporation is responsible for ensuring that stormwater quality is adequately addressed in the construction and operational phases of development proposals. The Master Plan outlines Sydney Airport Corporation's plan to continue to develop, implement and review management plans including the Stormwater Quality Management Plan and Wetland Management Plan to continually improve environmental performance at the airport.

2.1.4 Sydney Airport Environment Strategy 2019–2024

The Airports Act requires that airport operators provide an assessment of the environmental issues associated with implementing the airport master plan and a plan for dealing with those issues. This is documented in an environment strategy that forms part of an airport's master plan. The Sydney Airport Environment Strategy 2019–2024 (the Environment Strategy), which forms part of Master Plan 2039, provides strategic direction for the environmental performance and management of Sydney Airport for the five-year period between 2019 and 2024.

The purpose of the Environment Strategy is to:

- Establish a framework for assessing compliance and ensuring that all operations at Sydney Airport are undertaken in accordance with relevant environmental legislation and standards
- Promote the continual improvement of environmental management and performance at Sydney Airport and build on the achievements and goals of previous strategies
- Realise improvements in environmental sustainability, by minimising Sydney Airport's environmental footprint and working towards a more efficient and resilient airport.

The Environmental strategy identifies environmentally significant areas. Although acknowledging that the natural environment at the airport has been altered significantly since 1920, there are still areas of important heritage and biodiversity. This includes the Sydney Airport Wetlands which incorporate Engine Ponds East and West, Mill Pond and Mill Stream.

The following key actions/initiatives in the Environment Strategy are relevant to water quality and protecting the environmentally significant areas:

- Identify water quality improvement projects for waterways surrounding Sydney Airport and proactively seek out partnership opportunities to implement feasible projects
- Develop and implement a guideline for introducing water sensitive urban design and rainwater harvesting into new developments within the airport site as appropriate
- Incorporate design features in new developments to reduce contaminant loads in stormwater and to align with catchment water quality objectives
- Continue to ensure that stormwater quality is considered for the construction and operational phases of development proposals
- Continue to implement the initiatives contained in the Sydney Airport Stormwater Quality Management Plan, including continuation of regular stormwater quality sampling
- Continue to implement the Sydney Airport Wetlands Management Plan and Wetlands Enhancement Program.

The Environment Strategy identified that the key indicator of whether these initiatives and actions are being achieved is a continuation, or improvement, in the results of water quality monitoring of stormwater from the airport.

2.1.5 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is administered by the Australian Department of the Environment and Energy and provides a legal framework to protect and manage nationally important flora, fauna, ecological communities and heritage places defined as 'matters of national environmental significance' (MNES).

Under the EPBC Act, proposed actions (i.e. activities or projects) with the potential to significantly impact matters protected by the EPBC Act must be referred to the Australian Minister for the Environment to determine whether they are controlled actions, requiring approval from the Minister. The following matters are defined as protected matters by Part 3 of the EPBC Act:

- Matters of national environmental significance
- The environment of Commonwealth land
- The environment in general, if proposed actions are being carried out by an Australian Government agency.

As part of the assessment of the preliminary draft MDP, DITCARD will, on behalf of the Minister for Infrastructure, Transport and Regional Development, seek advice from the Australian Minister for the Environment under section 160(1) of the EPBC Act.

There is potential for the project to impact on the environment of Commonwealth land. Impacts could include a reduction in aquatic ecological diversity, disturbance of contaminated sediments, changes to drainage patterns and measurable reduction in water quality. With the implementation of appropriate mitigation measures to maintain or minimise impact to water quality there should not be a significant impact.

2.2 National strategies

2.2.1 National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS) aims to protect the nation's water resources by providing guidance on improving water quality while supporting the businesses, industry, environment and communities that depend on water for their continued development. The main policy objective of the NWQMS is to achieve sustainable use of water resources, by protecting and enhancing their quality, while maintaining economic and social development.

The NWQMS includes water quality guidelines that define desirable ranges and maximum levels for certain parameters (based on scientific evidence and judgement) for specific uses of waters or for protection of specific values. They are generally set at a low level of contamination to offer long-term protection of environmental values. The NWQMS water quality guidelines include the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) and the Australian Drinking Water Guidelines (NHMRC 2011).

2.2.2 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) (ANZECC (2000)) were prepared as part of the NWQMS. The guidelines provide a process for developing water quality objectives required to sustain current or likely future environmental values for natural and semi-natural water resources.

The ANZECC (2000) guidelines use a number of terms to refer to levels of assessment for water quality:

- **Environmental values** – particular values or uses of the environment that are important for a healthy ecosystem or for public benefit, and which require protection. They include values or uses such as aquatic ecosystems, primary and secondary contact activities, drinking water and aquatic food
- **Water quality guidelines** – A water quality guideline is a numerical concentration limit or narrative statement recommended to support and maintain a designated water use or environmental value
- **Water quality objectives** – A water quality guideline is defined above as a numerical concentration limit or descriptive statement recommended for the support and maintenance of a designated water use or environmental value. Water quality objectives take this a step further. They are the specific water quality targets agreed between stakeholders, or set by local jurisdictions, that become the indicators of management performance. For this project these objectives were defined by the NSW Water Quality and River Flow Objectives (DECCW, 2006) described in section 3.4
- **Guideline trigger values** – The ANZECC (2000) guidelines adopt a risk-based approach that is intended to improve the application of guidelines to all Australian and New Zealand aquatic environments. It uses decision frameworks (particularly for the protection of aquatic ecosystems) that help users tailor water quality guidelines to local environmental conditions. As such, the old 'single number' triggers (see ANZECC 1992) are regarded as guideline trigger values that can be modified into regional, local or site-specific guidelines

  Guideline trigger values are concentrations that, if exceeded, would indicate a potential environmental problem, and so 'trigger' a management response, eg further investigation and changes to site practices and controls in response to exceedances. Subsequent refinement of the guideline trigger values according to local conditions may be required.

The ANZECC (2000) guidelines acknowledge that different levels of protection may be appropriate for different water bodies. For aquatic ecosystems, the ANZECC (2000) guidelines provide more detailed guidance on the level of protection to be achieved by the selected water quality guidelines. For aquatic ecosystems, three categories of ecosystem condition are identified:

- High conservation or ecological value systems
- Slightly to moderately disturbed systems
- Highly disturbed systems.

It should be noted that in 2018, the ANZECC (2000) guidelines were revised to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) (ANZG (2018)). The updated guidelines are available at http://www.waterquality.gov.au/anz-guidelines. As at June 2019, the default guideline values for various toxicants in ANZG (2018) are the same as the ANZECC (2000) guidelines. Throughout this document, discussion of guideline trigger values and levels of protection are referenced to the ANZECC (2000) guidelines as the original source document for these parameters, noting that this should infer consistency with ANZG (2018) as at June 2019.

The environmental values and water quality guidelines, objectives or guideline trigger values adopted for the project are discussed further in section 3.4.

2.2.3 PFAS National Environmental Management Plan

Per- and poly-fluoroalkyl substances, also known as “PFAS”, are a group of manufactured chemicals that have been used since the 1950s in a range of common household products and specialty applications, including in the manufacture of non-stick cookware; fabric, furniture and carpet stain protection applications; food packaging; some industrial processes; and in some types of fire-fighting foams. There are many types of PFAS, with the best known examples being perfluorooctane sulfonate, known as “PFOS”, perfluorooctanoic acid, known as “PFOA”, and perfluorohexane sulfonate, known as “PFHxS”.

Because these chemicals have been used for decades, PFAS are found widely in the land and water environments around the world. People are exposed to small amounts of PFAS in everyday life through exposure to dust, indoor and outdoor air, food, water and contact with consumer products that contain these chemicals. For most people food is thought to be the primary source of exposure[1].

More recently, PFAS have been found to have contaminated sites where there has been historic use of fire-fighting foams that contained PFAS. Over time, these chemicals have worked their way through the soil to contaminate surface and groundwater, and have migrated into adjoining land areas. The release of PFAS into the environment is an emerging concern, because these chemicals are highly persistent, have been shown to be toxic to fish and some animals, and can accumulate in the bodies of fish, animals and people who come into contact with them. However, there is currently no consistent evidence that exposure to PFAS causes adverse human health effects[2].

The Heads of EPA of Australia and New Zealand (HEPA) PFAS National Environmental Management Plan 2018 (PFAS NEMP) provides governments with a consistent, practical, risk-based framework for the environmental regulation of PFAS contaminated materials and sites. The PFAS NEMP has been developed as an adaptive plan, able to respond to emerging research and knowledge.

The PFAS NEMP is a reference on the state of knowledge related to the environmental regulation of PFAS. It represents a how-to guide for the investigation and management of PFAS contamination and waste management, including recommended approaches, which will be called upon to inform actions by the EPA and other regulators.

With respect to assessing site investigation results, health and ecological criteria suitable for generic land uses have been provided in Table 1 to Table 5 of the PFAS NEMP. The soil criteria for a commercial/industrial land use in Table 2 and Table 3 has been considered for the project.

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[1] *enHealth Guidance Statements on Perfluorinated Chemicals*
[2] *https://www.health.gov.au/internet/main/publishing.nsf/Content/ohp-pfas.htm*

A conservative target of 95% protection of marine water ecosystems will be adopted in this assessment for chemicals that bioaccumulate in wildlife. The Stockholm Convention scientific body, the Persistent Organic Pollutants Review Committee has concluded that PFHxS meets the screening criteria for persistence and bioaccumulation. As a precautionary approach, the 95% protection of marine water ecosystems will be adopted as the criteria for all PFAS compounds in this assessment.

2.3 State legislation and guidelines

2.3.1 Environmental Planning and Assessment Act 1979

Parts of the project in NSW jurisdiction are declared State significant infrastructure. State significant infrastructure is regulated under the EP&A Act and requires proponents to apply to the NSW Minister of Planning for approval, supported by an EIS.

2.3.2 Protection of the Environment Operations Act 1997 (NSW)

The *Protection of the Environment Operations Act 1997* (POEO Act) regulates air, noise, land and water pollution. Under the POEO Act, activities likely to generate pollution require Environment Protection Licences (EPLs) detailing authorised activities as well as controls in place to mitigate impacts. The EPA is typically responsible for implementing the POEO Act.

Section 120 of the act is the prohibition of pollution of waters. A person who pollutes any waters is guilty of an offence.

2.3.3 NSW Contaminated Land Management Act 1997

Alexandra Canal is subject to a remediation order (No. 23004) under the *Contaminated Land Management Act 1997.* As disturbance of the canal sediments may impact the receiving waterways, the order regulates activities that could disturb contaminated sediments in the canal, citing:

The bed sediments at the site have been found to be contaminated … in such a way as to present a significant risk to harm human health and the environment.

The order requires any works or activities that would disturb canal sediments occur in accordance with a management plan approved by the EPA.

Disturbance of sediments in Alexandra Canal is therefore highly undesirable. Mitigation measures to minimise disturbance are discussed in section 8. The potential for sediment mobilisation in the Canal from new outlets and changes to existing outlets is discussed in section 6.2.

The former Tempe landfill was taken to be “significantly contaminated land” on 25 July 2000 under the *Contaminated Land Management Act* (No. 21005) and declared as a Remediation Site due to the findings that leachate generated by the buried waste was migrating from the landfill towards Alexandra Canal.

On 19 March 2003, Council entered into Voluntary Remediation Agreement (VRA) No. 26050 with the EPA to manage the environmental risks identified (NSW Environment Protection Authority, 2003). Further details regarding the VRA are provided in the Technical Working Paper 16 – Landfill Assessment.

2.3.4 NSW Water Quality and River Flow Objectives

For each catchment in NSW, the NSW Government has endorsed the community's environmental values for water, and identified water quality objectives. These were adopted following extensive consultation with the community in 1998. The NSW Water Quality and River Flow Objectives (DECCW, 2006) are the agreed environmental values and long-term goals for NSW's surface waters and are consistent with the national framework in the ANZECC (2000) guidelines. They set out:

- The community's values and uses for NSW rivers, creeks, estuaries and lakes (i.e. healthy aquatic life, water suitable for recreational activities like swimming and boating, and drinking water)
- A range of water quality indicators to help assess whether the current condition of waterways supports those values and uses.

The catchments affected by the project are Cooks River and Botany Bay (included as sub catchment of Georges River by DECCW). The NSW Water Quality and River Flow Objectives (DECCW, 2006) provide the environmental values and associated water quality objectives for these catchments. These values and objectives are discussed in section 3.4.

2.3.5 Managing Urban Stormwater – Soils and Construction

The Managing Urban Stormwater – Soils and Construction series of handbooks are an element of the NSW Government's urban stormwater program specifically applicable to the construction phase of developments. These provide guidance for managing uncontaminated soils in a manner that protects the health, ecology and amenity of urban streams, rivers estuaries and beaches through better management of stormwater quality.

The handbooks were produced to provide guidelines, principles and recommended minimum design standards for good management practice in erosion and sediment control during the construction of roads. Of particular relevance to the project are Volume 1, 4th Edition (Landcom, 2004) and Volume 2D, Main Road Construction (DECC, 2008) (collectively referred to as 'the Blue Book' in this report). The construction mitigation measures proposed in this report are largely based on the guidelines provided in the Blue Book.

For contaminated soils or acid sulfate soils, while the management principles are still relevant, additional site specific management measures, monitoring and treatments, which are not covered in the Blue Book, are required. An overview of requirements is provided in section 8. Detailed discussions of treatment requirements are in Technical Working Paper 5 – Contamination and Soils and Technical Working Paper 16 – Landfill Assessment.

2.3.6 NSW MUSIC Modelling Guidelines

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) estimates stormwater flows and pollution generation, and simulates the performance of single or multiple stormwater treatment measures that are typically connected in series to improve overall treatment performance. MUSIC estimates this performance over a continuous historical period rather than for discrete storm events. By simulating the performance of stormwater treatment measures, MUSIC is typically applied to conceptually evaluate whether a proposed treatment system would achieve stormwater flow and water quality targets.

The NSW MUSIC Modelling Guidelines (BMT WBM, 2015) show practitioners how to set up a MUSIC model for site layouts, considering the site characteristics, drainage configuration and the climatic region. The guidelines have recommended pollutant concentrations for various sources, such as roads, that should be used in the model. The guidelines have been followed for the MUSIC modelling carried out to inform this assessment.

2.4 Local guidelines

2.4.1 Botany Bay and Catchment Water Quality Improvement Plan 2011

The Sydney Metropolitan Catchment Management Authority (SMCMA) has developed the Botany Bay and Catchment Water Quality Improvement Plan. The main objective of the plan was to set targets for pollutant load reductions, in terms of total nitrogen (TN), total phosphorus (TP) and suspended sediment (TSS), required to protect the condition of Botany Bay, its estuaries and waterways. Pollutant reduction targets are set for large urban/industrial developments which are based on those defined for the Growth Centres Commission by DECC (2007). As no targets are set for road infrastructure developments, the targets for large urban/industrial developments have been adopted for this assessment. The target pollutant load reductions can be found in Table 3-3.

3. Methodology

3.1 Introduction

When designing, constructing and operating a new road project, it is important to protect waterways from pollutants (such as sediment or chemicals) that have the potential to enter local waterways as a result of the project.

As poor water quality has a negative impact on the health of our ecosystems, recreational activities and other activities, water quality guidelines (ANZECC (2000)) are used to guide water quality management. The guidelines identify different uses and activities for waterways (e.g. drinking, swimming, crop use) and appropriate water quality values for those uses and activities. They enable water management to be tailored to different waterway environmental conditions and different water uses, so that different waterways and catchments can be protected. Application of the ANZECC (2000) Guidelines is used to identify catchment and waterway-specific water quality management goals for different potential pollutants (trigger values).

To guide water quality management decisions, and to identify when an impact has occurred, the ANZECC (2000) Guidelines also identify methods for measuring and monitoring water quality. These are standard methods adopted across Australia.

For the Sydney Gateway road project, the assessment methodology followed the ANZECC (2000) Guidelines and used standard methods for impact assessment including:

- Review of existing data on the project area and its catchment to provide an understanding of existing environmental conditions, sensitive areas and constraints
- Identification and assessment of activities that could result in water quality impacts during construction and operation
- Identification of mitigation and management measures that would assist in achieving, or moving towards achieving, the desired water criteria
- Recommending an appropriate water quality monitoring strategy.

To identify specific environmental values for waterways in the Sydney Gateway road project area, a review of existing environmental conditions, water quality data and current users of the waterways was undertaken. This information was used to identify appropriate criteria (trigger values) for water quality impacts upstream and downstream of the project site during operation and construction.

Key steps in the ANZECC (2000) Guidelines used to assess potential water quality impacts for the Gateway road project are illustrated in Figure 3-1.

The purpose of this process is to understand the environment, inform project design, inform selection of suitable construction methods and ensure the project operates in a way that will protect the existing water quality environment.

This section describes:

- The review of existing information
- The development of assessment criteria
- The approach to water quality modelling
- Methods used to assess potential construction phase and operation phase impacts to water quality.

Figure 3-1 Key steps in water quality impact assessment – application of the ANZECC (2000) Guidelines

3.2 Review of existing information

Table 3-1 provides a summary of the key documents reviewed to inform an understanding of the existing surface water environment of the project. This included identification of environmental values, water quality objectives and development of site specific water quality objectives where required.

Specific information considered in the assessment included:

- The Secretary's Environmental Assessment Requirements (SEARs) – as outlined in section 1.2
- Sydney Airports Environmental Strategy 2019–2024
- Airports (Environment Protection) Regulations 1997
- ANZECC (2000) Guidelines
- PFAS National Environmental Management Plan
- Concept design drawings and construction methodology
- Previous studies prepared for the alignment and surrounding/connecting projects
- Existing hydrology/flooding, surface water quality, and groundwater monitoring data.

Table 3-1 Key data sources

Report reference	Report description	Project data collated
Sediment-Water Column Interactions in Alexandra Canal (University of Queensland, Centre for Marine Studies, 2002).	A review of the sediment mobilisation, and particle distribution within Alexandra Canal	Particle distribution within Alexandra Canal
Online rainfall database (Bureau of Meteorology, accessed July 2018).	Database of water, climate, and environmental data	Historical rainfall data
Sediment Investigation, Gateway, Alexandra Canal for Roads and Maritime (AECOM, 2018).	Data from sediment sampling within Alexandra Canal	Contaminant and particle distribution
WestConnex New M5 – Surface Water Technical Working Paper for EIS (AECOM, 2015).	Water quality data	Surface water quality results and project impact assessment
M4–M5 Link Environmental Impact Statement (AECOM, 2015).	EIS for the proposed tolled, multi-lane road link between M4 East at Haberfield and the New M5 at St Peters	Surface water quality results
WestConnex New M5 – Environmental Impact Statement (AECOM, 2017).	EIS for the new multi-lane twin motorway tunnels between the New M5 and St Peters, a new road interchange, and upgrade of local roads at St Peters to Mascot	Surface water quality results
Sydney Gateway – Monthly Baseline Surface Water Monitoring data (December 2017–March 2019) (AECOM, 2018–2019).	Excel data of all monitoring data over the entire baseline monitoring period	Surface water monitoring data at numerous locations in Alexandra Canal, Cooks River and Mill Stream
WestConnex New M5 project construction phase water quality data (AECOM, 2017).	1 year (August 2016 – July 2017) of construction phase water quality monitoring data	Water quality monitoring data
Sydney Gateway, State Significant Infrastructure Scoping Report (Roads and Maritime 2018).	Detailing the project and key environmental issues associated with the project	Key environmental issues

3.3 Assessment of impacts and mitigation effectiveness

3.3.1 Construction phase impact assessment

The construction phase impact assessment aims to identify potential water quality impacts based on current understanding of the likely construction approach and construction methods. Best management practice mitigation measures are then proposed to minimise, mitigate and manage identified potential impacts.

The construction phase impact assessment for this project addressed the following elements:

- Identification of potential water quality impacts during construction, including construction activities that could mobilise sediments into the surface water environment. It is recommended that controls be guided by the Blue Book requirements. Further details on this approach are provided in section 5
- The soils and groundwater within the project area are known to be impacted by various contaminants, including PFAS, associated with historical industrial land uses. Overarching construction related surface water impacts associated with the disturbance of contaminated soil, sediment and groundwater are discussed in this report. This includes the management of discharge of extracted groundwater and contaminated surface water. A detailed review is addressed in Technical Working Paper 5 – Contamination and Soils and Technical Working Paper 7 – Groundwater.

Key steps used to identify potential construction phase impacts are illustrated in Figure 3-2.

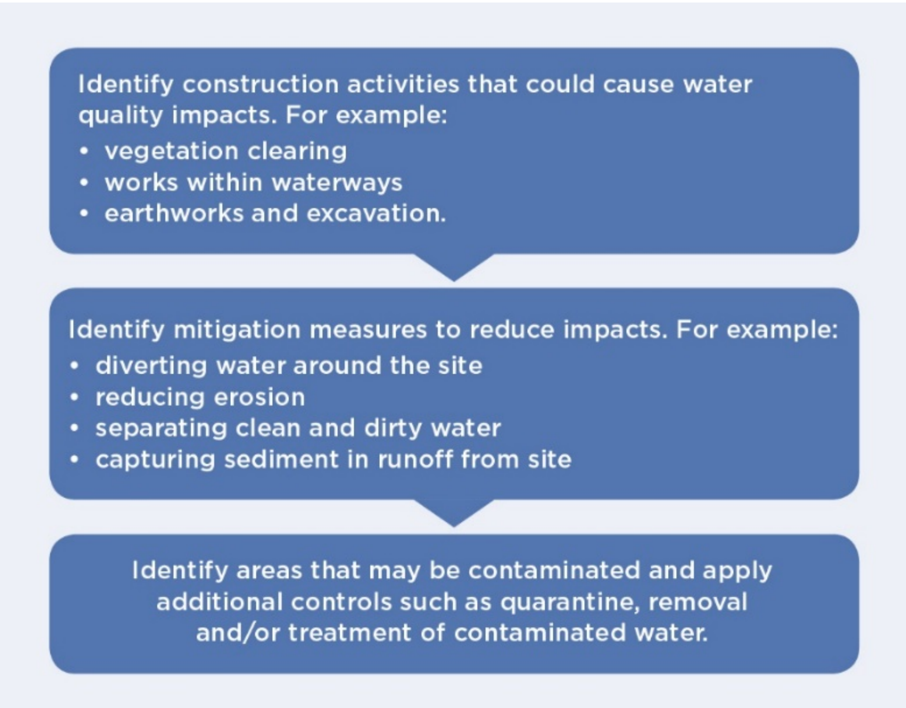


Figure 3-2 Construction phase impacts – assessment method

3.3.2 Operation phase impact assessment

To assess potential water quality impacts during operation of the completed project, the impact of changes in land use and drainage on stormwater pollutant loading and flow volumes discharging into the surrounding water environment, as a result of the operation of the project, are considered and modelled.

The key steps of operation phase impact assessment are illustrated in Figure 3-3 and Figure 3-4.

MUSIC modelling software was used to quantitatively assess:

- Existing and operational pollutant loads
- Operational pollutant loads with the inclusion of treatment devices
- Change in flow regime from existing to operational conditions, and the impact on the water catchment.

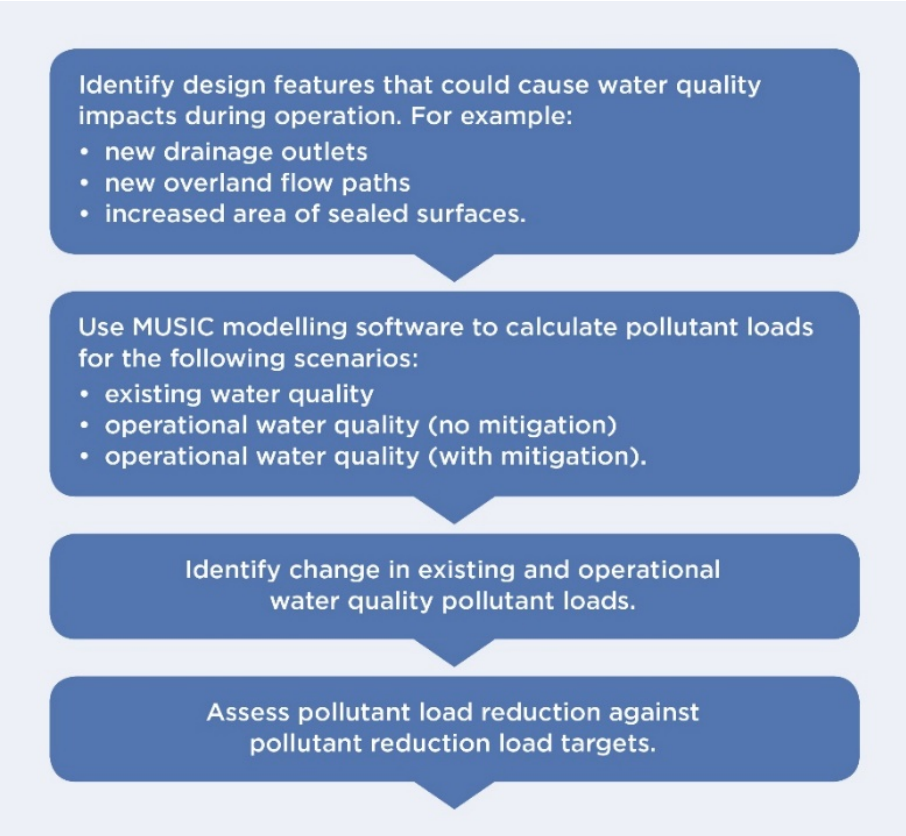


Figure 3-3 Operation phase impacts – assessment method for water quality

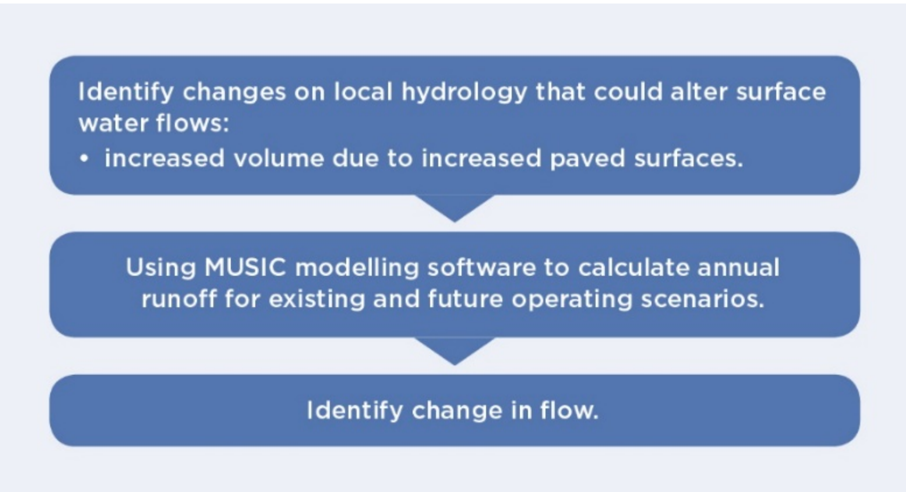


Figure 3-4 Operation phase impacts – assessment method for water flow

The use of MUSIC software to assess pollutant loadings impact is an industry standard approach, used in most environmental impact assessments across Australia. Further details on the approach are provided in Appendix C. The assessment parameters adopted were total suspended solids, total phosphorus and total nitrogen.

The potential geomorphic impacts of this project (such as changes in bed and bank stability) during operation were investigated, based on the findings of flood modelling. The potential for these impacts is discussed in section 6.5.

A qualitative cumulative impact assessment was undertaken, taking into account the Botany Rail Duplication and other major projects. These impacts are discussed in section 7.

Based on these assessments, this paper provides recommendations for mitigation measures during operation to minimise and manage potential impacts to waterways. These are detailed in section 8.

3.4 Assessment criteria

3.4.1 Overview

One of the key steps of impact assessment is to identify appropriate assessment criteria. By applying the legislative and policy frameworks described in section 2, assessment criteria were developed based on the following:

- ANZECC (2000) Guidelines (incorporated within the ANZG (2018) national framework) for assessing water quality
- NSW Water Quality and River Flow Objectives (DECCW, 2006) for catchments affected by this project (i.e. Botany Bay (Georges River) and Cooks River catchments); and
- Airports (Environment Protection) Regulations 1997 for waterways within Sydney Airport lands.

The NSW Water Quality and River Flow Objectives (DECCW, 2006) provide environmental values and associated water quality objectives. ANZECC guidelines and the Airports (Environment Protection) Regulations recommend contaminant trigger values for these environmental values. As explained in section 2.2.2, guideline trigger values are the criteria used for concentrations that, if exceeded, would indicate a potential environmental problem, and so ‘trigger’ a management response.

Setting trigger values for projects involving works in or near waterways generally involves the following process:

- Trigger values are first identified for long term aspirational goals for water quality, which tend to be the most stringent values based on all relevant environmental values
- The existing water quality in the waterways is then determined from monitoring data and the waterways are classified in accordance with the ANZECC (2000) guidelines
- As assessment is then made as to whether the long term aspirational goals are currently being met, and if not, whether the relevant activity would influence achieving them
- For temporary activities that won’t influence achieving long term aspirational goals, site specific trigger values that reflect the existing water quality rather than the long term goals are established that indicate whether a management response is required in relation to the activity. These trigger values may be different to the trigger values based on long term aspirational goals.

For this project, an overview of the process to establish the site specific trigger values and discharge criteria for the construction phase is set out in Table 3-2 below. The process establishes the following:

- Long term (or ‘default’) trigger values that would apply to the waterways. The most stringent trigger values are applied in this case to reflect the long term goals of improving water quality in the waterways. These values are used to understand the trigger values for the waterways that would apply in the long term to achieve the target environmental values, and how the existing water quality in the waterways compares against the long term goals

- Site specific trigger values for monitoring in the waterways during construction, and in the period after construction until the works areas are adequately stabilised. These trigger values are based on and protective of existing water quality conditions in the waterways
- Discharge criteria for water to be discharged from the site during construction that is subject to special management measures (e.g. groundwater from dewatering, or runoff from exposed contamination areas). The proposed criteria are based on the short term site specific trigger values but slightly more stringent values are adopted in some cases for substances that could result in longer term impacts (for example, toxicant that an bioaccumulate).

Further discussion and justification of this approach is provided in the following sections.

Table 3-2 Overview of process for establishing trigger values and discharge criteria

Assessment steps	Approach
1) Identify Environmental Values of the receiving waterways	Determined from a review of applicable legislation and guidelines
2) Identify the Water Quality Objectives for the receiving waterways and the default trigger values	Key references are ANZECC (2000) Guidelines, the NSW Water Quality and River Flow Objectives and the PFAS National Environmental Management Plan. The NSW Water Quality and River Flow Objectives outlines the environmental values (EVs) relevant for particular catchments. ANZECC (2000) Guidelines and the PFAS National Environmental Management Plan outline water quality objectives (WQOs) that are protective of the various EVs. For physical and chemical stressors: The most stringent WQO is adopted from all applicable EVs for each stressor. The resulting WQOs are adopted as the default trigger values. For toxicants (both non-bioaccumulative and bioaccumulative): The appropriate trigger values depend on the existing water quality in the waterway. These are determined at Step 3.
3) Establish existing water quality conditions in the waterways	Review monitoring data to determine existing water quality and assess existing condition against default trigger values determined at Step 2. For physical and chemical stressors: The existing water quality does not meet the default trigger values and the waterways are classified as 'highly disturbed'. For non-bioaccumulative toxicants: Given the 'highly disturbed' classification, an 80% protection level for species in marine waters is considered appropriate. For bioaccumulative toxicants: Given the 'highly disturbed' classification, a 95% protection level for species in marine waters is considered appropriate.
4) Establish the site specific trigger values in the waterway that are protective of existing water quality	These trigger values will apply during construction and after construction until the works areas are adequately stabilised. Given that EVs such as 'secondary / primary contact recreation' or 'aquatic food' will not apply in the short term due to the poor existing water quality, the more relevant ecological EVs are used to set these trigger values. For physical and chemical stressors: Use the least stringent of (1) the 80th percentile value from the monitoring data and (2) the default trigger value for aquatic ecosystems in marine waters. For non-bioaccumulative toxicants: Use the least stringent of (1) the 80th percentile value from the monitoring data and (2) the 80% level of protection for species in marine waters. For bioaccumulative toxicants: Use the least stringent of (1) the 80th percentile value from the monitoring data and (2) the 95% level of protection for species in marine waters.

Assessment steps	Approach
5) Establish discharge criteria for on-site water subject to special management measures	Discharge criteria are required to ensure that the quality of water managed during construction meets appropriate requirements prior to discharge to the receiving waterways. This applies to temporary discharges of contaminated water sources such as extracted groundwater and runoff from disturbed contaminated areas. It does not apply to runoff from typical disturbed areas which would be managed using standard Blue Book erosion and sedimentation controls. For physical and chemical stressors: Use the least stringent of (1) the 80th percentile value from the monitoring data and (2) the default trigger value for aquatic ecosystems in marine waters (as above for Step 4). For non-bioaccumulative toxicants: Use the least stringent of (1) the 80th percentile value from the monitoring data and (2) the 80% level of protection for species in marine waters (as above for Step 4). For bioaccumulative toxicants: Use the 95% level of protection for species in marine waters (this is a more stringent requirement to the above Step 4 to ensure that these particular toxicants are controlled to a higher standard in discharged water).

The surface water pollutant reduction targets identified in the Botany Bay and Catchment Water Quality Improvement Plan (2011) are applied to new developments to reduce impacts on the receiving waterways with the long-term goal of improving the waterways. These targets have been adopted as preferred targets in the operational impact assessment for the project.

3.4.2 Environmental values

Water quality objectives for a catchment depend on the environmental values within the catchment. The majority of the project site is located in the Cooks River catchment. A small portion at the eastern end of the project site drains to Botany Bay, which is located in the Georges River catchment (Figure 3-5).

Specific values for different catchment types are defined by the NSW Water Quality and River Flow Objectives (DECCW, 2006). Figure 3-5 indicates that most of the site is within an estuary type catchment zone. The specific environmental values for this zone are discussed in the following sections.

3.4.2.1 Cooks River catchment

The following environmental values are defined by NSW Water Quality and River Flow Objectives for the Cooks River estuaries waterways:

- Aquatic ecosystems
- Visual amenity
- Secondary contact recreation
- Primary contact recreation; and
- Aquatic food.

The Cooks River is popular for fishing and boating. Currently no fishing is permitted in Alexandra Canal, and only rod and line fishing is permitted in the Cooks River (DPI, 2019). While the consumption of fish or shellfish caught in the Cooks River is not recommended, the ‘aquatic food’ environmental value is identified because the goal is to return the water to this quality in the future. For the same reason, the ‘primary contact recreation’ value is also included, although swimming is not currently recommended.

Analysis of water quality monitoring data (see section 4.7) shows that aquatic ecosystems in Alexandra Canal (within the Cooks River catchment, which receives the majority of the project area discharge) are currently ‘highly disturbed’. Therefore, the goal is to bring these ecosystems back to a less disturbed condition. The relevant water quality objectives for each of the relevant environmental values are the appropriate long term aspirational goals for this catchment. The long term aspirational goals for water quality are not, however, currently being achieved in the catchment. The proposal would be temporary and would not influence achieving the long term aspirational goals.

The trigger values provided in Schedule 2 of the Airports (Environment Protection) Regulations 1997 were also considered to use as part of the assessment criteria for the Alexandra Canal and Cooks River because the eastern portion of the catchment along Qantas Drive between Alexandra Canal and Joyce Drive, drains through the airport site's drainage systems to Alexandra Canal. However, due to the ultimate destination of surface water runoff, the ANZECC (2000) trigger values are more appropriate for Alexandra Canal.

3.4.2.2 Georges River catchment

A small area within the project site near the intersection of Sir Reginald Ansett Drive and Keith Smith Drive drains to Mill Stream via the airport stormwater system. As Mill Stream drains to Botany Bay it is considered to be part of the Georges River catchment. The reach into which stormwater from the project area discharges is estuarine. For this reason, the environmental values for estuaries in the Georges River catchment were adopted for Mill Stream waterways. These are:

- Aquatic ecosystems
- Visual amenity
- Secondary contact recreation
- Primary contact recreation; and
- Aquatic food.

The reach of Mill Stream that will receive discharge from the project area is a concrete lined channel, and therefore can be classified as 'highly disturbed'. The water quality objectives each of the relevant environmental values are the appropriate long term aspirational goals for this catchment. The long term aspirational goals for water quality are not, however, currently being achieved in the catchment. The proposal would be temporary and would not influence achieving the long term aspirational goals.

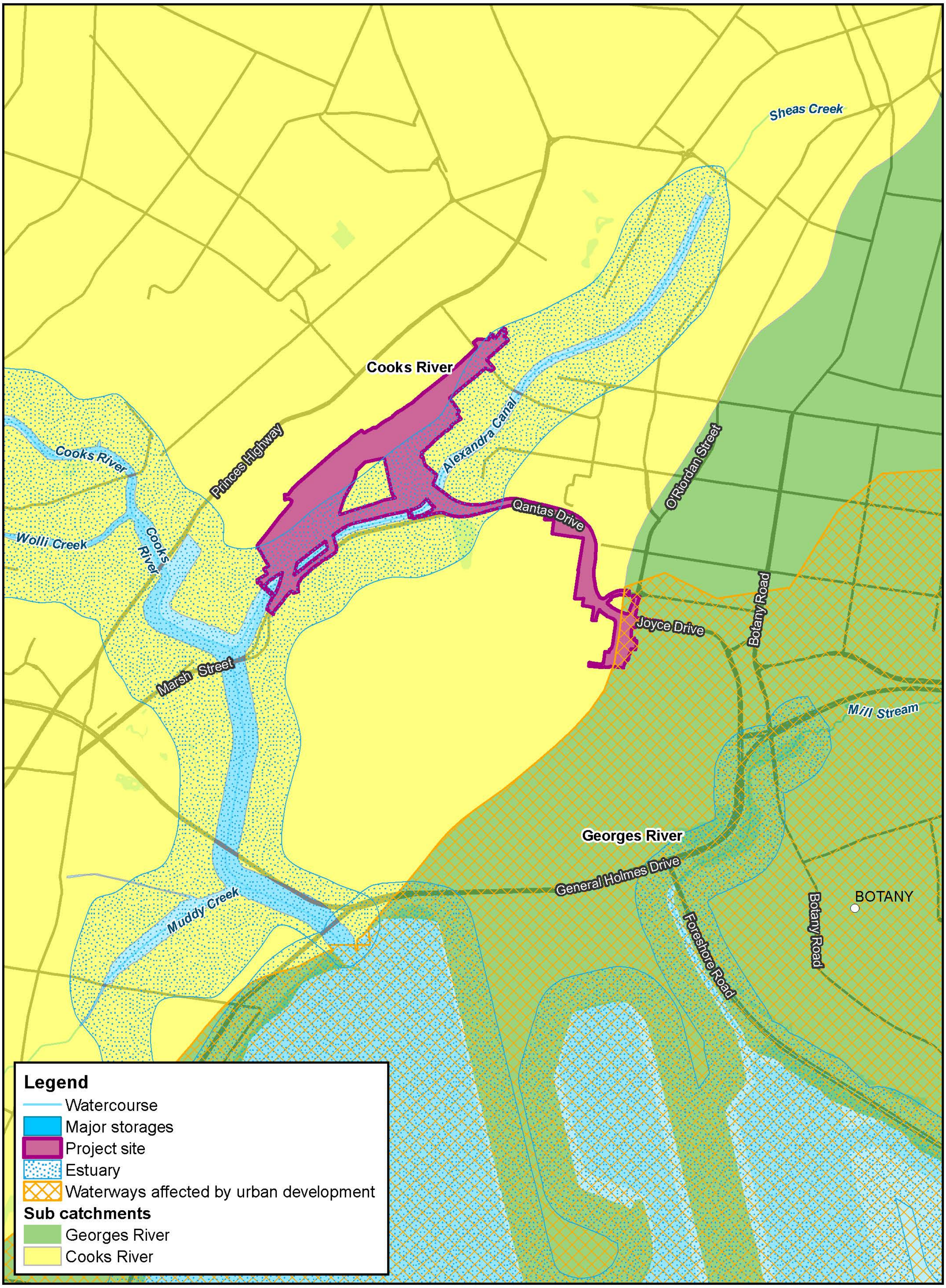
Discharge from the project to Mill Stream is within Commonwealth land (see Figure 4-2). The water quality conditions in Mill Stream were assessed using two sets of trigger values:

- Limits of accepted contamination specified in Schedule 2 of the Airport (Environmental Protection) Regulations 1997; and
- ANZECC (2000) guidelines.

These two sets of trigger values contain different pollutants indicators. For those indicators that are common to both, the ANZECC (2000) guidelines trigger values are usually higher for nutrients and lower for toxicants. For some indicators, such as pH, the ANZECC (2000) guidelines provide an absolute range of values while the Airport (Environment Protection) Regulations 1997 provide a maximum percentage deviation from existing values.

Because Mill Stream is on Commonwealth Land, the Airport (Environment Protection) Regulations 1997 guidelines are appropriate for assessment. However, because Mill Stream flows to NSW waterways (Botany Bay), the ANZECC (2000) guidelines are useful to understand potential impacts. The adopted approach to assess the state of the waterway is to review Mill Stream water quality data against the trigger values from both guidelines.

In addition, the management of water quality on Commonwealth land would need to be consistent with the Sydney Airport Environmental Strategy 2019–2024. The key performance indicator which is adopted in the Sydney Airport Environmental Strategy 2019–2024 and relevant to surface water quality is that water quality monitoring results for stormwater from the airport stay the same or improve.



0 250 500 Metres

Figure 3-5

Major sub-catchments of Botany Bay

Author: Jeong Greaves
Date: 2019-04-17
Map no: PS109315_GIS_263_A2

3.4.3 Water quality objectives and default trigger values

Water quality trigger values are the criteria used to identify if there is a potential environmental problem in the waterway. If the water quality concentration is outside the allowable range/value for a particular environmental value, there is potential risk to that environmental value.

There are two types of contaminants classified in ANZECC (2000): physical and chemical stressors and toxicants. The method for defining the default trigger values is different for each:

- Physical and chemical stressors (section 3.3 of ANZECC (2000)):
  - Naturally occurring physical and chemical stressors (e.g. nutrients and pH) can cause serious degradation of aquatic ecosystems when ambient values are too high or too low
  - The default trigger values for physical and chemical stressors are based on ANZECC (2000) guideline trigger values
- Toxicants (section 3.4 of ANZECC (2000)):
  - Chemical contaminants that have the potential to exert toxic effects at concentrations that might be encountered in the environment
  - The trigger values for toxicants depend on the level of protection required. As the relevant waterways are highly disturbed ecosystems, the protection levels for 80% of species in marine waters for non-bioaccumulative toxicants are considered applicable to Alexandra Canal and Mill Stream
  - For bioaccumulative toxicants, based on the precautionary principle, the more stringent protection levels for 95% of species in marine waters are considered appropriate. Bioaccumulative toxicants include PFAS, polychlorinated biphenyls (PCBs), some pesticides, lead, cadmium, mercury, dioxins, furans, benzo(a)pyrene, hexachlorobenzene and chlorobenzenes.

PFAS is not in the list of toxicants in ANZECC (2000). The PFAS NEMP (Heads of Environmental Protection Authorities Australia and New Zealand, 2018) has been used to provide trigger values for PFAS.

The default trigger values for physical and chemical stressors and toxicants for each of the relevant environmental values are provided in Appendix A. These default trigger values are recommended for the evaluation of water quality conditions in the existing environment against long term water quality goals.

Although Mill Stream ultimately discharges into Botany Bay, which is part of the Georges River catchment, it is within Sydney Airport land. The acceptable limits for water pollution set out in the Airports (Environment Protection) Regulations 1997 therefore need to be considered. For Mill Stream both the Airports (Environment Protection) Regulations 1997 and ANZECC (2000) guidelines will be adopted for the assessment of existing water quality conditions (see Appendix A). This will involve reviewing the existing water quality data against both sets of criteria, the purpose being to identify if the existing conditions achieve both assessment criteria.

The default trigger values in Appendix A consider all the environmental values in order to gain an understanding of how closely the existing conditions align with the long term water quality goals.

3.4.4 Site specific trigger values protecting existing water quality and associated monitoring of waterways

This section establishes site specific trigger values that would be applied for short term monitoring of the waterways during construction, and in the period after construction until such time as the works areas are adequately stabilised, to ensure that construction of the project maintains the existing water quality in the waterways.

A number of contaminants (see section 4.7), including physical and chemical stressors and toxicants, currently exceed the default trigger values (water quality objectives) in Appendix A for various environmental values and the waterways are classified as 'highly disturbed'. The environmental values of secondary and primary contact recreation and aquatic foods are not currently recommended by authorities as uses of the waterways due to the existing water quality. For the purposes of managing potential short term impacts on the waterways, the environmental values of secondary and primary contact recreation and aquatic foods can therefore be disregarded and the primary environmental value is considered to be aquatic ecosystems.

It is therefore considered appropriate to develop site specific trigger values that are protective of the environmental value 'aquatic ecosystems' and that recognise the highly disturbed nature of the aquatic ecosystems and existing water quality. The following site specific trigger values are proposed:

- For physical and chemical stressors: Use the least stringent of (1) the 80th percentile value from the monitoring data and (2) the default trigger value for aquatic ecosystems in marine waters
- For non-bioaccumulative toxicants: Use the least stringent of (1) the 80th percentile value from the monitoring data and (2) the 80% level of protection for species in marine waters
- For bioaccumulative toxicants: Use the least stringent of (1) the 80th percentile value from the monitoring data and (2) the 95% level of protection for species in marine waters.

For this project the 80th percentile values are determined from the most downstream monitoring stations from works area, which are SW6 for Alexandra Canal and SW8 for Cooks River. The short term site specific trigger values are presented in Table B-1 of Appendix B. For Mill Stream, the default trigger values from Appendix A are repeated in Table B-1 due to the limited water quality monitoring data available for this waterway, however, refined short term site specific trigger values for this waterway should be determined as more monitoring data is collected. The trigger values in Table B-1 are indicative at this stage and should be refined prior to construction when further monitoring data is available.

3.4.5 Discharge criteria

Surface water would be collected and groundwater would be extracted (construction water) during construction of the project. Discharging construction water to the Alexandra Canal or Mill Stream, either directly or via stormwater systems, would not cause environmental degradation or pollution if it is of suitable quality relative to existing water quality.

Construction water from potentially contaminated sources tested in situ against suitable water quality criteria prior to discharge. The proposed water quality discharge criteria are as follows:

- For physical and chemical stressors: Use the least stringent of (1) the 80th percentile value from the monitoring data and (2) the default trigger value for aquatic ecosystems in marine waters
- For non-bioaccumulative toxicants: Use the least stringent of (1) the 80th percentile value from the monitoring data and (2) the 80% level of protection for species in marine waters
- For bioaccumulative toxicants: Use the 95% level of protection for species in marine waters.

Indicative discharge criteria are presented in Table B-2 of Appendix B. Criteria are only provided for Alexandra Canal as this waterway is likely to receive the majority of the temporary discharges during construction. Appropriate discharge criteria for Mill Stream would need to be developed from future monitoring of existing water quality within this waterway.

The discharge criteria proposed in this document are based on the results of water quality monitoring available at the time this assessment was carried out. Water quality monitoring is ongoing. Discharge criteria adopted for construction would be based on water quality monitoring data at the time (based on sampling over periods of more than 12 months at each location) and would be selected based on the methodology presented above. The EPA would be responsible for determining discharge criteria and therefore the discharge criteria adopted for construction may, therefore, differ from the values presented in this assessment.

3.4.6 Pollutant reduction targets

The Botany Bay and Catchment Water Quality Improvement Plan developed by SMCMA sets stormwater pollutant load reductions targets for total suspended solids, total nitrogen and total phosphorus to protect estuaries and waterways within the Botany Bay catchment (Table 3-3).

Achieving these pollutant reduction targets is expected to lead to cleaner waterways and healthier environments in the catchment, and will increase the community's ability to use Botany Bay and its estuaries and rivers (SMCMA, 2011).

Table 3-3 Pollutant reduction targets for Botany Bay catchment (SMCMA, 2011)

Stormwater pollutant	Greenfield/large developments
Gross pollutants	90%
Total suspended solids	85%
Total phosphorus	60%
Total nitrogen	45%

4. Existing environment

4.1 Catchment and waterway overview

The project site is located within the lower reaches of the Cooks River and local Botany Bay catchments, which are both sub-catchments of the regional Botany Bay catchment (Sydney Metropolitan Catchment Management Authority, 2011). The regional Botany Bay catchment covers about 1,165 square kilometres and contains the sub-catchments of Georges River, Woronora River, Cooks River and the local catchment around Botany Bay which extends north towards the suburb of Randwick. Most of the project site drains to Alexandra Canal, a sub-catchment of the Cooks River, and a small portion of the project site near the intersection of Sir Reginald Ansett Drive and Keith Smith Drive drains to Mill Stream via the airport stormwater system. Mill Stream is part of the local sub-catchment that drains to Botany Bay.

Figure 4-1 shows the surface water features near and within the project site including Alexandra Canal, Mill Stream and Botany Bay to the south-east. The mouth of the Cooks River is located to the south of the project. The figure indicates that Alexandra Canal and Cooks River are contained in the Cooks River catchment and Mill Stream is contained in the Botany Bay local sub-catchment. It indicates that a portion of Mill Stream is located on Commonwealth land.

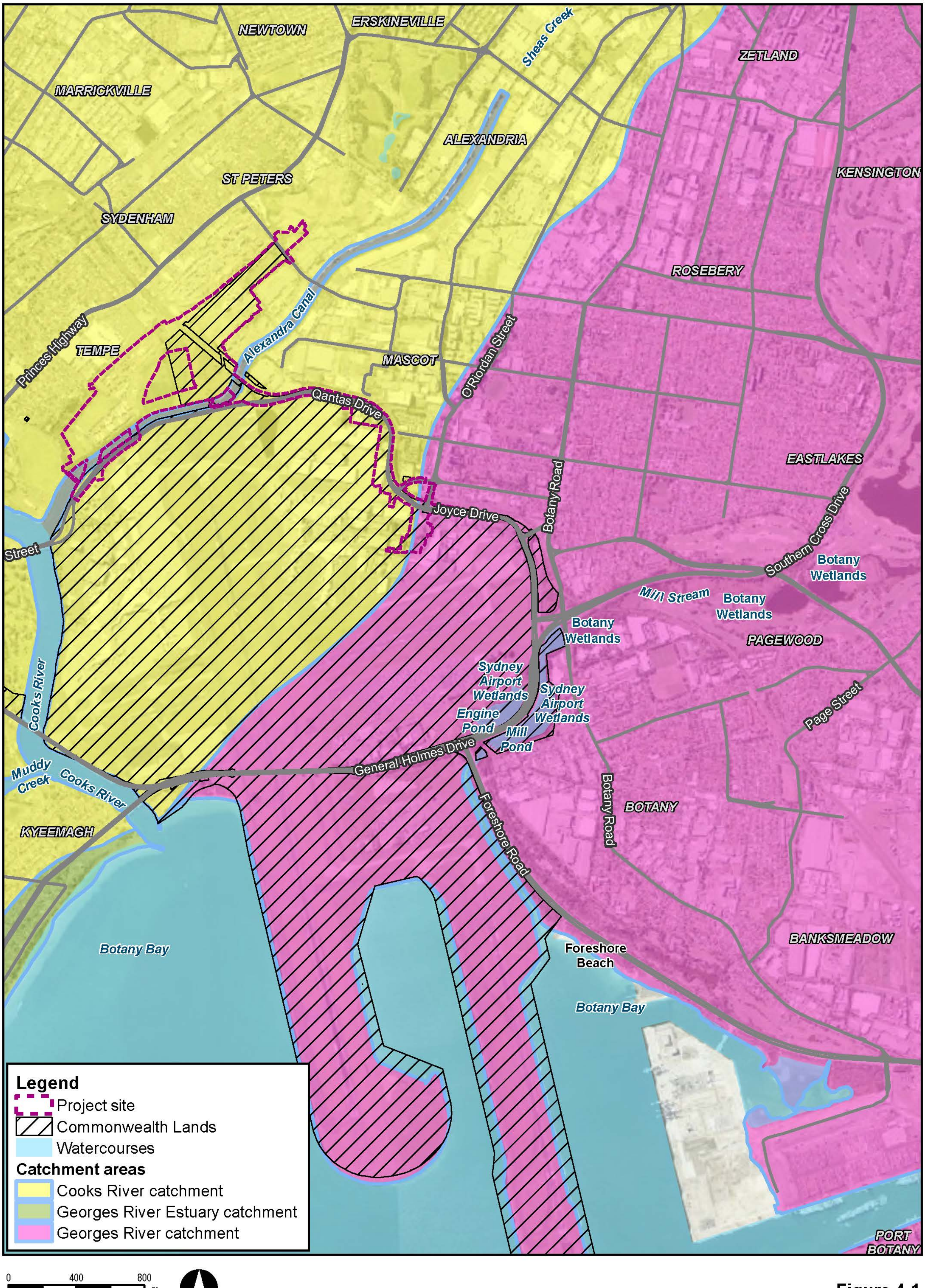


Figure 4-1

Catchments and watercourses

Author: Jeong Greaves
Date: 2019-04-29
Map no: PS109315_GIS_264_A3

4.1.1 Cooks River catchment

The Cooks River catchment covers an area of around 100 square kilometres (10,000 hectares) in south-eastern Sydney. It flows in a generally easterly direction discharging to Botany Bay at Mascot. The major tributaries are Wolli Creek, Bardwell Creek, Muddy Creek, Alexandra Canal, Sheas Creek, Cup and Saucer Creek, Cox's Creek and Freshwater Creek.

The catchment is home to almost 400,000 people, with 130,000 dwellings and around 20,000 commercial and industrial premises. The catchment is highly urbanised and has a history of intensive land use ranging from residential to heavy industry. The catchment has very little remaining bushland and only a small amount of parkland (SMCMA, 2011*)*.

The Cooks River is one of the most urbanised and degraded river systems in Australia, with stormwater identified as a key contributor to water quality and quantity problems. Present levels of pollutants make it unsafe for swimming, unsuitable for many aquatic species and a health risk for commercial fishing.

Within the catchment, it is estimated that roughly 89% of stormwater travels through a combination of pit and pipe networks, open concrete channels, metal sheet piled channels and rock armoured channels. Around 71% of the stream reaches in the Cooks River catchment have no vegetation or are used for flood control (SMCMA, 2011*)*.

Several authorities are responsible for the management of the Cooks River and its catchment, including the local councils located within the Cooks River catchment, the Local Land Services Board, the NSW Environment Protection Authority and Sydney Water Corporation.

The Cooks River Alliance is a partnership of four local councils formed to help achieve sustainable urban water outcomes in the Cooks River. The Alliance publishes an ecological and waterway score card for the Cooks River Catchment based on sampling and assessment of sites within the catchment. The Cooks River Lower Cooks Estuary and Alexandra Canal received a score of D in the 2015–2016 sampling (no values are available for 2017) (Cooks River Alliance, 2017). A score of D indicates poor ecological condition, with most indicators non-compliant with guidelines and showing significant departure from reference conditions. Additionally, the waterway has degraded water quality and poor habitat, reflected by a macroinvertebrate community dominated by pollution tolerant species.

The report card for the Cooks River Lower Cooks Estuary notes frequent non-compliance with guideline values for turbidity and chlorophyll-a. The highest turbidity and chlorophyll-a levels were recorded in March 2017 and the lowest in early January 2017. These results reflected the rainfall during these periods, with falls of 158 millimetres and 232 millimetres recorded in February and March respectively; a significant contrast to the 48 millimetres recorded in January. Heavy rainfall across the catchment results in an influx of sediment laden, nutrient enriched urban stormwater entering the estuary, causing elevated turbidity and excessive algal growth (Cooks River Alliance, 2017).

4.1.2 Alexandra Canal catchment

The Alexandra Canal catchment has an area of about 2,300 hectares. The canal was constructed through dredging and channelisation of a natural watercourse called Sheas Creek. It flows into the Cooks River near the north-western corner of Sydney Airport before it discharges into Botany Bay to the west of Sydney Airport.

Alexandra Canal is tidally dominated through its connection to the Cooks River. It is around 3.9 kilometres long and 60 metres at its widest. The tidal influence from the Cooks River extends to the head of the canal.

The canal is owned and operated by Sydney Water Corporation, as are the major trunk stormwater drainage lines discharging into it. Numerous minor drains in the Alexandra Canal catchment are managed by City of Sydney, Inner West and Bayside Councils.

Dredging and channelisation of Sheas Creek started in 1880s and was mostly complete by 1900. The size and tidal action of the creek resulted in the canal acting as a sediment trap. Major changes in the canal occurred when the airport was expanded over three phases from 1947 to 1970 (Office of Environment and Heritage, 2018).

Runoff into Alexandra Canal was very contaminated in the past from surrounding heavy industry. Contaminants entering via stormwater today come from heavy industry, urban areas and road networks.

The historic industrial land use in the catchment, extensive land reclamation and industries discharging water directly to the canal have been major contributors of pollution to the canal. Older sediments are known to be highly contaminated, and these are overlain by more recent, less contaminated sediments (University of Queensland (UoQ), 2002). In 2004, the NSW Environment Protection Authority (EPA) issued a Remediation Order (No 23004) under the NSW *Contaminated Land Management Act 1997* with specific requirements for the sediments in the canal, citing:

The bed sediments at the site have been found to be contaminated …in such a way as to present a significant risk to harm human health and the environment.

Disturbing these sediments is therefore highly undesirable. Where feasible, the disturbance of sediment in the canal has been minimised in the project design.

AECOM (2018) carried out a sediment investigation within Alexandra Canal on behalf of Roads and Maritime. The investigation identified the contaminants of concern. The known contaminants of concern confirmed to be present in the canal bed sediments were:

- Heavy metals particularly, copper, lead and zinc
- Polycyclic aromatic hydrocarbons (PAHs)
- Polychlorinated biphenyls (PCBs)
- Organochlorine pesticides (OCPs); and
- Nutrients, particularly ammonia.

The contaminants of potential concern included:

- Total recoverable hydrocarbons (TRH) and total petroleum hydrocarbons (TPH)
- Volatile organic compounds (VOCs)
- Semi volatile organic compounds(SVOCs) (in addition to PAHs and OCPs)
- Dioxins and furans
- PFAS; and
- Asbestos.

The UoQ (2002) study showed that sediments entering the catchment include a variety of pollutants and toxins at sufficient levels to maintain sediment concentrations above the ANZECC (2000) guidelines levels. Consequently, any attempt to manage the sediment and pollutants in Alexandra Canal cannot succeed without a management program for the whole catchment (UoQ, 2002).

A constructed pond, known as the Northern Pond, is located on the airport site and discharges to Alexandra Canal. The pond provides flood mitigation and a spill control function (see Figure 4-2).

In August 2000, the NSW EPA declared the former Tempe landfill a 'remediation site' (declaration 21005) under section 21 of the NSW *Contaminated Land Management Act 1997* (CLM Act) due to leachate migrating off site towards Alexandra Canal. Marrickville Council subsequently entered into a voluntary remediation proposal (VRP) with EPA. The VRP is still in place and requires that 'the proposed remediation is to ensure that the water quality of Alexandra Canal is not adversely impacted by leachate originating from the site'. As a result of the order, a leachate management system was installed for the part of the former tip within NSW jurisdiction. The system consists of a bentonite cut-off wall (generally along the canal), a leachate collection system and a leachate treatment plant. The leachate collection system keeps leachate levels below the top of the bentonite cut-off wall. Treated leachate is discharged to sewer under a trade waste agreement with Sydney Water Corporation. The leachate management system, if operating effectively, prevents leachate from migrating into Alexandra Canal. It is noted, however, that the leachate management system does not manage leachate from part of the former tip in Commonwealth land. Furthermore, groundwater in the vicinity can have elevated ammonia levels, likely due to contact with leachate.

4.1.3 Mill Stream catchment

The Mill Stream catchment extends from Centennial Park in the north to its outlet into Botany Bay in the south. According to Protecting our Waterways, the catchment covers an area of about 35.9 square kilometres (3,590 hectares). The upper reach of the catchment is located within the Randwick City Council LGA, while the lower reach is located within the Bayside Council LGA.

A relatively small portion of the project footprint near the intersection of Sir Reginald Ansett Drive and Keith Smith Drive near the domestic terminals is located within the Mill Stream catchment. The area of project footprint is drained by subsurface pipes that discharge into Mill Stream, upstream (east) of Foreshore Road. The section of Mill Stream into which the pipes discharge is below the flow control structures on Mill Pond and is estuarine.

Engine Pond and Mill Pond are located south-east of the project near the downstream (south-west) end of Mill Stream catchment, they are upstream of the pipes that receive runoff from the project. Mill Pond, Engine Pond and the Mill Stream are collectively known as the Sydney Airport Wetlands and are considered as environmentally significant areas in the Sydney Airport Environment Strategy 2019–2024. They are managed by Sydney Airport Corporation as part of the Botany Wetlands Environmental Management Steering Committee.

4.1.4 Drainage system through the project site

Stormwater from the project mostly drains into Alexandra Canal. The north-west and western portion of the project drains through numerous outlets to Alexandra Canal, ranging in size from 305 mm to 1500 mm pipes.

The eastern portion of the project area near Qantas Drive, between Alexandra Canal and Joyce Drive, drains through the airport site drainage systems. A portion of the project area drains into the Northern Pond and a portion drains directly into Alexandra Canal through two twin pipes (see Figure 4-2).

Stormwater from the project area south of Joyce Drive is collected by a drainage system discharging into Mill Stream.

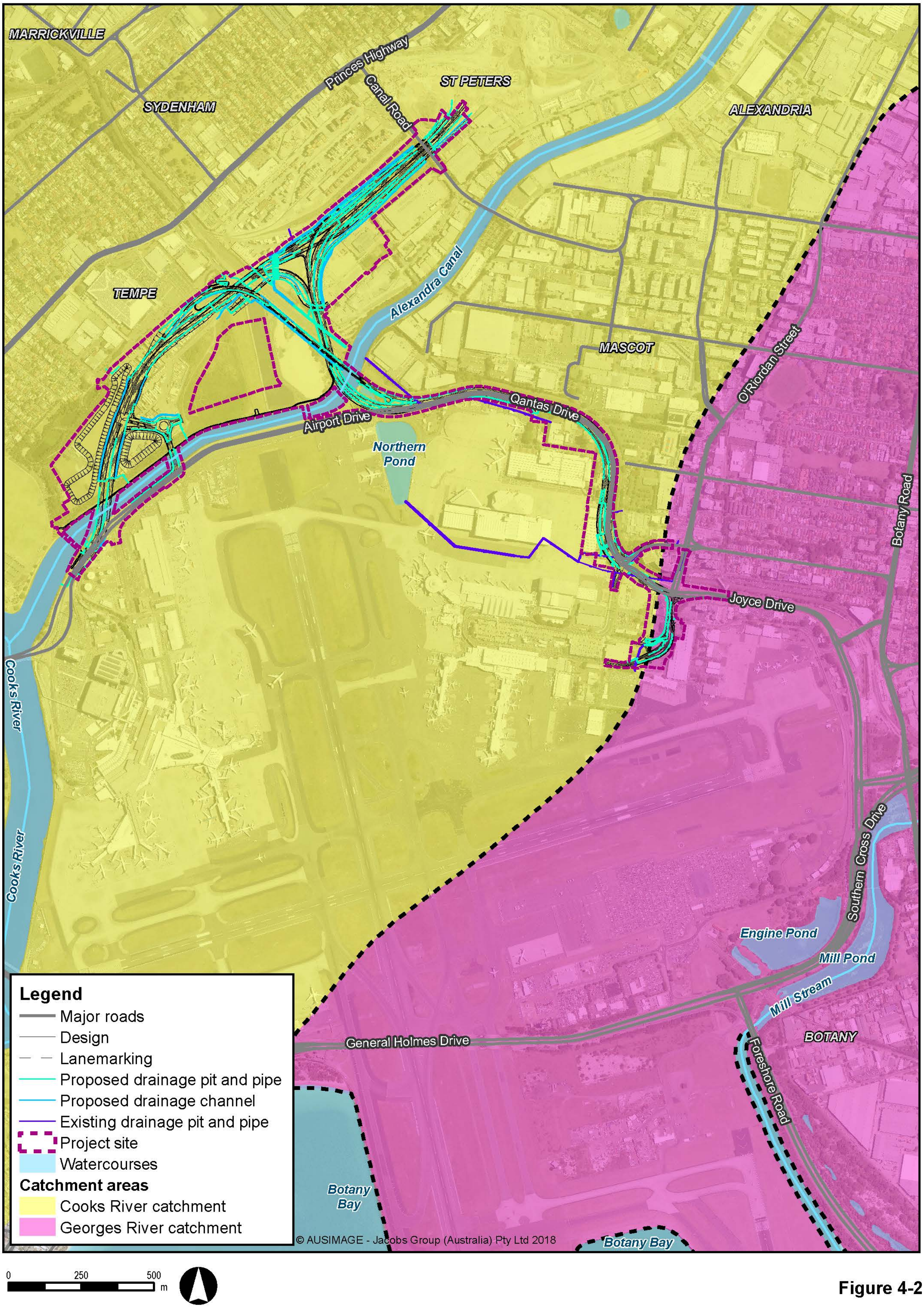


Figure 4-2

Drainage design

Author: Jeong Greaves
Date: 2019-05-02
Map no: PS109315_GIS_267_A3

4.2 Rainfall

The climate data recording station nearest to the project is at Sydney Airport AMO (station number 66037). Rainfall data has been recorded since 1929. On average, June is the wettest month with 124.5 millimetres of rain, and September the driest month with 59.7 millimetres of rain (Bureau of Meteorology, 2018). Average rainfall for all years of data is shown in Figure 4-3.

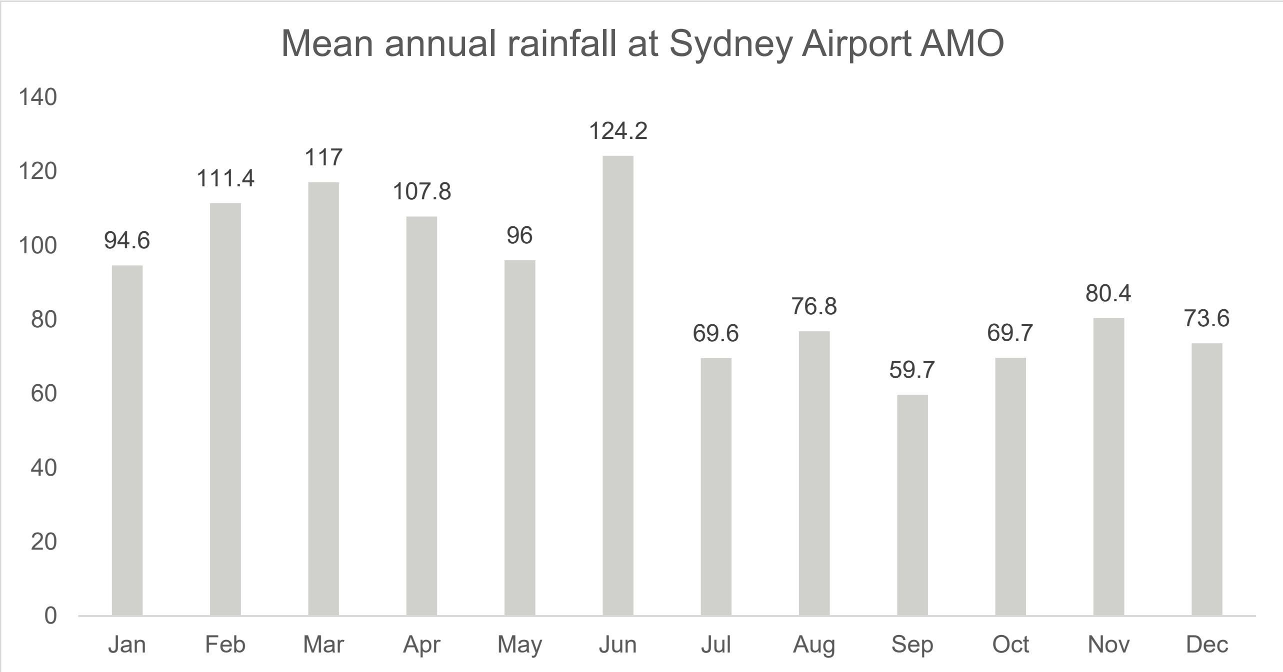


Figure 4-3 Mean annual rainfall for all years of data (BOM, 1929–2018)

4.3 Soil landscapes

According to the 1:100,000 Sydney Region Geological Map (Geological Survey of New South Wales, 1983), the regional geology consists of Triassic Hawkesbury Sandstone and Ashfield Shale overlain by Quaternary sediments (unconsolidated sands with minor peat, silts and clays and hard iron-cemented layers known as waterloo rock). The Quaternary sediments infilled drowned river valleys that were incised into Hawkesbury Sandstone bedrock. These sediments, otherwise known as the Botany Sands, are composed of predominantly unconsolidated to semi-unconsolidated permeable sands. They are interspersed with lenses and layers of peat, peaty sands, silts and clays (low permeability), which become more common at greater depths. Refer to Technical Working Paper 5 – Contamination and Soils for further information.

Based on the Soil Landscapes of Sydney (Figure 4-4), the project is located on Disturbed Terrain extending across Sydney Airport land to the west, along the Botany wetlands, the lower reaches of the Cooks River and up Alexandra Canal to the north.

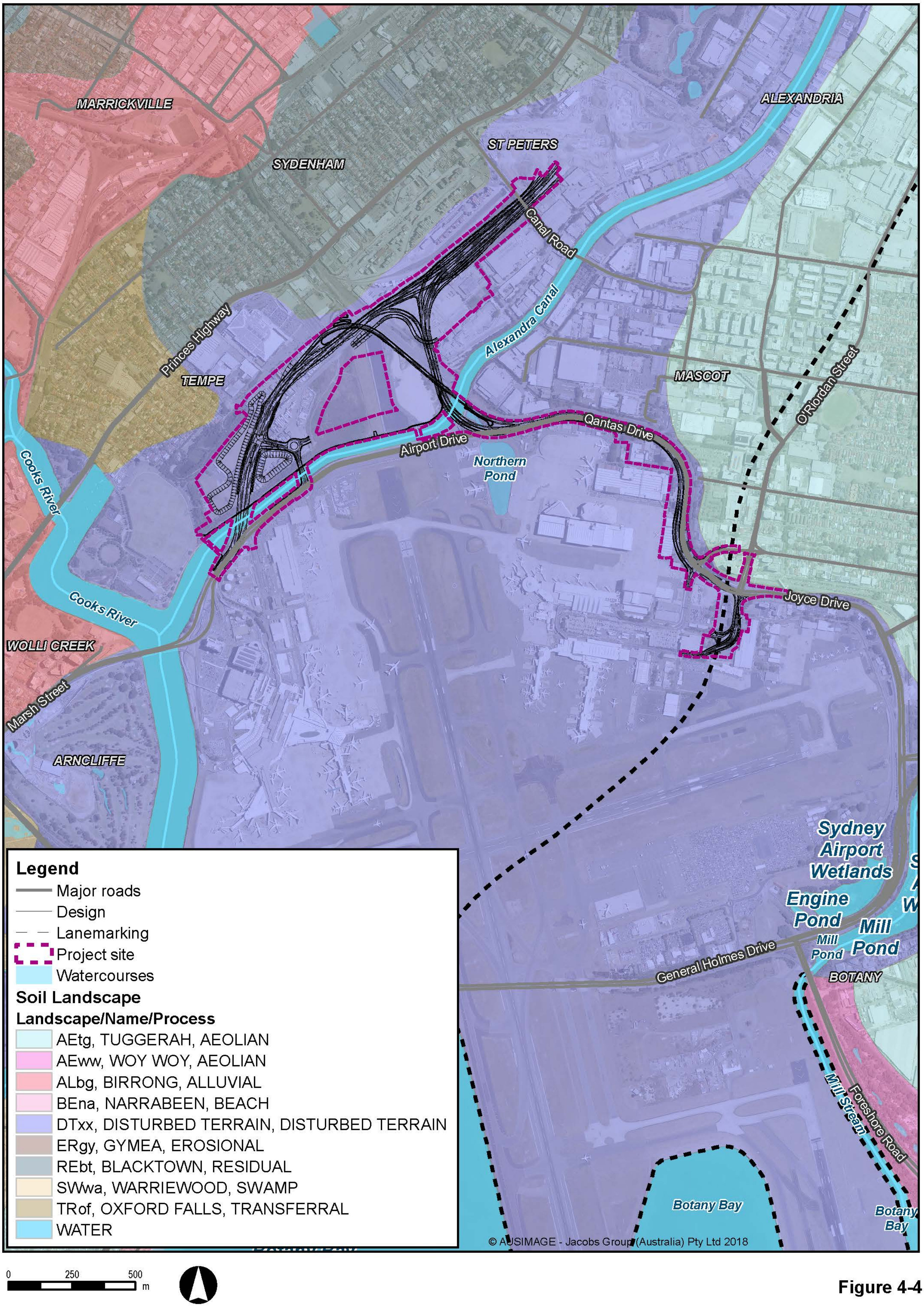


Figure 4-4

Soil landscapes

Author: Jeong Greaves
Date: 2019-04-17
Map no: PS109315_GIS_270_A1

4.4 Geomorphology

Soil along the project is about 30 metres thick, and bedrock is expected to be encountered from -10 metres AHD to -20 metres AHD. The New M5 WestConnex EIS (AECOM, 2017) noted that the geomorphological characteristics of the Alexandra Canal and Cooks River are primarily categorised as having no potential for lateral or vertical adjustment (concrete channel, piped channel, rock-lined channel, shaped channel and underground concrete channel).

The natural landform of the Mill Stream catchment comprises rounded sand dunes and expanses of gentle slopes with local depressions and exposed water tables. The lower reaches of Mill Stream, into which the project could discharge (upstream (east) of Foreshore Road), is a concrete lined estuarine channel that has no potential for lateral or vertical adjustment.

4.5 Hydrogeology

There are two main groundwater systems beneath the site: a deep, confined groundwater system associated with the Triassic aged, fractured/porous Hawkesbury Sandstone and a shallow, unconfined/semi confined system within Quaternary aged marine sands (the Botany Sands) referred to as the Botany Sands Aquifer (Hatley, 2004).

The Botany Sands Aquifer is considered an unconfined, highly permeable aquifer. The flow directions within this aquifer are generally controlled by topography. From the recharge areas located at higher elevations north-east of the Botany basin, groundwater flows south and south-west towards rivers and other tributaries and into Botany Bay. Based on available bore monitoring data, groundwater is about 35 metres AHD near Centennial Park, with elevations gently declining south to the Botany Bay. Flow gradients range from 0.003 to 0.01 (Hatley, 2004).

Further details on the existing groundwater environment are in the Technical Working Paper 7 – Groundwater.

4.6 Sensitive receiving environments

The project has the potential to interact with a number of sensitive receiving environments including Cooks River, Mill Stream and Botany Bay.

There is no registered surface water licence for water usage in the Georges River or Cooks River catchment (WaterNSW, 2019), which indicates that there is currently no water extraction for private or commercial water supply. The current sensitivity of the surface water environment therefore relates to ecological and recreational values.

Botany Bay, which is not considered to be a pristine environment, is used for a range of beneficial purposes such as recreation and fishing (despite the NSW Department of Primary Industries (DPI) prohibiting commercial fishing in Botany Bay and Cooks River under the Fisheries Management (General) Regulation 2010). Recreational fishing is prohibited in the area between the runways extending into Botany Bay, but is not prohibited in or around Mill Stream or in the broader Botany Bay area.

Cooks River and Botany Bay are both marked as key fish habitats under the *Fisheries Management Act 1994.* Key fish habitats are aquatic habitats that are important for the sustainability of the recreational and commercial fishing industries, the maintenance of fish populations generally and the survival and recovery of threatened aquatic species. The Biodiversity Development Assessment Report (see Technical Working Paper 14) states that Tempe Wetland and Alexandra Canal do not provide habitat for any threatened fish species known from the locality.

As mentioned in section 4.1.3, Mill Pond, Engine Pond and Mill Stream are designated as Environmentally Significant Areas and are managed by Sydney Airport Corporation as part of the Botany Wetlands Environmental Management Steering Committee and Sydney Airport Environment Strategy 2019–2024.

The Botany Bay area provides summer habitat for a number of migratory wading birds that are listed under the EPBC Act, and the ponds may also be used on occasion by these species.

The overall likelihood of threatened flora and fauna species that are known or predicted to occur within the locality actually being present has been assessed as low, as has the likelihood of future threatened flora recruitment.

4.7 Water quality data

4.7.1 Water quality data in Alexandra Canal from New M5 project

Water quality data was collected during construction phase monitoring for the New M5 project. A year (August 2016–July 2017) of monthly sampling data was supplied (WestConnex, 2018).

Monitoring points SW-02, SW-06 and SW-07 for the New M5 project were in similar locations (respectively) to monitoring points SW2, SW7 and SW8 in the Alexandra Canal for this project (see Figure 4-5 for approximate locations).

Table D-1 in Appendix D shows the 80th percentile values for SW02, SW06 and SW07 for the year of data provided. The trigger values in Table D.1 are based on the assessment criteria detailed in section 3.4 and trigger values in Appendix A for Alexandra Canal. It is evident that total nitrogen, iron, manganese, zinc and total phosphorus exceed the ANZECC (2000) water quality objectives at least 80% of the time. These exceedances are indicated in red in Table 4-1.

It is noted that the analysed data was collected during the construction phase of the New M5 project, and it is possible that runoff could have affected the baseline data.

4.7.2 Baseline water quality data collected for this project

Water quality data has been collected at a number of locations in Alexandra Canal, Cooks River and Mill Stream since December 2017. Fifteen months of data (from December 2017–March 2019) were provided for this study. Data has only been collected at SW9 (Mill Stream) since August 2018 due to issues with access. Location descriptions and an accompanying map of monitoring locations are shown in Table 4-1 and Figure 4-5 respectively.

Table 4-1 Baseline water quality monitoring locations (Table 1 AECOM, 2018)

Site Ref	Water Course	Type	Suburb	Location Description	Easting	Northing	Monitoring Purpose
SW1	Alexandra Canal	Tidal	Mascot	Drainage line flowing from Mascot Industrial area into Alexandra Canal	-33.923140	151.175986	Downstream of industrial area inflow
SW2	Alexandra Canal	Tidal	Mascot	Alexandra Canal - upstream of proposed road and rail bridge	-33.924333	151.174602	Downstream of industrial area inflow
SW3	Alexandra Canal	Tidal	Mascot	North pond connection surface water body	-33.925684	151.174625	Downstream location of Northern Lands Car Park
SW4	Alexandra Canal	Tidal	Tempe	Alexandra Canal - at proposed Blue Option road bridge to QANTAS Drive	-33.927153	151.168323	Downstream location of Tempe Tip, Sydney Airport
SW5	Alexandra Canal	Tidal	Tempe	Alexandra Canal - at proposed Green Option road bridge to QANTAS Drive	-33.929990	151.163728	Downstream location of Tempe Tip, Sydney Airport
SW6	Alexandra Canal	Tidal	Tempe	Alexandra Canal - before the confluence with Cooks River	-33.932843	151.162005	Downstream location of Tempe Tip, Sydney Airport before Cooks River
SW7	Cooks River	Tidal	Wolli Creek	Cooks River - North of Princes Highway	-33.927658	151.156588	Upstream of construction works in Cooks River
SW8	Cooks River	Tidal	Kyeemagh	Cooks River south of Marsh Street	-33.938560	151.161819	Downstream location of Sydney Airport
SW9	Mill Stream	Freshwater	Botany	Mill Stream - adjacent to Eastlakes Golf Course, north of the project alignment	-33.937163	151.202408	Upstream of rail corridor
SW10	Mill Pond	Freshwater	Botany	Mill Pond - south of the project alignment, east of Botany Road	-33.939162	151.195937	Downstream of Sydney Airport and rail corridor
SW11	Mill Pond	Freshwater	Botany	Drainage line parallel to General Holmes Drive flowing into Mill Pond at Southern Cross Drive	-33.939654	151.193290	Downstream of Sydney Airport

Figure 4-5 Sydney Gateway surface water monitoring locations (AECOM, 2018–2019)

The project discharge location would be a point in Mill Stream, below the flow control structure south of Southern Cross Drive and east of Foreshore Road, where Mill Stream is a concrete lined estuarine channel. Currently all data on Mill Stream (SW9, SW10 and SW11) are from freshwater locations. Roads and Maritime has commenced sampling in the vicinity of the potential discharge location in order to improve the understanding of the baseline water quality conditions at this location and to establish appropriate discharge criteria as described in section 3.4.5.

Where possible, data was collected during both wet and dry conditions. According to ANZECC (2000) guidelines, 12 to 24 months of baseline monthly water quality data is ideal to gain a reasonable understanding of baseline conditions. Monthly water quality monitoring in both dry and wet weather conditions is ongoing.

For this project, 25 sampling events have been provided by AECOM, including a combination of wet and dry events, between December 2017 and March 2019. Over this period, there were 17 sampling events were recorded at SW1–SW6, 25 recorded at SW7, SW8, SW10 and SW11, and 13 recorded for SW9. Because of the overall limitations on data, wet and dry events were combined to provide the average, median and maximum values shown in Appendix E. Samples that were below the limit of detection were not included in the calculations of the means, medians, 80th percentile values and maximums. The contaminants were assessed against the adopted trigger values. These were determined from the environmental values and water quality objectives in the ANZECC (2000) guidelines. The water quality data for existing conditions is assessed against the adopted trigger values in Appendix A.

4.7.2.1 Alexandra Canal

Table E-1, Table E-2 and Table E-3 in Appendix E highlight the mean, median, maximum and 80th percentile values for the key physical properties, nutrients and contaminants of concern. Sampling points SW1 to SW8 are located in Alexandra Canal and Cooks River. A summary of key observations from the water quality at these sampling points is provided below:

- Total nitrogen, chloride, sulfate, total dissolved solids, aluminium, iron, manganese, zinc and ammonia mean, median, maximums and 80th percentile values exceed ANZECC (2000) guidelines for all sites, apart from median filtered iron at SW8, median and total manganese at SW8, and median filtered manganese at SW6
- Phosphorus exceeds ANZECC (2000) guidelines values at all sites, apart from medians at SW5, SW6 and SW8. Phosphorus levels are higher in the Cooks River than in Alexandra Canal
- All total suspended solids maximums, apart SW2, SW1, SW3 and SW7 medians and SW1, SW2, SW3 and SW4 80th percentile values, exceed ANZECC (2000) guidelines values
- All maximums and 80th percentile values for turbidity exceed ANZECC (2000) guidelines apart from 80th percentile values at SW7 and SW8
- All copper maximums and 80th percentile values exceed ANZECC (2000) guidelines apart from the 80th percentile value for SW8
- Along Alexandra Canal, the concentrations of the majority of key non-complying contaminants, such as sulfate and metals, increase downstream and peak near SW5 and SW6 before entering Cooks River
- For nitrogen-related compounds there is a significantly higher ammonia level (more than 10 times the trigger values) between SW1 and SW6. The concentrations peak at SW2 and then diminish further downstream. Total nitrogen also peaks at SW2. The monitoring data suggests that there are ammonia sources between SW1 and SW6. Since this section of Alexandra Canal is next to the former Tempe landfill, this could be the source of the high ammonia levels.

In summary, sampling points within the Cooks River and Alexandra Canal (SW1 to SW8) frequently exceed ANZECC (2000) guideline values for sulfate, total dissolved solids, total suspended solids, chloride, total nitrogen, aluminium, iron, manganese, zinc and ammonia.

4.7.2.2 Mill Stream

Below is a discussion on the existing conditions of the freshwater sampling points on Mill Stream. When available, data for estuarine sampling point on Mill Stream will require similar analysis against Mill Stream trigger values.

Table E-4 in Appendix E highlights the mean, median, maximum and 80th percentile values for the key physical properties, nutrients and contaminants of concern. Table F-1 in Appendix F compares the same contaminants with the accepted limits of contamination specified in Schedule 2 of the Airports (Environment Protection) Regulations 1997. A summary of key observations at SW9, SW10 and SW11 located in Mill Stream is outlined below:

- Total nitrogen, aluminium, iron, manganese, zinc, ammonia and total suspended solids exceed ANZECC (2000) guidelines for all sites
- Turbidity exceeds ANZECC (2000) guidelines at all sites apart from the median at SW10 and SW9
- All maximum and 80th percentile values phosphorus and average phosphorus at SW10 and SW11, exceed ANZECC (2000) guidelines
- Copper at all locations and maximum filtered copper at SW11 exceed ANZECC (2000) guidelines
- All the above contaminants exceed the limits of accepted contamination specified in Schedule 2 of the Airports (Environment Protection) Regulations 1997. Nitrate does not exceed ANZECC (2000) guidelines but does exceed Airports (Environment Protection) Regulations 1997
- Concentrations of contaminants are generally higher upstream at SW9 and diminish further downstream.

In summary, sampling points in Mill Stream (SW9 to SW11) frequently exceeded ANZECC (2000) guidelines for total nitrogen, aluminium, iron, manganese, zinc, ammonia and turbidity and the limits of accepted contamination specified in Schedule 2 of the Airports (Environment Protection) Regulations 1997.

4.7.2.3 PFAS

To assess site investigation results for PFAS, the ecological criteria provided in Table 5 of the PFAS NEMP have been considered. The target trigger values detailed in section 3.4 are the levels for the protection of 80% of marine water ecosystems for Mill Pond and 80% of marine water ecosystems for Alexandra Canal. Adopting a precautionary approach for PFAS in this assessment, a conservative objective of protection of 95% of marine water ecosystems has been adopted for this project due to the potential for bioaccumulation.

A summary of key observations is outlined below:

- PFAS compounds, including PFOS and PFOA, were detected in sampling points within the Cooks River, Alexandra Canal and Mill Stream
- PFOS was detected in up-gradient sampling points
- The PFAS levels at all sites complied with the NEMP levels for protection of 95% of marine water ecosystems.

4.8 Existing conditions (MUSIC model)

MUSIC modelling was undertaken to estimate the pollutant loadings for total suspended solids, total phosphorus and total nitrogen under existing conditions. MUSIC is the preferred modelling tool for the assessment of water sensitive urban design strategies across Australia (BMT WBM, 2015). The software represents an accumulation of the best available knowledge and research on urban stormwater management in Australia.

Full details of the MUSIC model, including catchment parameters, are provided in Appendix C.

4.8.1 Alexandra Canal catchment

As part of the drainage design work for the project, a 181 hectare area of the Alexandra Canal catchment was delineated as surface and the drainage network affected by the project. This catchment was separated into land use types, to include pavement, commercial and green/re-vegetated land as part of the MUSIC modelling. The existing land use areas in the catchment are shown in Table 4-2.

Table 4-2 Existing land uses in project area within Alexandra Canal catchment

Land use type	Area (ha)
Commercial	154.28
Pavement (untreated)	15.88
Re-vegetated land	10.75
Total	181

Based on these land use types and areas, the existing pollutant loadings in Alexandra Canal were estimated from MUSIC for the drainage catchment affected by the project. Table 4-3 shows the existing annual pollutant loads into Alexandra Canal.

Table 4-3 Existing pollutant loads from the project area within Alexandra Canal catchment

Pollutant	Existing pollutant load (kg/yr)
Total Suspended Solids	315,000
Total Phosphorus	509
Total Nitrogen	3,777

4.8.2 Mill Stream catchment

A relatively small portion of the project footprint which lies within the Mill Stream catchment. The area of project footprint is drained by a piped drainage line that discharges into Mill Stream. As part of the drainage design work for the project, a 2.7-hectare area of the Mill Stream catchment was delineated as surface and the drainage network affected by the project. The catchment area was delineated by the project drainage design team and includes a mix of pavement, commercial and green or revegetated land use types (Table 4-4).

Table 4-4 Existing land uses in project area within Mill Stream catchment

Land use type	Area (ha)
Pavement	1.7
Green area	0.1
Commercial	0.8
Total catchment area	2.7

Based on these land use types and areas, the existing pollutant loadings in Mill Stream were estimated from MUSIC for the drainage catchment affected by the project. Table 4-5 shows the existing annual pollutant loads in the Mill Stream catchment.

Table 4-5 Existing pollutant loads from the project area within Mill Stream catchment

Pollutant	Existing (kg/yr)
Total Suspended Solids	4,870
Total Phosphorus	7.84
Total Nitrogen	58.2

5. Assessment of construction impacts

5.1 Summary of key findings

During construction, water quality impacts may arise in the following ways:

- Temporary impervious surfaces may increase discharges to waterways, disturbing contaminated sediment
- Exposure of soils during earthworks may result in soil erosion and movement of eroded sediments off site by wind and/or stormwater
- Works within waterways may disturb contaminated sediment
- Sediment, stormwater and groundwater (including potential contaminants) entering waterways; and
- Extracted groundwater discharged to surface water bodies.

These impacts are expected to be temporary, and are considered manageable with the application of best practice mitigation measures during construction. Some water may require special management and treatment before discharge or offsite disposal.

5.2 Construction impacts

5.2.1 General

Any water to be discharged from construction areas has potential to impact on nearby waterways and to cause sedimentation and erosion of local waterways if not appropriately managed.

Table 5-1 describes general construction activities associated with the project that have potential to impact water quality in the waterways if not appropriately managed. The potential impact is indicated. The likelihood of these potential impacts is low with appropriate mitigation measures described in section 8.1.

Potential impacts from construction of upgrades and new stormwater infrastructure in Alexandra Canal are discussed in section 5.2.2. Geomorphic impacts are discussed in section 5.3. Construction water balance impacts are discussed in section 5.2.8.

Table 5-1 Potential water quality impacts during construction (unmitigated)

Activity with potential impact to water quality	How impact could occur	Potential water quality impact
Earthworks activities (such as vegetation clearing, stripping of topsoil and stockpiling)	Exposure of soils resulting in erosion and movement off site of eroded sediments by wind and stormwater.	Increased turbidity, lowered dissolved oxygen levels and increased nutrients. Potential for increased contaminants in waterways if soil is contaminated.
	Exposure of acid sulfate soils.	Generation of sulfuric acid and subsequent acidification of waterways.
Activities where dewatering of groundwater is required (such as drainage infrastructure and utility works)	Discharge of extracted groundwater (including potentially contaminated groundwater) to waterways.	Increased pollutant loads, disturbance of bed sediments that increase the amount of mobilised sediments in waterways and any contaminants* present in the sediments (treatment may be required for this water depending on the level of contamination).

Activity with potential impact to water quality	How impact could occur	Potential water quality impact
Bridge construction	All temporary works associated with the construction of the bridges would be located outside the channel of Alexandra Canal. However, there is potential for increased runoff into waterways from temporary hardstand area and contaminated* groundwater seeping into excavations.	Increased turbidity, lowered dissolved oxygen levels due to increased nutrients from leachate affected groundwater (if encountered). Potential for increased mobilisation of contaminants* from canal sediments.
General	Litter from construction activities.	Increased gross pollutants affecting visual amenity.
	Inadequate containment of spills or leaks of fuels and/or oils from construction equipment and/or from vehicle/truck incidents may result in contaminated runoff entering local waterways.	Increased contaminants in waterways.

*Contaminants of concern are discussed in section 4.1.2.

5.2.2 Construction of new and upgraded drainage infrastructure and stormwater outlets

There are 10 new outlets proposed in the Alexandra Canal. The majority of the outlets have their invert level above normal tidal levels. This means that construction activities can proceed without direct interaction with the waterbody.

However, the inverts of some of the outlets (such as Outlet 04, refer to Figure 6-1) are below low tide level, which means that construction works would be required below the water level. These works below water levels have the potential to disturb and cause localised mobilisation of contaminated sediments.

These impacts can be mitigated through the following measures:

- Installing silt curtains around each outlet location
- Establishing coffer dams, within the area protected by silt curtains, to provide a dry working environment and minimise the potential mobilisation of disturbed sediments
- Constructing the new outlets and scour protection in the canal wall within the area protected by the coffer dams.

Some canal bed sediments might be disturbed using this method, particularly when constructing and removing the coffer dams. The above method would, however, minimise the likelihood of sediment disturbance and the amount potential sediment mobilisation for the duration of the outlet construction works. The silt curtains would contain any mobilised sediment to the general vicinity. Due to the tidal and estuarine nature of Alexandra Canal it is likely that any mobilised sediment would re-settle close to location of disturbance. Alexandra Canal does not contain habitat for threatened fish and is not generally used for primary or secondary contact activities. The risk of significant impacts associated with sediment and contaminant disturbance and mobilisation due to outlet construction would, therefore, be minimal.

Due to the presence of contaminated sediments and the existing remediation order for Alexandra Canal, all works associated with the outlets would be undertaken in accordance with a management plan approved by the NSW EPA.

5.2.3 Potential impacts on geomorphology

Potential impacts on the geomorphology of waterways can occur in the form of changes to bed and bank conditions, scour (erosion) and sediment build up which can smother instream geomorphic units and habitat features.

Changes to bank conditions of the watercourse in the vicinity of the project site are unlikely because there is no potential for lateral or vertical adjustment (concrete channels). Therefore, the potential impacts are to the bed conditions.

All temporary works associated with the construction of the Terminal 1 connection bridge, Freight Terminal bridge, Qantas Drive bridge and Terminal link bridge would be located outside the channel of Alexandra Canal. Therefore, these temporary works will have no impact on flow conveyance or scour potential within the Canal.

The construction of the Qantas Drive extension bridge foundations would result in a small loss of storage volume in the Sydney Airport northern pond immediately adjacent to Alexandra Canal. The project includes enlargement of the pond to ensure that the volume loss is offset. The volume of offset required would be confirmed during detailed design with Sydney Airport. These works would occur in the pond system that is offline from Alexandra Canal, and therefore will have no impact on flow conveyance or scour potential within the Canal, nor the pond itself which is a static storage system that experiences very low to negligible flow velocities.

Other than the construction of new drainage outlets described in section 5.2.2, no works are proposed within the channel of Alexandra Canal. The coffer dams required to facilitate construction of the drainage outlet works would have the potential to alter local flow velocities in the immediately vicinity of the dam walls, which may increase the potential for localised scour. This would likely occur during flood events rather than under typical tidal flows regimes. As discussed in section 4.1.2, however, Alexandra Canal acts as a sediment trap. Any associated sediment disturbance would be unlikely to affect the overall sediment distribution within the canal and bed geomorphology generally.

General soil disturbance within the project site has the potential to increase sediment loads into the affected watercourses. Controls would be implemented at all work sites in accordance with the Blue Book to minimise erosion and sedimentation in the affected watercourses. Any increased sediment loads during construction would be unlikely to substantially alter existing sediment volumes and distributions in the affected watercourses. The risk of significant changes to bed geomorphology due to increase sediment loads during construction of the project would be very low.

Changes in local hydrology in the project site due to construction have the potential to alter stormwater runoff volumes and velocities. Increased velocities could lead to increased scour at stormwater outlets and in the main channels of the affected watercourses. Any increases in scour due to the project would be more likely during storm events when sediment mobilisation is more likely to occur under existing conditions. The project is, however, unlikely to substantially alter the overall hydrology of wider catchments and is, therefore, unlikely to substantially change stormwater runoff volumes or flow rates and velocities within the channels. The risk of significant changes to bed geomorphology due to increased flow volumes and velocities due to changes in hydrology in the project area during construction would be very low.

5.2.4 Discharge of extracted groundwater to surface water

Extracted groundwater from construction activities has potential to increase the pollutant loads if discharged into the waterways. For the extracted groundwater to have a low impact on the waterways, the groundwater discharged to surface water must be within discharge criteria selected based on the methodology presented in section 3.4.5 (refer also to Table B-2 in Appendix B for indicative proposed discharge criteria).

The assessment of the groundwater monitoring data in Technical Working Paper 7 – Groundwater identified the following analytes in groundwater within the potential dewatering areas of the project site that exceed the proposed discharge criteria in Table B-2 in Appendix B:

- Aluminium – 7 exceedances out of 20 results
- Lead – 1 exceedance out of 52 results
- Manganese – 20 exceedances out of 20 results
- Mercury – 1 exceedance out of 52 results
- Zinc – 9 exceedances out of 52 results
- Bicarbonate – 20 exceedances out of 20 results
- Ammonia – 28 exceedances out of 39 results
- Nitrogen – 20 exceedances out of 20 results
- Phosphorus – 17 exceedances out of 20 results
- pH – 17 exceedances out of 32 results
- Total suspended solids – 1 exceedance out of 1 result
- PFOS – 10 exceedances out of 46 results.

Treatment of extracted groundwater may therefore be required before it can be discharged to the receiving waterways, with the treatment process designed to meet the discharge criteria set out in Appendix B. Prior to and during construction, the groundwater quality would continue to be monitored within the dewatering areas and the monitoring data assessed against the discharge criteria to determine if treatment is required prior to discharge. The risk of significant water quality impacts due to short term discharge of extracted groundwater that meets discharge criteria based on the existing water quality and relevant ANZECC (2000) default triggers, as described in section 3.4.5, would be low.

Discharge of the extracted groundwater to the affected waterways has the potential to increase flow and velocities, which could result in erosion and scour of the channel bed in the waterways. The extracted water could be discharged to local stormwater systems that are connected to the waterways, which would then discharge to the waterways via existing outlets. In the case of Alexandra Canal, the water could also be discharged directly to the waterway. Discharge of extracted water has the potential to disturb and mobilise contaminated sediments at the discharge locations if not appropriately managed.

The land on which Alexandra Canal is located is owned by Sydney Water Corporation and the canal functions as a stormwater channel. In consultation about the Sydney Gateway road project, Sydney Water Corporation (personal communication from Willy Ramlie, Account Manager – Motorways, Sydney Water Corporation, 12 June 2019) has indicated that temporary discharges of construction water to the canal would be acceptable, subject to meeting appropriate flow rates and water quality criteria. Current groundwater modelling suggests a daily groundwater take of approximately 1100-5000 cubic meters per day (daily to worst case) with these high water takes only for short periods of time (refer to Figure 5-1). If extracted groundwater is to be discharged to surface water, it may be feasible to discharge to Alexandra Canal by controlling dewatering rates using appropriate staging of works to meet discharge limits agreed with Sydney Water Corporation. Any discharge of construction water to Alexandra Canal would occur in consultation with the Sydney Water Corporation.

The highest predicted rate of groundwater take of 5,000 cubic metres per day, or 58 litres per second, is similar to the lowest rate of discharge of 50 litres per second from existing drainage outlets on Alexandra Canal for the 1 Exceedance per Year flood event. Maintaining short term discharges at rates similar to the lowest rate of wet weather discharge from existing drainage outlets and locating the points of discharge appropriately, i.e. at or near existing drainage outfalls or locations where stable channel bed conditions are present, will therefore pose a low risk of disturbance of sediment and associated impacts.

Mill Stream, downstream from the potential discharge location, is within the airport site. Consultation with Sydney Airport Corporation and the Airport Environment Officer would occur prior to discharge of construction water to Mill Stream.

Consultation with the NSW EPA would occur prior to discharge of construction water to the affected waterways.

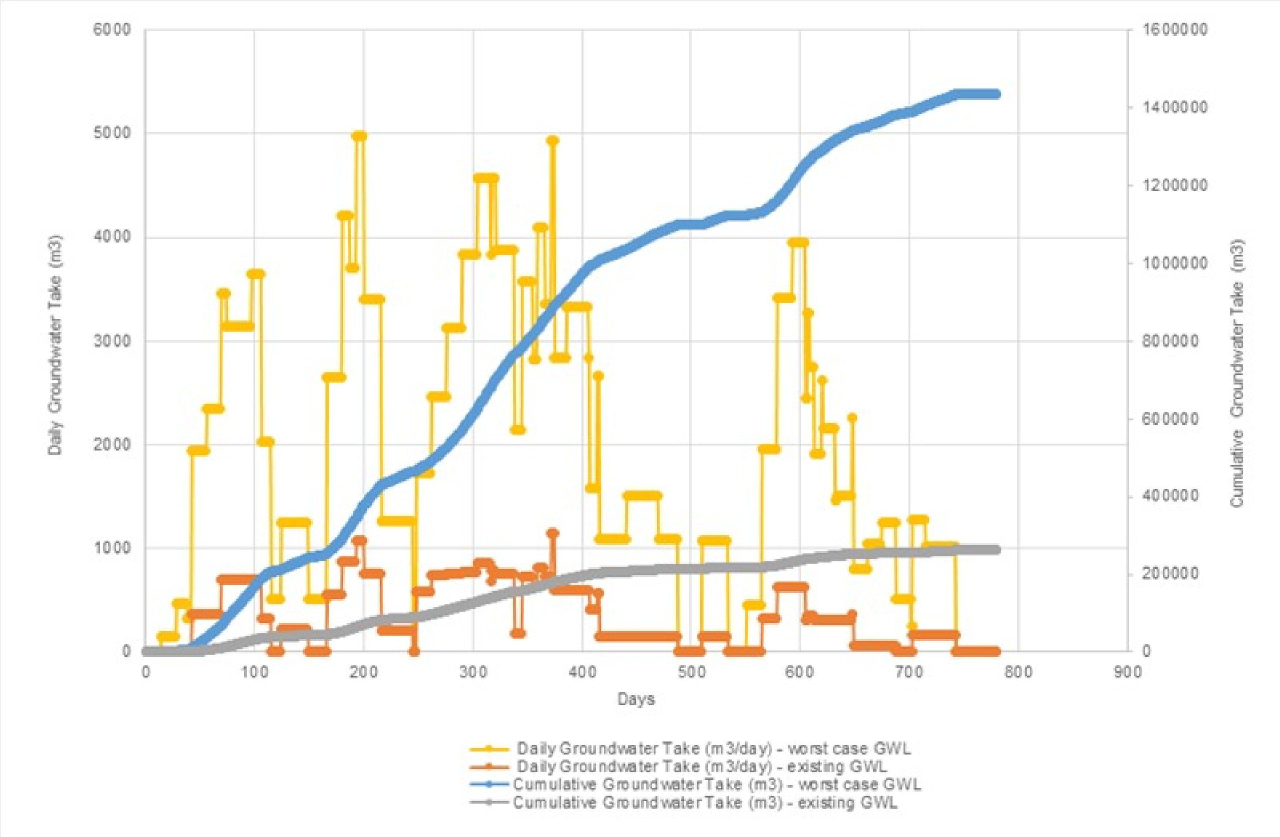


Figure 5-1 Estimated daily groundwater take (Technical Paper 7 – Groundwater)

5.2.5 Runoff from works areas at the former Tempe landfill

Construction would involve the excavation and encapsulation of the waste materials within the former Tempe landfill. During the short period when the existing capping layer would be stripped and waste materials would be exposed there is potential for surface water to become contaminated.

This potential impact is assessed and appropriate management measures are described in detail in the Technical Working Paper 16 – Landfill Assessment.

5.2.6 Contaminated runoff from project site

Soils in various locations within the project site are contaminated. Excavation would be required in potentially contaminated soil. Surface water runoff may therefore come into contact with contaminated materials within the project site. Contaminated runoff may result in water pollution if it enters the affected waterways.

The potential for contaminated surface water would be reduced by isolating contaminated land and materials from surface water runoff, and preventing rain from falling directly on contaminated materials wherever practicable. Potentially contaminated surface water runoff would be captured and would either be treated to a level suitable for discharge (as per the discharge criteria developed as described in section 3.4.5) or classified in accordance with *Waste Classification Guidelines Part 1: Classifying waste* (NSW EPA, 2014) and taken for appropriate offsite disposal. With the implementation of appropriate mitigations measures, the risk of significant water quality impacts due to contaminated surface water runoff from the project site during construction would be low.

5.2.7 Runoff from uncontaminated disturbed areas

For works within uncontaminated areas, there is potential for earthworks and other construction activities to cause erosion and sedimentation of the waterways if not appropriately managed. These impacts would be managed through implementation of soil and water management principles consistent with the Blue Book. Further details are provided in section 8.1.

As discussed in section 4.1.2, Alexandra Canal acts as a sediment trap. The tidal nature of the affected reach of Mill Stream means that it would also act as a sediment trap. Neither watercourse contains aquatic ecosystems of high conservation significance. They are not, therefore, particularly sensitive to small increases in sediment loads temporarily during construction of the project. With the implementation of appropriate mitigation measures, the risk of significant water quality impacts due to increase sediment loads during construction would be very low.

5.2.8 Construction phase water balance assessment

The water balance assessment considers changes in flow between existing conditions and construction phase conditions. It is noted that changes in the water balance during construction would be temporary in nature and limited to the duration of the construction phase. The assessment is focussed on Alexandra Canal, which is the main waterway that would be affected by construction activities.

Sources of water during construction that have the potential to impact the flow regime within Alexandra Canal are as follows:

- Discharge of extracted groundwater, following treatment to meet the discharge criteria if required
- Changes to runoff characteristics within the former Tempe landfill
- Runoff from uncontaminated disturbed areas.

Where extracted groundwater from construction works meets the discharge criteria in Table B-2 of Appendix B, it would be discharged to surface water. Groundwater modelling indicates that there could be up to 1 400 000 cubic meters (Figure 5-1) of groundwater extracted over the construction period, with peak extraction rates of 1100–5000 cubic meters per day (daily to worst case) depending on the required depths of excavations and the depth to groundwater at the time, which varies (refer to Technical Working Paper 7 – Groundwater). Subject to meeting flow rate and water quality requirements, Sydney Water Corporation would permit discharge of this water to Alexandra Canal.

Within the former Tempe landfill, leachate generation during construction is estimated to increase from existing levels to around 200 cubic meters per day (average rainfall scenario) due to temporary removal of sections of the landfill cap to facilitate construction (refer to Technical Working Paper 16 – Landfill Assessment).The amount of additional leachate generation would depend on area of cap removed, which would vary over time, and the rainfall that occurs during that time. Leachate from the former Tempe landfill is currently disposed to sewer in accordance with a trade waste agreement with Sydney Water Corporation. The additional leachate generated during construction would be disposed in the same way. The rainfall that would infiltrate the landfill materials during construction and generate additional leachate would have ordinarily flowed as surface water runoff to Alexandra Canal or Cooks River via existing pathways under existing conditions. These flows are not considered to be significant in relation to the overall water balance.

Runoff from the uncontaminated disturbed areas would be managed and directed in a controlled manner to existing drainage lines and outfalls via appropriate sedimentation and erosion controls. The works would be staged such that existing drainage catchment areas and runoff rates would be maintained, with no increase in flows to the waterways.

Therefore, only discharge of extracted groundwater has the potential to impact on the flow regime and water balance within Alexandra Canal.

If the worst case groundwater extraction of 5,000 cubic metres per day occurred in the 1.6 kilometre reach of Alexandra Canal that could be affected by discharge from the project, under low tide level conditions this would represent approximately 7% of the volume of water in this reach. This impact would be even less during average and high tide conditions. This worst case discharge rate is unlikely to occur as the groundwater extraction rates would be managed to minimise discharges to Alexandra Canal. The impact of this additional volume of water discharged to the canal is expected to be minimal.

In addition, construction workers would need access to potable water on site for use such as dust suppression, and wastewater would be generated daily. The urban setting of the project means potable water is likely to be supplied from Sydney Water Corporation, and wastewater would be discharged to Sydney Water Corporation's sewage system. Thus, the construction workers' water use and wastewater disposal on site would not have impact on the construction water balance.

In summary, the sources of water generated and used during construction can be managed without affecting the receiving waterway and by utilising existing utility services (potable water supply and wastewater infrastructure) to meet on site demands.

5.3 Summary of impacts on waterways on Commonwealth land

This section focuses on the impacts on waterways on Commonwealth land, rather than on the land itself. Two parcels of Commonwealth land are present over Alexandra Canal: to the south of Botany rail bridge and an area at the crossing of Nigel Love Bridge. These parcels are mostly stratum title that applies over a certain distance above ground (aerial). The parcels include full title for small areas within the canal, likely to allow for bridge piers (not proposed as part of the project). The project discharge location on Mill Stream is within Commonwealth land (this is listed as part of the Environmentally Significant Areas in the Airport Environmental Strategy). All these waterways would receive discharge from the project, either directly from surface runoff or through the drainage network.

Potential impacts on these waterways during construction may occur as a result of increased sedimentation entering waterways, increasing turbidity and changing bed and bank conditions. These impacts are expected to be temporary and manageable with the application of appropriate sedimentation and erosion controls, along with treatment measures required to discharge extracted groundwater, and are therefore not predicted to be significant.

The proposed compensatory storage works to the Sydney Airport northern pond (see section 5.2.3 for further discussion) occurs on Commonwealth land but these works will not impact on the flow characteristics or function of the pond during the construction phase. Sedimentation risks during construction of these works would be managed by standard controls in accordance with the Blue Book.

5.4 Consistency with the Sydney Airport Master Plan 2039 and Environment Strategy 2019–2024

The Sydney Airport Master Plan 2039 aims to ensure that stormwater quality is adequately addressed in the construction and operational phases of development proposals. This study is consistent with that objective.

Table 5-2 highlights the key actions and initiatives in the Sydney Airport Environment Strategy 2019–2024 that are relevant to water quality and demonstrates how this project would be consistent with this strategy.

Table 5-2 How this project is consistent with the Sydney Airport Environment Strategy 2019–2024

Water quality and water use action plan within the Environmental Strategy 2019–2024 document	How this project is consistent with the Strategy
Identify water quality improvement projects for waterways surrounding Sydney Airport and proactively seek out partnership opportunities to implement feasible projects.	Not related to water quality
Continue to implement cost effective water efficiency and saving opportunities.	Not related to water quality
Investigate the feasibility of further expanding the capacity of the recycled water treatment plant in the North-West Sector of the airport site to address increased demand for non-potable water.	Not related to water quality
Develop and implement a guideline for introducing water sensitive urban design and rainwater harvesting into new developments within the airport site as appropriate.	Not related to water quality during construction
Consider the impacts associated with climate change (increased rainfall intensities and elevated sea levels) on the performance of the stormwater drainage network and level of flood protection at the airport site and use this information to inform the design of proposed developments and associated stormwater infrastructure.	Not related to water quality during construction
Incorporate design features in new developments to reduce contaminant loads in stormwater and to align with catchment water quality objectives.	Not related to water quality during construction
Investigate feasibility of developing a new recycled water treatment plant to provide recycled water to the Terminal 2 and Terminal 3 precinct.	Not related to water quality
Continue to ensure that stormwater quality is considered for the construction and operational phases of development proposals.	This assessment satisfies this requirement. Implementation of the proposed mitigation measures would ensure that stormwater quality is considered during construction
Continue to implement the initiatives contained in the Sydney Airport Stormwater Quality Management Plan, including continuation of regular stormwater quality sampling.	Document yet to be finalised by Sydney Airport. Mitigation measures include ongoing monthly monitoring during construction and post construction until the works area is adequately stabilised (see section 8.3)
Continue to implement the Sydney Airport Wetlands Management Plan and Wetlands Enhancement Program.	Document yet to be finalised by Sydney Airport
Continue to work with airport tenants and users to reduce the water quality impacts of airfield activities.	Not related to the Sydney Gateway road project

The key performance indicator relevant to surface water quality for the actions and initiatives in Table 5-2 is that water quality monitoring results for stormwater from the airport stay the same or improve. During construction, there are minor impacts associated with increased sediment loads in runoff and construction discharges. They would be temporary and minimised with appropriate mitigation measures. This would not have a meaningful impact on this long term key performance indicator.

6. Assessment of operational impacts

6.1 Summary of key findings

A number of potential impacts on water quality during operation have been identified:

- Greater quantities of stormwater discharge from new and existing outlets and new overland flow paths resulting in increased flow velocities, which may increase scouring of soils, change the bed profile and sediment processes, and affect water quality in receiving watercourses
- Contamination of stormwater discharge into local waterways due to vehicle and pavement wear, spills or leaks of fuels and/or oils from vehicle accidents
- Contaminated groundwater entering road drainage system
- Increase in sediment and pollutant loads in stormwater due to the increase in road surface and vehicular traffic, and associated pavement and tyre wear
- Increased scour and mobilisation of contaminated sediments from changes to flow patterns in Alexandra Canal due to new outlets and increased runoff though existing outlets
- Scour from bridge abutments at Terminal Link Bridge, Qantas Drive Bridge and Freight Terminal Bridge.

MUSIC modelling of operational impacts identified several key findings:

- Water balance analysis indicates a negligible increase in flows in both Alexandra Canal and Mill Stream because of the project
- The performance of proposed treatment devices is predicted to reduce the impact of the project on receiving waterways
- When comparing the existing water quality conditions to conditions during operation of the project, a minor increase is predicted for total suspended solids and total phosphorus in the Alexandra Canal catchment.

A small section of the proposed road catchment drains stormwater runoff to Alexandra Canal through existing twin 1500 millimetre diameter pipes within the airport site. Since it is not feasible to provide water quality treatment for this small section of the road (due to lack of space for treatment devices), there would be a minor water quality impact on water through these pipes. Since this is only a small portion of catchment (2.7 ha) and a small percentage change in impervious (7% increase in impervious surface compared to existing, which results in a 5% increase in flow), the water quality could be affected, but it is negligible.

An improvement is predicted in the Mill Stream catchment when comparing existing to design conditions.

6.2 Impact on sediment mobilisation potential and scouring

6.2.1 Stormwater outlets

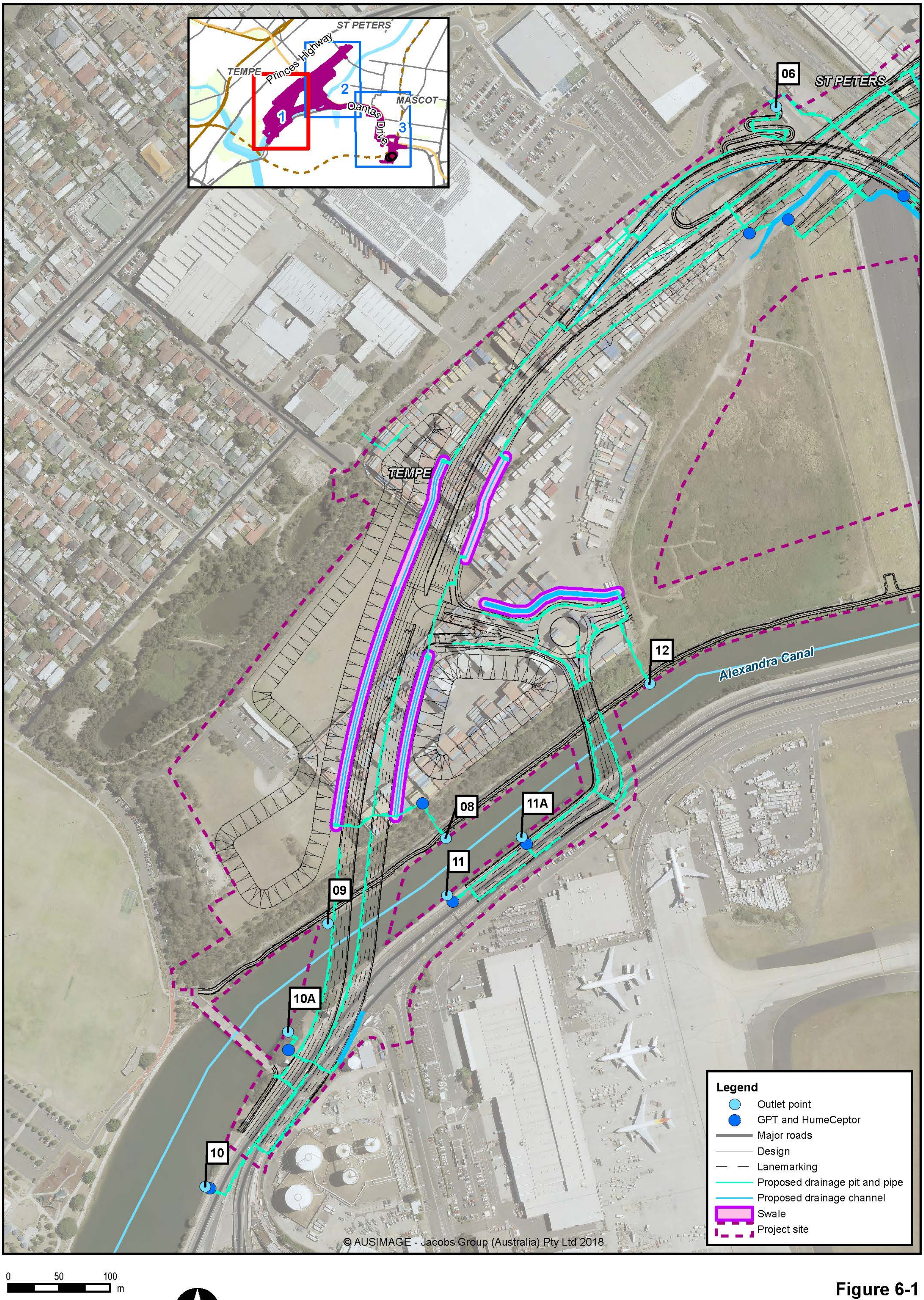
6.2.1.1 Methodology

There are 10 outlets to be upgraded or installed in Alexandra Canal as part of the project stormwater drainage system, as shown in Figure 6-1. There is potential for new discharges into the canal to increase scour and erosion of bed sediments and sediment mobilisation. An assessment of the potential for the new and upgraded stormwater outlets to increase the mobilisation of contaminated sediments around the outlets was undertaken. The methodology was as follows:

- Identify the locations of the 10 new and upgraded outlets and the existing and proposed case catchment areas and flows draining to the outlets
- Identify the 1 EY (Exceedances per Year) and 1% Annual Exceedance Probability (AEP) event flow velocities at the outlets for existing and proposed conditions
- Identify the sediment size range in Alexandra Canal
- Determine the relationship between flow velocity and sediment mobilisation for the sediments present in Alexandra Canal
- Assess potential changes in sediment mobilisation based on the outlet velocity changes and the sediment mobilisation characteristics of the sediments.

The assessment used the following sources of information:

- The hydraulic model developed for the project's flood assessment was used to generate hydraulic conditions (flow, water level and velocity) for the 1 EY and the 1% AEP design storms
- The locations of the new and upgraded outlets were identified from the design drawings (refer to Figure 6-1)
- The University of Queensland (2002) study 'Sediment Water Column Interactions in Alexandra Canal' was used to identify the sediment sizes in the Alexandra Canal near the outlets.



Author: Jeong Greaves
Date: 2019-05-02
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Figure 6-1

Stormwater outlets and treatment devices
Page 1 of 3

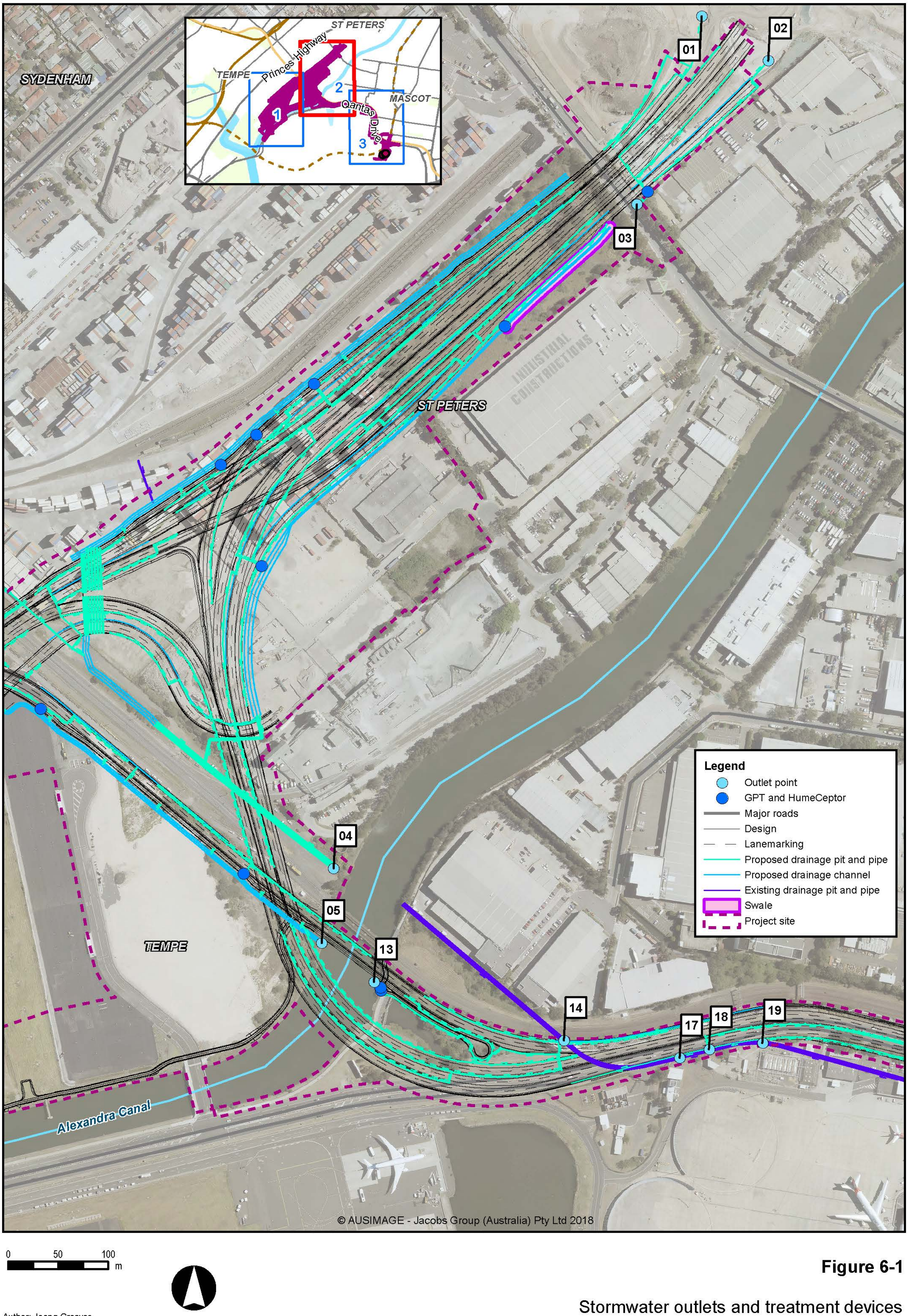

Figure 6-1

Stormwater outlets and treatment devices
Page 2 of 3

Author: Jeong Greaves
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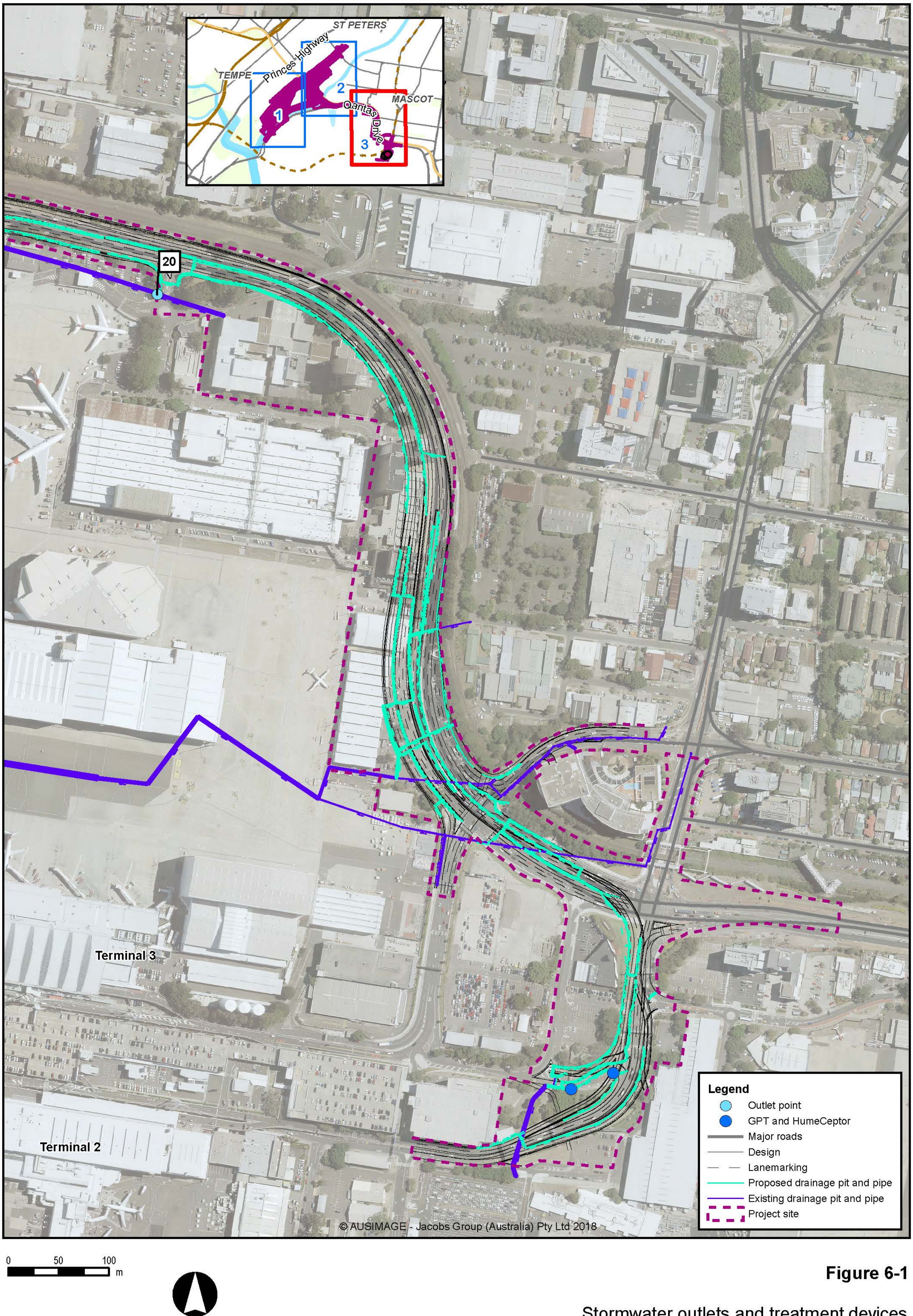

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Date: 2019-05-02
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Figure 6-1

Stormwater outlets and treatment devices
Page 3 of 3

6.2.1.2 Sediment size range

AECOM (2018) conducted surface sediment sampling in Alexandra Canal for this project. Twelve sediment samples were collected and the particle distribution is shown in Figure 6-2. Sediment sizes for the lower Alexandra Canal were also available from the University of Queensland (UoQ) Study 'Sediment Water Column Interactions in Alexandra Canal' (2002). The UoQ study indicated that the sediment size range was 0.013–0.6 mm. Figure 6-2 shows that the particle distribution spans a reasonably wide range but that the UoQ particle distribution can be considered as a representative (but conservative) average distribution, i.e. representing a finer particle size that is more susceptible to mobilisation. For this reason, the UoQ 'average' distribution was adopted for this assessment.

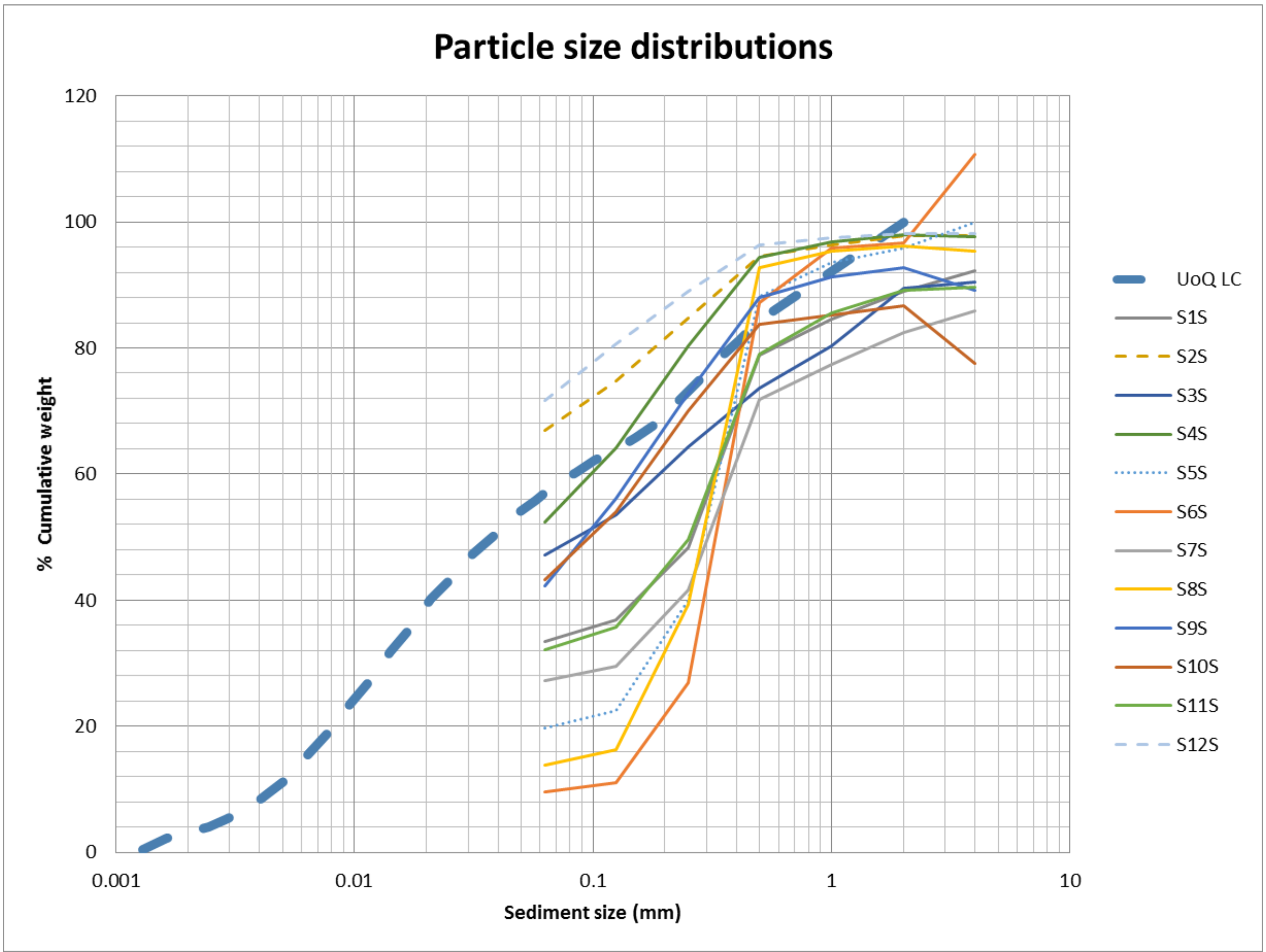

Figure 6-2 Particle size distributions for Alexandra Canal sediments from previous studies (University of Queensland (UoQ), 2002 and AECOM, 2018)

6.2.1.3 Hydraulic conditions at outlets

Hydraulic conditions at the outlets were determined from the project hydraulic model for the 1 EY and 1% AEP events. Model time series results for velocity were analysed at multiple locations around the outlets and the peak velocities were used to identify the maximum shear stress that would be applied at the channel bed at each location and for each event.

For outlets 04, 05 and 13, the hydraulic model included a direct hydraulic representation of the outlets under the proposed conditions. For the other outlets, the hydraulic model included a simplified representation by lumping together the inflows and applying them to the model at a suitable location within the reach that will receive the inflows. For these outlets, hand calculations of the velocities under proposed conditions at the specific discharge locations were used rather than the hydraulic model results. Outlet 9 was not assessed as there will be no changes to the upstream catchment draining to this outlet.

6.2.1.4 Sediment mobilisation potential

The potential for sediment to mobilise was assessed using the Hjulström Diagram, which indicates whether sediment is in suspension, transport, erosion or deposition, based on the size of the sediment and the velocity of flow.

An example of the Hjulström Diagram at Outlet 05 for the 1 EY event is shown in Figure 6-3. Particle size and velocity combinations occurring above the red line means erosion will occur; those below the blue line means deposition will occur; and those between the lines means sediments are in suspension, transitioning to transport mode. The third horizontal brown line on the left separates erosion and deposition zones for unconsolidated mud.

The horizontal lines represent the velocities for existing and proposed flow conditions at Outlet 05 for the 1EY at a number of locations in the outlet vicinity (i.e. at locations 'P38', 'P39', '114' and '123' in the hydraulic model domain within the Canal). Each line is extended horizontally over the full range of sediment sizes that are present in the Alexandra Canal near the outlet.

Bed sediment will start to be mobilised if the velocity of the flow exceeds the critical velocity for that sediment size (the 'erosion zone'). The study adopted the velocity outputs from the hydraulic modelling and UoQ sediment size ranges to assess the likelihood of erosion, transportation or deposition of sediment due to flow from the proposed outlets. A similar diagram was produced at all outlets to assess the likelihood of erosion under proposed conditions.

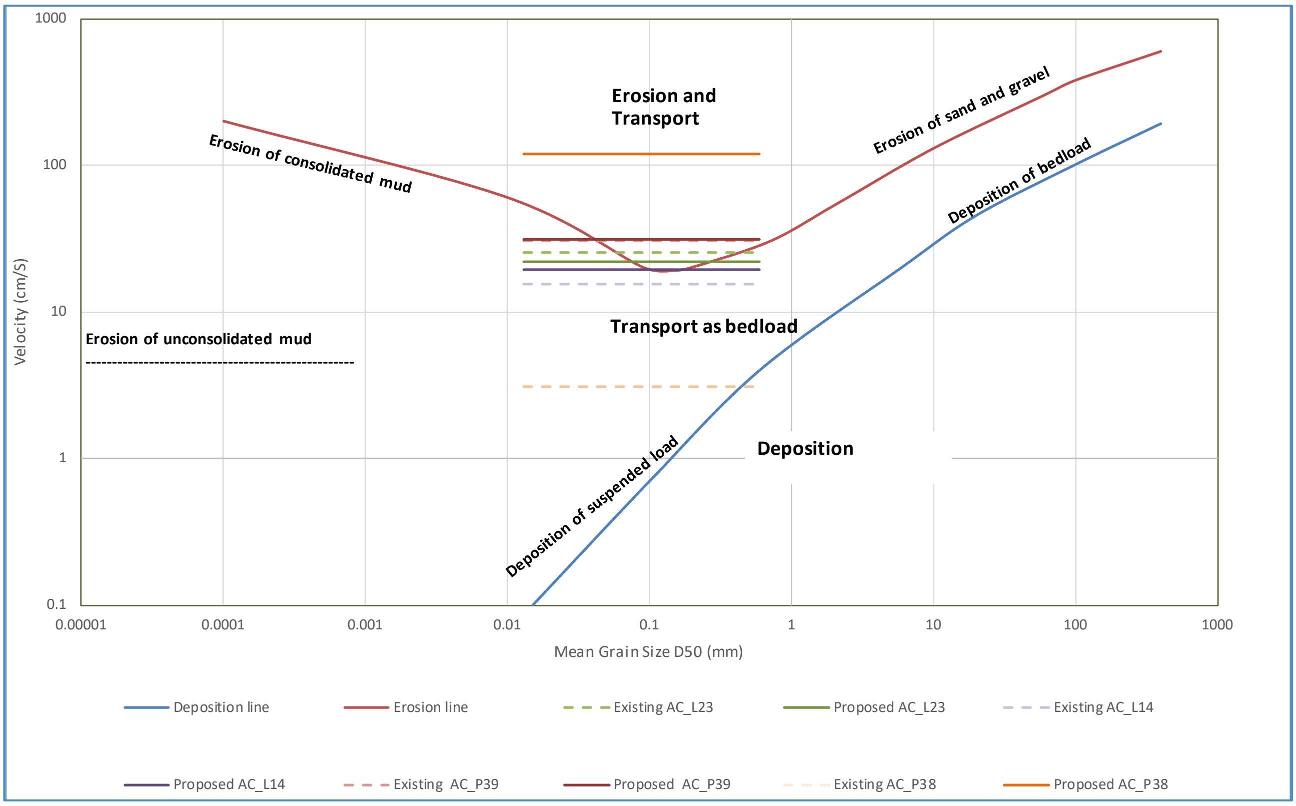

Figure 6-3 Example Hjulstrom Diagram for Outlet 05

6.2.1.5 Key findings

The key findings from the assessment area as follows:

- At Outlets 04, 05 and 13, when considering the 1% AEP event, it was found that the surface sediments were already in the erosion zone. Therefore, the project will not change the sediment mobilisation potential for this event at these locations
- At Outlet 04, localised erosion is expected for the 1 EY event and an energy dissipater is recommended to mitigate this impact
- At Outlet 05, a small amount of additional sediment is expected to be mobilised in the 1 EY event. An energy dissipater, while not essential, is recommended as a precaution
- At Outlet 10a, there is a 178% increase in catchment area. It is likely that sediment erosion would occur, but the erosion is localised and sediment would settle downstream. A detailed review of the change in flow and velocity regime at this outlet should be undertaken at the detailed design stage to determine whether mitigation measures may be required at this location
- At Outlet 11a, the localised velocity at the outlet is predicted to be slightly above ambient velocity during operation for the 1 EY event. However, the catchment area is 45% less than under existing conditions. The flow velocity and potential for sediment erosion are therefore expected to be lower under the proposed conditions
- At Outlets 08, 10, 11 and 12 the impact, no significant changes to hydraulic conditions are expected and therefore mitigation measures are not required.

The overall finding of the study is that sediments are likely to be mobilised locally at some proposed outlet locations, and that energy dissipation devices would be required to minimise this mobilisation. Table 6-1 summarises the likely required mitigation at each outlet.

Table 6-1 Summary of required mitigation at outlets

Outlet	Mitigation required?
04	Yes – energy dissipater
05	Optional (recommended)
13	No
08	No
09	N/A (no change to upstream catchment)
10	No
10a	Potential for impact, further analysis recommended at detailed design stage
11	No
11a	No
12	No

6.2.2 Bridge abutments

The following bridge abutments are within the floodplain of Alexandra Canal and have potential risk of scour:

- Terminal Link Bridge – shallow flow with 1% AEP flood velocity less than 2 m/s at abutments. Some cover may be required to prevent scouring up to 1% AEP flood
- Qantas Drive Bridge – low velocity, less than 1.5 m/s in the 1% AEP flood event. Some nominal cover may be required for scour protection up to 1% AEP flood
- Freight Terminal Bridge – low velocity, around 1 m/s in the 1% AEP flood event. Some nominal cover may be required for scour protection up to 1% AEP flood.

The velocities around the abutments are low and appropriate landscaping and cover material placed through and around the abutments will be sufficient to prevent scouring and mobilisation of scoured material into the waterways during flood events.

6.3 Surface water balance

The water balance assessment considers changes in flow between existing conditions and operation conditions. An increase in flow generally reflects an increase in impervious area, which could result in increased pollutant load, increased erosion and sedimentation potential and changes to the bed conditions of the waterways.

To identify changes in flow between existing conditions and operational conditions, MUSIC modelling was undertaken to estimate changes in annual stormwater runoff volume to receiving waterways because of the project. MUSIC catchments and input parameters are shown in Appendix C.

The impervious surface footprint of the project area within the Alexandra Canal catchment for the project is approximately 27 hectares. Under existing conditions, the effective impervious surface is 21 hectares. Due to the project, six hectares of commercial land would become pavement and 100 per cent impervious.

For the Mill Stream catchment, the proposed impervious footprint of the project area is 1.16 hectares, increasing from 1.03 hectares of pavement under existing conditions. This represents a change of 0.13 hectares from green vegetated land to 100 per cent impervious sealed road surface. Table 6-2 shows the predicted changes in flow due to increased impervious surface area in the project site.

Table 6-2 Existing vs operational condition flow from impervious surface area in the project site

Project site catchment	Existing conditions flow (ML/yr)	Operation conditions flow (ML/yr)	Percentage change in flow (%)
Alexandra Canal	249	266	6
Mill Stream	8.9	9.8	10

When the wider drainage catchment is considered, the predicted changes in stormwater flow from both the Alexandra Canal and Mill Stream catchments are very small. The Alexandra Canal catchment affected by the project is a total of 181 hectares made up of a mix of sealed roads, commercial and green land. The Mill Stream catchment affected by the project is a total of 2.7 hectares made up of a mix of sealed roads, commercial and re-vegetated land. Further details of the catchments can be found in Appendix C. Table 6-3 shows the percentage change in flow in the wider catchment areas.

Table 6-3 Percentage change in flow for larger catchments

Catchment	Existing conditions flow (ML/yr)	Operation conditions flow (ML/yr)	Percentage change in flow (%)
Alexandra Canal	1740	1750	1
Mill Stream	24.5	25.4	4

The project would have a negligible impact on the volume of stormwater discharged to Alexandra Canal and Mill Stream catchments.

Operation of the project is not expected to consume potable water or to generate wastewater. There is no water take or discharge from operation of the project other than stormwater.

6.4 Water quality impact assessment

The increase in impervious surface area means there is potential for higher pollutant loads to be discharged to the receiving environments of Alexandra Canal and Mill Stream. MUSIC modelling was undertaken to assess the ability of the proposed water treatment devices to achieve the Botany Bay pollutant reduction targets (SMCMA, 2011).

Locations where water treatment devices such as gross pollutant traps, swales and other secondary treatment devices could be installed were identified and modelled in MUSIC to assess the ability of these treatment devices to achieve the Botany Bay pollutant reduction targets.

6.4.1 Water quality treatment in the project

6.4.1.1 Alexandra Canal catchment

In the Alexandra Canal catchment, the concept design includes 15 treatment trains of gross pollutant traps (GPTs) and fine sediment removal devices at locations where there would be space for such treatment devices. Figure 6-1 shows the proposed treatment devices and the location of swales. Table 6-4 and Table 6-5 provide the catchment areas relating to the treatment devices. Some of the catchment areas that these devices would treat are very small, because treatment devices are proposed in any location that had available space as part of a holistic treatment strategy for the project. This would need to be refined at the next stage of design to optimise treatment device performance and minimise maintenance.

The GPTs and fine sediment removal devices have a high flow bypass of 1 EY built into the model.

There are three vegetated swales in in the vicinity of the former Tempe landfill:

- 137-metre-long swale treating 0.4 hectares of commercial space near the roundabout
- 315-metre-long swale on the northbound side of the road
- 235-metre-long swale (split into two) on either side of the entrance to the Qantas Drive extension (see Figure 6-1) on the southbound side of the road, to treat 1.8 hectares of design pavement north and south of the roundabout.

In Figure 6-1 the thick purple line shows the 137-metre-long swale and the thick blue lines show the 315 and 235 metre swales (split into two either side of the road). It is assumed that the swales would be designed to convey the same flow capacity as the stormwater infrastructure, which is the 10 per cent AEP event. See Appendix C for further treatment device input details. Swales constructed in the landfill area would be constructed from fill material and designed with flow velocities sufficiently low to prevent scouring of the bed material and material overlying the landfill capping layer.

Table 6-4 Alexandra Canal catchment treatment device locations

Name	Discharge point	Catchment area treated (ha)
GPT and fine sediment removal device 1	03	0.3
GPT and fine sediment removal device 2	04	1.4
GPT and fine sediment removal device 3	04	0.4
GPT and fine sediment removal device 4	04	0.2
GPT and fine sediment removal device 5	04	1.2
GPT and fine sediment removal device 6	04	2.2
GPT and fine sediment removal device 7	05	2.8
GPT and fine sediment removal device 8	05	0.2
GPT and fine sediment removal device 9	05	1.3
GPT and fine sediment removal device 10	05	0.4
GPT and fine sediment removal device 11	08	0.3
GPT and fine sediment removal device 12	10	0.7
GPT and fine sediment removal device 13	11	0.2
GPT and fine sediment removal device 14	11a	0.6
GPT and fine sediment removal device 15	12	1.8
Total treated design pavement		**13.9**

6.4.1.2 Mill Stream catchment

In the vicinity of Mill Stream, two treatment trains are proposed to be included in the design: a GPT and a fine sediment removal device (see Table 6-5). The runoff would flow through the existing trunk drainage and discharge to Mill Stream. The treatment devices have been modelled in MUSIC. Details are shown in Appendix C.

Table 6-5 Mill Stream catchment proposed treatment devices and locations

Name	Location	Road catchment area treated during operation (ha)
GPT and fine sediment removal device 1	Near Shiers Avenue/Sir Reginald Ansett Drive intersection	0.17
GPT and fine sediment removal device 2	Near Shiers Avenue/Ninth Street intersection	0.80
Total treated design pavement		**13.9**

6.4.2 Assessment of ability to achieve pollutant reduction load

6.4.2.1 Alexandra Canal catchment

The pollutant load from the 27 hectares of impervious surface area in the road design was assessed in MUSIC using the sealed roads pollutant loads and 100 per cent impervious surface. Appendix C provides further details.

The treatment devices in section 6.4.1.1 have been modelled in MUSIC to determine whether the treatment devices would be sufficient to meet the stormwater pollution reduction targets. Table 6-6 shows the modelling results for the operational load without treatment, compared to the operational load with treatment and the per cent pollutant load reduction. This was assessed against the target pollutant reduction. The pollutant load percentage reduction targets were adopted from the Botany Bay Water Quality Improvement Plan (SMCMA, 2011).

Table 6-6 Alexandra Canal pollutant reduction

Pollutant	Pollutant load (without treatment)	Pollutant load with treatment	Pollutant reduction	% Pollutant load reduction achieved	% Reduction target	Target achieved
Total Suspended Solids (kg/yr)	94400	46400	48000	50.8%	85	No
Total Phosphorus (kg/yr)	158	112	46	29.1%	60	No
Total Nitrogen (kg/yr)	638	504	134	21.0%	45	No

This assessment indicates that the pollutant reduction targets would not be achieved with the project. Further analysis to assess the impacts under existing conditions and operational conditions was undertaken and is discussed in section 6.4.3.1.

6.4.2.2 Mill Stream catchment

Part of the operational stormwater runoff would flow to the lower estuarine reach of Mill Stream. The total design footprint in this catchment is 1.16 hectares. The operational impervious surface pollutant load was assessed in MUSIC using the sealed roads pollutant loads and 100 per cent impervious surface. See Appendix C for further details.

The treatment devices described in section 6.4.1.2 have been modelled in MUSIC to determine if the provisions made would be sufficient to meet the stormwater pollution reduction targets. Table 6-7 shows the modelling results for the operational load without treatment, compared to the operational load with treatment and the per cent pollutant load reduction. This was assessed against the target pollutant reduction. The pollutant load percentage reduction targets were adopted from the Botany Bay Water Quality Improvement Plan (SMCMA, 2011).

Table 6-7 Mill Stream catchment – Operational pollutant load reduction

Pollutant	Pollutant load (without treatment)	Pollutant load with treatment	Pollutant reduction	% Pollutant load reduction achieved	% Reduction target	Target achieved
Total Suspended Solids (kg/yr)	2200	578	1622	73.7%	85	No
Total Phosphorus (kg/yr)	3.5	2.0	1.6	45.7%	60	No
Total Nitrogen (kg/yr)	26.4	15.9	10.5	39.8%	45	No

This assessment indicates that the pollutant reduction targets would not be achieved with the project. Further analysis to assess the impacts under existing conditions and operational conditions was undertaken and is discussed in 6.4.3.2.

6.4.3 Existing and operational catchment assessment

6.4.3.1 Alexandra Canal catchment

Section 4.8 provides a summary of the operational land use types affected by the project in the Alexandra Canal catchment. Table 6-8 shows the proposed land use types and areas during the operational phase of the project compared to existing conditions.

Table 6-8 Alexandra Canal project drainage catchment – Land use type and area for existing and operation conditions

Land use type	Operational phase area (ha)	Existing area (ha)
Commercial	138.80	154.28
Pavement (untreated)	17.41	15.88
Pavement (treated*)	15.70	NA
Re-vegetated land	9.6	10.75

*Treated by GPT and fine sediment removal device or swale

Based on the land use types shown in Table 6-8 and the treatment devices discussed in section 6.4.1.1, the percentage change in pollutant load from the existing conditions to operation with treatment conditions was modelled and is shown in Table 6-9.

Table 6-9 Percentage change in pollutant loading from existing to operation with treatment

Pollutant	Existing load	Operational load with treatment	Percentage change
Total Suspended Solids (kg/yr)	315000	318000	1%
Total Phosphorus (kg/yr)	509	551	8%
Total Nitrogen (kg/yr)	3777	3690	-3%

Table 6-11 indicates there is a negligible increase in pollutant loading from existing to operational conditions for total suspended solids and a minor increase in total phosphorus, indicating a moderate impact.

6.4.3.2 Mill Stream catchment

A similar analysis was undertaken for Mill Stream catchment. Section 4.8.2 provides a summary of the existing land use types affected by the project in the Mill Stream catchment. Table 6-10 shows the proposed land use types and areas during the operational phase of the project compared to existing conditions.

Table 6-10 Mill Stream catchment – existing and operation catchments

Land use type	Operational phase area (ha)	Existing area (ha)
Treated pavement	1.8	1.7
Green area	0	0.1
Commercial	0.8	0.8

Based on the land use types shown in Table 6-10 and the treatment devices discussed in section 6.4.1.2, the percentage change in pollutant load from the existing condition to operation with treatment is shown in Table 6-11.

Table 6-11 Percentage change in pollutant load from existing to operation with treatment

Pollutant	Existing	Operation with treatment	Percentage change
Total Suspended Solids (kg/yr)	4460	3100	-36%
Total Phosphorus (kg/yr)	7.19	5.95	-19%
Total Nitrogen (kg/yr)	53.3	45.6	-16%

It is evident that the inclusion of treatment devices in the proposed design results in a reduction in all pollutants when comparing the existing condition to the operational condition. Therefore, operation of the project would result in an improvement in water quality runoff, compared to existing conditions.

6.4.4 Summary of water quality modelling

6.4.4.1 Alexandra Canal catchment

As shown in Table 6-6 the pollutant reduction targets would not be achieved for Alexandra Canal with the project. There is a negligible increase in pollutant loading from existing to operational conditions for total suspended solids, and a minor increase in total phosphorus, indicating a small impact.

The operational water quality impacts were assessed by considering predicted changes nutrient loadings to the waterways. These are unlikely to impact the habitat value of the catchment. There are no sensitive receivers within Alexandra Canal, and the very small impact is not expected to cause any adverse effects. The impact is considered for these reasons to be acceptable.

The need for further mitigation measures is discussed in section 8. The performance of the treatment devices, and the type and operation of specific stormwater treatment measures across the project, should be further refined as part of detailed design with the aim of achieving the pollution reduction targets supported by revised modelling. Given the space constraints around Alexandra Canal and the treatment options available, however, it is unlikely that the pollution reduction targets would be met for this catchment.

6.4.4.2 Mill Stream catchment

As shown in Table 6-7 the pollutant reduction targets are not achieved for the Mill Stream catchment. However, the water quality treatment measures proposed in the design would reduce pollutants export rates during operation to below the existing rates. So, although the pollutant reduction targets are not met, there an overall improvement in water quality in predicted. This is consistent with the Sydney Airport Environment Strategy 2019–2024.

The performance of the treatment devices, and the type and design of specific stormwater treatment measures across the project, should be further refined as part of detailed design and supported by modelling, with the aim of achieving pollutant reduction targets. Given the space constraints and the treatment options available, it is unlikely that the pollution reduction targets would be met in this catchment. Nevertheless, an overall improvement in water quality in the receiving waters could be expected.

6.4.5 Contaminant impacts

6.4.5.1 Contaminated groundwater entering road drainage system

As discussed in section 4.1.2, contaminants are widespread in the project site and groundwater is likely to contain contaminants. Contaminants could seep into the road stormwater drainage system and discharge to Alexandra Canal as contaminated stormwater. The drainage system for this project would be designed to protect the stormwater system from groundwater seepage. The likelihood of contaminated groundwater discharges to Alexandra Canal through the stormwater system is very low (Technical Working Paper 6 – Groundwater).

6.4.5.2 Landfill leachate

The Tempe Landfill Impact Assessment indicates that leachate generation would reduce due to the project, associated with the improved capping design in the areas affected by the project. Furthermore, enhancement to the leachate management system required to address increased leachate generation during construction (due to the opening of the cap) would ensure that the system would have more than enough capacity during the operational phase to ensure no migration of leachate from the former Tempe landfill to Alexandra Canal (Technical Working Paper 16 – Landfill Assessment).

6.5 Geomorphic and scour impacts

There is potential for geomorphic impacts such as changes in bed stability. This would typically occur as a result of increases in runoff due to increased impervious surface. As noted in section 6.3, there would be a minor change in flow from existing conditions to operational conditions. This minor change would not alter flow velocities significantly.

Technical Working Paper 6 – Flooding assesses the changes in flow characteristics during large flood events across the entire catchments affected by the project, including the main flow channels and the floodplains. The key findings from that assessment relating to main channel flow, geomorphology and scour potential are as follows:

- The project would result in the following changes in peak velocities during a 1% AEP event in the Alexandra Canal channel:
  - Change of plus and minus 0.1 m/s on an existing velocity of 0.9 m/s in a section of Alexandra Canal in the vicinity of the Terminal Link and Qantas Drive bridges. The net impact on bed erosion and bank stability in Alexandra Canal would be minor
  - Increase by less than 0.1 m/s on an existing velocity of 1.1 m/s in a section of Alexandra Canal in the vicinity of the Freight Terminal bridge. The impact on bed erosion and bank stability in Alexandra Canal would be minor given the relative increase and the localised extent of the impact
- There would be a slight reduction in flows and scour potential in the Tempe Wetlands, which is due to a portion of the catchment that presently drains toward the wetlands being diverted towards Alexandra Canal as part of the proposed works for the Terminal 1 connection. Scour protection would be provided at the outlet to new or upgraded drainage systems that may be required to control runoff from the project in order to mitigate any localised increases in velocity and scour in the Tempe Wetland
- Given the nature of proposed works within the Mill Stream catchment are very small, the project would have a negligible impact on peak flows and velocities in Mill Stream.

In addition, the geomorphological characteristics of the watercourses are primarily categorised as having no potential for lateral or vertical adjustment, due to the engineered nature of the receiving waters environment (concrete channel, piped channel, rock-lined channel, shaped channel and underground concrete channel). For these reasons, no geomorphic impacts from operation of the project are expected.

6.6 Summary of impacts on Commonwealth land

This section focuses on the impacts on waterways on Commonwealth land, rather than on the land itself. Waterways on Commonwealth land include portions of Alexandra Canal Mill Stream (see Figure 4-1). All these waterways would receive discharge from the project, either directly from surface runoff or through the drainage network.

A small section of the road design would drain into the Northern Pond on the airport site (subject to the Sydney Airport Master Plan 2039). Water from this pond drains directly into Alexandra Canal. Since it is not feasible to provide water quality treatment for this small section of the road 2.7 ha with a 7% increase in impervious area, there would be a 5% increase in flow and a minor water quality impact from this section of the project. Water would be discharged from the project through this stormwater network. The water quality could be affected, but it is negligible. The pond will be modified to offset the loss of storage volume caused by the introduction of the new piers for the Qantas Drive extension bridge foundations. The modifications will include enlargement of the pond to ensure that the existing storage volume is maintained.

Runoff from the project would discharge to Mill Stream. The MUSIC modelling carried out indicated that there would be an improvement in water quality in this water body when comparing existing to operational conditions for the Mill Stream catchment.

6.7 Consistency with Sydney Airport Master Plan 2039 and Environment Strategy 2019–2024

The Sydney Airport Master Plan 2039 sets out to ensure that stormwater quality is adequately addressed in the construction and operational phases of development proposals. This study is consistent with that objective.

Table 6-12 highlights the key actions and initiatives in the Sydney Airport Environment Strategy 2019–2024 that are relevant to water quality and demonstrates how this project will be consistent with this strategy.

Table 6-12 How this project is consistent with the Sydney Airport Environment Strategy 2019–2024

Water quality and water use action plan from the Environment Strategy 2019-2024	How this project is consistent with the Strategy
Identify water quality improvement projects for waterways surrounding Sydney Airport and proactively seek out partnership opportunities to implement feasible projects.	The proposed inclusion of water treatment devices for surface water runoff where space is available is consistent with this requirement.
Continue to implement cost effective water efficiency and saving opportunities.	Not related to water quality.
Investigate the feasibility of further expanding the capacity of the recycled water treatment plant in the North-West Sector of the airport site to address increased demand for non-potable water.	Not related to water quality.
Develop and implement a guideline for introducing water sensitive urban design and rainwater harvesting into new developments within the airport site as appropriate.	Gross pollutant traps, fine sediment removal devices and swales are proposed part of design where space is available.
Consider the impacts associated with climate change (increased rainfall intensities and elevated sea levels) on the performance of the stormwater drainage network and level of flood protection at the airport site and use this information to inform the design of proposed developments and associated stormwater infrastructure.	Not related to water quality.

Water quality and water use action plan from the Environment Strategy 2019-2024	How this project is consistent with the Strategy
Incorporate design features in new developments to reduce contaminant loads in stormwater and to align with catchment water quality objectives.	Gross pollutant traps, fine sediment removal device and swales are proposed part of design where space is available.
Investigate feasibility of developing a new recycled water treatment plant to provide recycled water to the T2 and T3 precinct.	Not related to water quality.
Continue to ensure that stormwater quality is considered for the construction and operational phases of development proposals.	This assessment satisfied this requirement. Implementation of the proposed mitigation measures would ensure that stormwater quality is considered during detailed design and in the operational phase.
Continue to implement the initiatives contained in the Sydney Airport Stormwater Quality Management Plan, including continuation of regular stormwater quality sampling.	Document yet to be finalised by Sydney Airport. Mitigation measures include ongoing monthly monitoring during construction and post construction until the works area is adequately stabilised (see section 8.3).
Continue to implement the Sydney Airport Wetlands Management Plan and Wetlands Enhancement Program.	Document yet to be finalised by Sydney Airport.
Continue to work with airport tenants and users to reduce the water quality impacts of airfield activities.	Not related to water quality.

The key performance indicator relevant to surface water quality for the actions and initiatives in Table 6-12 is that water quality monitoring results for stormwater from the airport stay the same or improve. During operation, this key performance indicator would be achieved for the component of the project that is located in the Mill Stream catchment, as indicated by the MUSIC modelling. For the portion of the project that would discharge into Alexandra Canal, as indicated by the MUSIC modelling, further investigation would be required during detailed design to assess opportunities to achieve this key performance indicator.

7. Cumulative impacts

7.1 Botany Rail Duplication

The broader Sydney Gateway program includes another major project to duplicate the existing Botany rail line. The project would duplicate around three kilometres of rail line – see Figure 7-1. The Botany Rail Duplication project would include track realignment, modifications to rail and road bridges and embankments, and all associated ancillary works. The Botany rail line runs along the length of Qantas Drive and Joyce Drive and as such is located immediately next to the Sydney Gateway road project site. The Botany Rail Duplication would also affect the Mill Stream catchment.

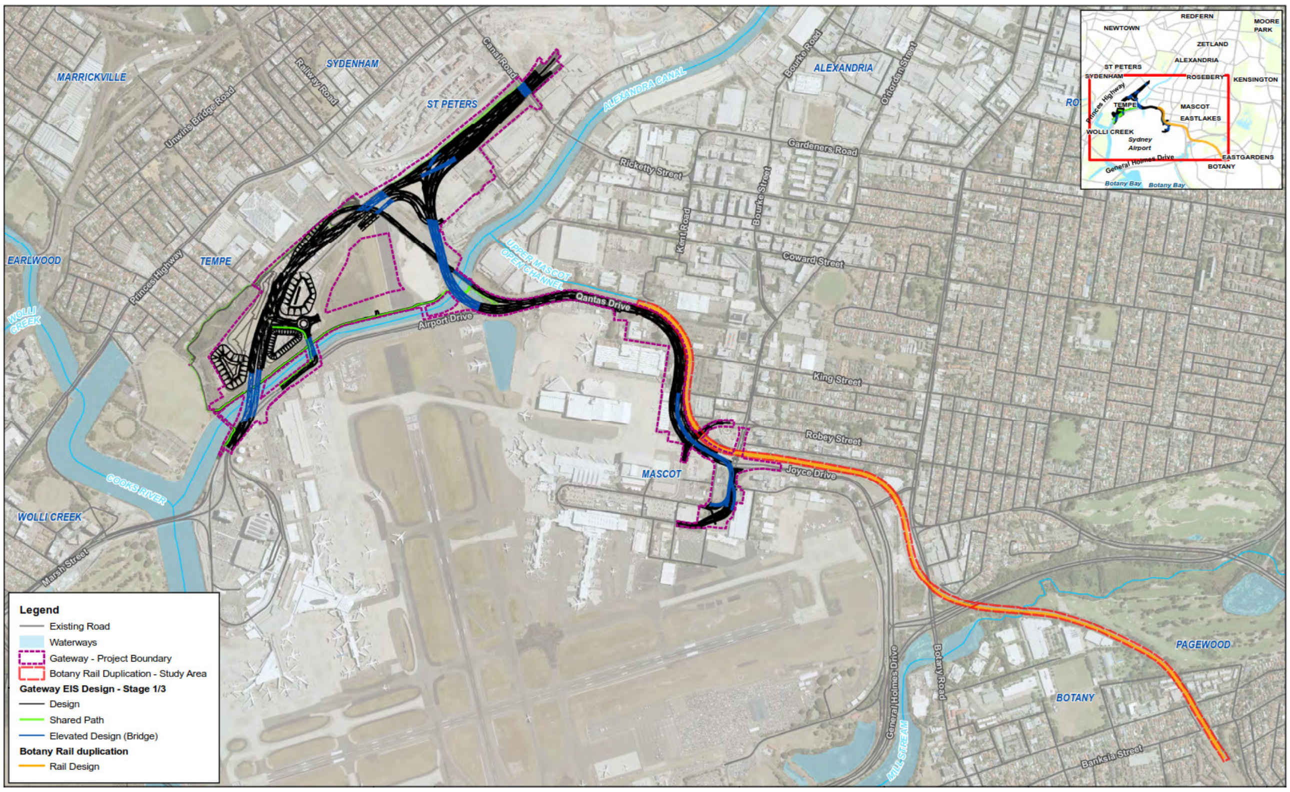

Figure 7-1 Gateway Road project and Botany Rail Duplication projects

Potential sources of surface water contamination from the Botany Rail Duplication may include:

- Earthworks during construction
- Operational wear of rail infrastructure (for example ballast and sleepers) and train brake pads on locomotives and wagon rolling stock
- Lubricants and oils dripping from locomotives; and
- Fuels, oils or other chemical spills or leaks from use of plant and equipment during construction rail maintenance operations.

These would potentially result in sediments, gross pollutants, metals, organic compounds and nutrients entering waterways.

Construction impacts would be mitigated in accordance with the Blue Book and implementation of appropriate mitigation measures would result in no significant impacts during construction. The project would be constructed within the existing rail corridor and so would not involve significant new areas of impervious surface. The potential increase in surface water contamination due to pollutants from the Botany Rail Duplication in operation is therefore expected to be negligible.

As the proposed rail project is a duplication of the existing rail line, sources of contaminants are already likely to be present and entering waterways. The potential for the duplication to increase the level of contaminants significantly is expected to be low.

Drainage from the rail line would flow into the Sydney Airport pit and pipe network and through to Northern Pond or Alexandra Canal. However, there is no anticipated change in water quality in the canal. Cumulative impacts associated with the project and the Botany Rail Duplication are therefore likely to be negligible.

The Botany Rail Duplication has potential to have significant impact in Mill Stream with the construction of an additional rail bridge (including a pier and abutments) over Mill Stream and a large portion of flow from the Botany Rail Duplication project site discharging to Mill Stream. The Sydney Gateway road project has a very small portion of the project area within the Mill Stream catchment. This assessment indicates that significant water quality impacts in Mill Stream due to construction and operation of the Sydney Gateway road project are not anticipated. With the implementation of appropriate management and mitigation measures, the potential for the Sydney Gateway road project to increase cumulative impacts associated with both projects is therefore expected to be negligible.

7.2 Other proposed major developments

Additional major developments constructed within the Cooks River and Georges River catchments may have impacts on flow and water quality in the receiving waterways within the project site. Increases in impervious area during construction and operation of other major projects may contribute to the volume and pollutant loading of surface runoff in the area.

Major developments currently under construction in the vicinity of the project include:

- M4–M5 Link and New M5
- Sydney Metro South-West
- Airport North upgrades – O'Riordan Street
- Airport East upgrades – General Holmes Drive, Botany Road, Joyce Drive.

Sections of the New M5 and small sections of the M4–M5 Link will be constructed in the Georges River and Cooks River catchments to the north and west of the project site. Construction measures for the New M5 will include water treatment plants at Arncliffe and Canal Road which would discharge into the Cooks River and Alexandra Canal respectively. The EIS for the New M5 notes that the water discharging from these treatment plants would be of better quality than the current water quality of the receiving environments (AECOM, 2015).

The EIS for the New M5 concludes that the treatment devices included in the New M5 design would result in a minimal water quality impact to Alexandra Canal and the Cooks River. Similarly, the M4–M5 Link EIS documents conclude that the M4–M5 Link would reduce stormwater pollutant loading to receiving waterways and have a neutral or beneficial effect. A full outline of the measures being implemented to mitigate potential water quality impacts is available in the approval documents for New M5 and M4–M5 Link and construction management plans. As long as mitigation measures proposed in the EIS documents from these projects are fully implemented no significant impact is expected to water quality.

Other developments in the vicinity of the project, proposed but not yet approved, include the F6 Stages 1 and 2 and Qantas Flight Training centre.

If mitigation requirements are applied consistently across projects, no adverse cumulative surface water impacts are anticipated. As noted in section 6 and reflected in the approval documents for the WestConnex projects, where there is opportunity to include treatment devices or water treatment plants in the design and construction and operation of the project, the impacts on water quality are expected to be neutral or even beneficial when compared to existing conditions. As such, the residual risk to the environment from the cumulative impacts of other projects is expected to be low.

8. Recommended mitigation measures and monitoring program

8.1 Construction

A Soil and Water Management Plan (SWMP) should be prepared as part of the Construction Environmental Management Plan (CEMP) to manage and monitor potential surface water quality impacts during construction. This should be developed in accordance with the Blue Book, which is applicable to both NSW and Commonwealth land. Mitigation measures should be guided by the Blue Book to determine the magnitude of rainfall events to which the capacity of the construction mitigation measures should be designed. All works within or adjacent to waterways should be managed in accordance with the DPI's guidelines for Controlled Activities on Waterfront Land (DPI, 2012).

A soil conservation specialist should be engaged to provide advice regarding erosion and sediment control before the start of construction activities.

A range of mitigation measures should be implemented, including the following:

- Site specific erosion and sediment controls should be implemented at all work sites in accordance with the Blue Book. The controls would aim to:
  - Divert water from upslope areas around the site
  - Reduce erosion from within the site
  - Intercept runoff and capture sediment from site
  - Protect watercourses, drainage lines and drain inlets down-gradient from the site
- Erosion and sediment controls measures should be inspected and maintained throughout the works to ensure they are operating effectively
- Stockpiles of loose material should be protected from erosion due to rain and wind
- Where practical, permanent scour protection measures required for the operation phase should be installed early in the construction phase
- Areas of exposed soil should be minimised within the project site (for example by minimising vegetation clearing and ground disturbance), and disturbed areas should be protected and stabilised during periods of inactivity to reduce the potential for erosion
- Erosion, sediment and dust should be minimised during using appropriate stormwater controls and water sensitive design measures, eg containment bunds, silt traps, sediment basins and fences, turbidity barriers and diversions, dust suppression and earth compaction
- Regular visual inspections of stockpiles, temporary and permanent drainage lines, and construction areas should be carried out to assess the effectiveness of mitigation and management measures. Damaged sections should be replaced as appropriate
- Areas disturbed during construction should be rehabilitated and restored as soon as possible after completion of works to promote surface stability and to reduce the potential for erosion
- During periods of heavy or prolonged rainfall, works which have the potential to cause erosion should be suspended
- Site shutdown procedures should be developed and updated regularly as the construction progresses before forecast inclement weather, and before planned site shutdowns of more than 48 hours
- All interactions with acid sulfate soils should be carried out in accordance with the requirements of the Acid Sulfate Soil Manual (Acid Sulfate Soil Management Advisory Committee, 1998) to minimise potential acid generation and prevent acidic water from entering drainage systems and receiving waters

- Impervious and bunded areas should be established for the on-site maintenance of construction plant and equipment. No major plant and equipment maintenance would occur on site other than within designated maintenance areas
- Construction plant and equipment should be regularly inspected for leaks and will be removed from site as required to prevent soil and surface water contamination
- Construction plant and equipment should be refuelled using dedicated refuelling apparatus only. Stocked spill kits will be installed and be made available immediately during all refuelling. All personnel involved in refuelling activities will be trained in the use of spill kits
- Spills of fuels, lubricants, chemicals and other liquids should be cleaned immediately. Potentially contaminated materials will be appropriately contained, tested and stored prior to disposal at an appropriately licensed waste facility
- All potentially contaminating, contaminated and hazardous substances should be stored in secured, bunded and impervious locations. Storage locations will be isolated from surface water and outside the extent of the 20-year ARI design flood wherever practicable
- Batters and slopes should be adequately stabilised to hold the soils in place.

8.1.1 Works within Alexandra Canal

Recommended mitigation measures to manage potential impacts due to works within Alexandra Canal (such as construction of new and upgraded stormwater outlets):

- Works that could disturb sediments in Alexandra Canal should be avoided as much as possible, and where unavoidable, the works would be staged to minimise the footprint of disturbed areas
- For works required below the water surface level, disturbance and mobilisation sediments should be avoided by:
  - Installing silt curtains around each outlet location
  - Establishing coffer dams, within the area protected by silt curtains, to provide a dry working environment and minimise the potential mobilisation of disturbed sediments
  - Constructing the new outlets and scour protection in the canal wall within the area protected by the coffer dams

  Alternative management methods could also be developed and adopted to achieve the same outcome
- Works that could disturb the sediments within Alexandra Canal should be planned and carried out in consultation with NSW EPA and Sydney Water Corporation.

8.1.2 Temporary discharges to stormwater network and waterways

Recommended mitigation measures to manage temporary discharges to stormwater networks and waters during construction are as follows:

- Construction methods that minimise that amount of dewatering required and the amount of extracted water that needs to be managed should be investigated and adopted wherever practicable
- Potentially contaminated stormwater runoff should be collected and managed separately to other surface water runoff. Potentially contaminated water should be tested against discharge criteria selected as per section 3.4.5 (refer to Table B-2 of Appendix B for interim criteria). Construction water should be discharged to the stormwater system or directly to receiving waters only if contaminant levels are below the adopted discharge criteria; otherwise, appropriate treatment or offsite disposal should occur
- If extracted groundwater is to be discharged to waterways, this water should be tested and treated as required to meet the discharge criteria selected as per section 3.4.5 (refer to Table B-2 of Appendix B for interim criteria) and then discharged at a cumulative rate to be agreed with Sydney Water Corporation

- Surface runoff from areas of disturbance with the former Tempe landfill that has come into contact with landfill materials or other potentially contaminating substances should be managed as described in Technical Working Paper 16 – Landfill Assessment.

8.1.3 Residual construction water quality impacts

The recommended mitigation measures aim to minimise temporary impacts on waterways during construction. With the implementation of these measures, any potential impacts are unlikely to have a material impact on ambient water quality within the waterways.

Therefore, the construction of the project is unlikely to have an influence on whether the adopted long term ambient trigger values are protected (if currently met) or achieved (if not currently met).

8.2 Operation

8.2.1 Surface runoff

Even with the inclusion of treatment devices such as fine sediment removal devices and gross pollutant traps in the design, operation of the project would result in an increase in water quality pollutants exported to Alexandra Canal. As such, the project should aim to develop and implement treatment solutions to improve overall water quality in the receiving waters compared to the existing water quality during the detailed design phase.

For the Mill Stream catchment affected by the project, reductions in total suspended solids, total nitrogen and total phosphorus are predicted when compared to the existing loads because of the inclusion of treatment devices.

Surface water drains and associated infrastructure will be designed to prevent scour of soil, erosion and associated sedimentation impacts.

8.2.2 New discharge outlets

In regard to new discharge outlets in Alexandra Canal, scour protection should be provided in all areas susceptible to scouring. Scour protection should be developed through a review of detailed flood modelling results and supported by appropriate modelling during detailed design in consultation with stakeholders, including Sydney Water Corporation and NSW EPA.

8.2.3 Bridge abutments

The potential for scour at bridge abutments should be considered during detailed design for flow events up to and including the 1% AEP, and scour protection should be included in the detailed design as required.

8.2.4 Contaminated groundwater entering waterways

The road drainage system should be designed to prevent infiltration of contaminated groundwater.

8.2.5 Mitigation for spills

An Incident Response Plan to deal with accidents or spills should be developed and implemented to minimise the damage to the surroundings. If warranted, spill containment will be provided.

8.3 Surface water quality monitoring program

The key indicator for water quality from the Sydney Airport Environment Strategy 2019–2024 is that water quality monitoring results for stormwater from the airport should stay the same or improve. To demonstrate that this is being achieved, a water quality monitoring program is recommended.

A water quality monitoring program has been developed for the project based on the nature of the potential water quality impacts identified. Baseline monitoring commenced in December 2017 to obtain further understanding of existing conditions. An ongoing water quality monitoring program is recommended during construction and should continue post construction until the works area is adequately stabilised. Sampling should be undertaken monthly during a range of wet and dry conditions (where possible).

The monthly surface water quality monitoring that is currently occurring (monthly sampling with additional sampling within 24 hours after rainfall of more than 10 mm in 24 hours) should continue at the locations shown in Figure 4-5 prior to commencement of the project, to continue development of the baseline dataset.

Monitoring of waterways is recommended to be the same as the baseline assessment, including:

- In situ measurement of water quality parameters at each location for pH, electrical conductivity (EC), temperature, dissolved oxygen (DO), reduction-oxidation potential (redox) and turbidity. Direction of flow should be noted
- Laboratory analysis of all water samples for:
  - Physical properties: pH, total dissolved solids (TDS), total suspended solids (TSS), turbidity, major anions and cations (calcium, magnesium, potassium, sodium, chloride, sulfate, carbonate and bicarbonate alkalinity, total alkalinity)
  - Nutrients: nitrate, nitrite, total nitrogen, ammonia and total phosphorus
  - Contaminants of concern: per- and poly-fluoroalkyl substances (PFAS), total recoverable hydrocarbons (TRH), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), total phenols, organochlorine pesticides (OCP), organophosphorus pesticides (OPP), total and dissolved heavy metals (lead, zinc, copper, cadmium, chromium, nickel, iron, manganese, mercury, arsenic and aluminium) and tributyltin (TBT)

The water quality patterns of Alexandra Canal and Mill Stream near the project site are complex and there are existing pollutants sources in both waterways. In the case of trigger values being exceeded, surface water monitoring would need to be able to distinguish local sources of contaminants from contaminants exported from the project during the construction phase.

As a minimum, continued monitoring at locations SW2 and SW6 on Alexandra Canal and SW8 on the Cooks River is proposed, with SW2 and SW6 used to monitor water quality impacts from the project. The locations of these monitoring stations are presented in Figure 4-5. A new monitoring station is required near the discharge location to Mill Stream.

A number of contaminants (see section 4.7), physical and chemical stressors and toxicants, currently exceed the default ANZECC (2000) trigger values. The following site specific trigger values are proposed for short term water quality monitoring within the waterways during construction:

- For physical and chemical stressors, use the least stringent of the 80th percentile values from the monitoring data and the default trigger values for aquatic ecosystems in marine waters
- For non-bioaccumulative toxicants, use the least stringent of the 80th percentile values from the monitoring data and the 80% species protection level for marine waters
- For bioaccumulative toxicants, use the least stringent of the 80th percentile values from the monitoring data and the 95% species protection level for marine waters.

A full list of proposed site specific trigger values for water quality monitoring during construction is tabulated in Table B-1 in Appendix B.

Exceedances of the water quality objectives at downstream monitoring locations (SW6 in Alexandra Canal and new monitoring station in Mill Stream) would be investigated as follows:

- The concentration at the downstream monitoring location would be compared to the concentration at the upstream monitoring location
- If the concentration at the upstream location exceeds or is equal to the concentration at the downstream location, no further action is required
- If the concentration at the upstream location is lower than the concentration at the downstream location and exceeds the site-specific trigger value, then the monitoring data should be reviewed against long-term averages
- If the review confirms the exceedance of the site-specific trigger value at the downstream location and the lower concentrations at the upstream location, and the exceedance deviates from long term averages and variability in the historic monitoring data, then an investigation into the source of contamination and risks to environmental values would be undertaken
- If the investigation indicates potential for risks to environmental values, an action plan to mitigate potential harm would be developed.

The site specific trigger values proposed in Table B-1 are indicative and subject to refinement as more monitoring data is collected prior to construction.

At this stage there is no monitoring location at the project discharge location on Mill Stream. For this reason it is recommended to adopt the default ANZECC (2000) trigger values in Appendix A, until there is sufficient baseline data (12–24 months) to develop site specific values in accordance with the methodology described in section 3.4.4.

It is recommended that the monitoring program be continued after construction until the works areas are adequately stabilised, with the data assessed against the short term site specific trigger values in Table B-1. Monitoring may be continued beyond this point into operation, however, no significant water quality impacts are predicted for the operation phase and it may be appropriate to redesign the monitoring program and associated site specific trigger levels at that stage.

9. Conclusion

It is important to protect waterways from pollutants when designing, constructing and operating a new road project for the benefit of the environment and water users. This report sets out the results of a water quality impact assessment undertaken to inform design, construction planning and environmental assessment of the Sydney Gateway road project.

The project is located within the catchments of Alexandra Canal (which is a sub-catchment of the Cooks River catchment) and the Mill Stream catchment (which is a sub-catchment of the Georges River catchment). The identified environmental values for these catchments are:

- Aquatic ecosystems
- Visual amenity
- Secondary contact recreation
- Primary contact recreation
- Aquatic food.

The management framework set out in the ANZECC (2000) guidelines was used to identify appropriate criteria to assess the existing water quality data for these environmental values. As part of Mill Stream, is located on Commonwealth land, the limits of accepted contamination specified in Schedule 2 of the Airports (Environment Protection) Regulations 1997 were also assessed against the baseline water quality data.

A review of existing environmental and water quality conditions indicated that both Alexandra Canal and Mill Stream catchments are currently in a poor condition as a result of historical industrial uses in the area and the urban environment. Baseline water quality data indicated that the assessment criteria indicated in the ANZECC (2000) guidelines for the identified environmental values was frequently not met for the Alexandra Canal and Mill Stream.

During construction, there is the potential to impact these waterways through physical impacts such as increasing sedimentation to waterways, increasing turbidity and changing bed and bank conditions. There is also potential to increase contaminants in the waterways if contaminated sediments are disturbed; contaminated extracted groundwater is discharged to the waterways; runoff from contaminated disturbed areas enters the waterways; and standard erosion and sedimentation control measures are not implemented on site.

Standard construction management and mitigation strategies (as recommended in the Blue Book and widely adopted across the construction industry) to minimise sediment disturbance, mobilisation and runoff are recommended to be adopted during construction of the project. Where runoff from the project has potential to be contaminated, additional mitigation measures such has quarantine and removal of water may be required. If extracted groundwater is to be discharged to waterways, this may require treatment to meet the proposed water quality discharge criteria and Sydney Water Corporation discharge rate limits. These construction impacts would be temporary and manageable with application of appropriate construction mitigation measures.

The water balance assessment concluded that the change in flow due to the project during construction would be negligible, and the change in flow during operation would be minimal.

During operation, there is potential to impact waterways through:

- Greater volume of stormwater discharge from new outlets and new overland flow paths resulting in increased flow velocities, which may increase scouring and mobilisation of contaminated sediments
- Increase in sediment and pollution loads in stormwater due to the increase in road surface and vehicular tyre and pavement wear
- Contaminated groundwater and leachate entering the road drainage system.

In Alexandra Canal, a minor increase in pollutant loads is predicted by the MUSIC modelling after implementation of water quality treatment devices. In Mill Stream, MUSIC modelling found the water quality would improve with the inclusion of water quality treatment devices, when comparing existing conditions to design conditions. This achieves the key indicator for water quality from the Sydney Airport Environment Strategy 2019–2024.

Potential impacts on the geomorphic condition of the watercourses during construction and operation of the project are considered minor and manageable with application of proposed designs and current construction practice mitigation measures. Specific localised mitigation measures are proposed where outlet energy dissipation is required prior to releasing water to waterways. Consultation with NSW EPA and Sydney Water Corporation would occur prior to any potential disturbance of sediments within Alexandra Canal due to the project.

The key indicator for water quality from the Sydney Airport Environment Strategy 2019–2024 is that water quality monitoring results for stormwater from the airport should stay the same or improve. To demonstrate that this is being achieved, a water quality monitoring program is recommended.

It is recommended ongoing monitoring of waterways should occur against site specific trigger values in accordance with the approach described in section 8.3.

10. Bibliography

AECOM, 2015. WestConnex The New M5 Technical Working Paper – Surface Water. Roads and Maritime Services. Sydney.

AECOM, 2081–2019. Sydney Gateway Project – Monthly Baseline Surface Water Monitoring. January 2018 – January 2019.

ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia.

ANZECC & ARMCANZ, 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand, 2000b. The Australian Guidelines for Water Quality Monitoring and Reporting (Water Quality Monitoring Guidelines), Australian Water Association, Artarmon, NSW.

Bayside Council. (2018). *Protecting our Waterways*. Retrieved from City of Botany Bay: http://www.botanybay.nsw.gov.au/Environment/Water-Energy/Protecting-Our-Waterways

Bureau of Meteorology. (2018, July 5). *Climate statistics for Australian Locations*. Retrieved from Bureau of Meteorology: http://www.bom.gov.au/climate/averages/tables/cw_066037.shtml

Cooks River Alliance. (2014). *Cooks River Catchment 2013/2014 River Health Monitoring Technical Report.* Sydney: CTENVIRONMENTAL.

HUMES. (2017, April). HumeCeptor system technical manual Issue 5. Australia: Humes.

Lawson and Treloar Pty Ltd. (2003). *Proposed Expansion of Container Port Facilities Botany Bay NSW.* Sydney: Sydney Ports Corporation.

NSW Environment Protection Authority. (2000, July 25). Declaration of Remediation Site 21005.

NSW Environment Protection Authority. (2003, March 19). Voluntary Remediation Agreement 26050.

Sydney Metropolitan Catchment Management Authority. (2011). *Botany Bay & Catchment Water Quality Improvement Plan. Sydney: Botany Bay Water Quality Improvement Program.*

Cooks River Alliance, 2017. Cooks River Ecological Health Report Card 2016-2017. Cooks River Alliance, Sydney.

Department of Agriculture and Water Resources 2016 National Water Quality Management Strategy (NWQMS) http://agriculture.gov.au/water/quality/nwqms.

Department of Environment and Climate Change, 2007 managing urban stormwater: environmental targets Consultation Draft – October 2007

Department of Environment, Climate Change and Water, 2006. NSW Water Quality and River Flow Objectives. NSW Office of Environment and Heritage

Department of Primary Industries (DPI). (2019, June 18). Botany Bay and Georges River fishing, closures, restrictions and permits. Retrieved from Department of Primary Industries: https://www.dpi.nsw.gov.au/fishing/closures/location-closures/botany-bay-and-georges-river

Hatley R.K., 2004. *Hydrogeology of the Botany Basin*. Australian Geomechanics Vol 39 No 3 September 2004

Heads of EPAs Australia and New Zealand, PFAS National Environmental Management Plan.

Landcom, 2004. Managing Urban Stormwater – Soils and Construction – Volume 1, 4th Edition ('The Blue Book').

NSW Environment Protection Authority, 2014. Waste Classification Guidelines, Part 1: Classifying Waste.

NSW Department for Mines, 2002. Geological Series 1:250,000 Surface Geology Units (Statewide_250K_Geology_GCS94.shp). Geological Survey of New South Wales.

Office of Environment and Heritage, 2018. Alexandra Canal, heritage place and items. https://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=5053860 Accessed July 2018.

Roads and Maritime Services, 2018. Sydney Gateway, State Significant Infrastructure Scoping Report.

Sydney Airport Corporation Limited, date not available. *Sydney Airport Master Plan 2033*.

Sydney Metropolitan Catchment Management Authority (SMCMA), 2011. *Botany Bay and Catchment Water Quality Improvement Plan*. Sydney: Botany Bay Water Quality Improvement Program.

UoQ Centre for Marine Studies, 2002. Sediment-Water Column Interactions in Alexandra Canal, Sydney.

WaterNSW, 2019. NSW Water Register, https://waterregister.waternsw.com.au/water-register-frame, accessed 18 February 2019.

WestConnex, 2018. Surface Water Quality and Monitoring Program: 2016–2017 Annual Report. Document M5N-ES-RPT-PWD-0033 revised on 24 April 2018.

Appendix A

ANZECC (2000) water quality objectives

A1. Default trigger values for Alexandra Canal and Cooks River

Table A-1 shows the adopted trigger values for Alexandra Canal and Cooks River. Trigger values for physical and chemical stressors are based on the ANZECC (2000) default trigger values. The table only includes parameters for which trigger values are currently provided in ANZECC (2000). Also, trigger values for chloride, sodium, calcium, magnesium, potassium and sulfate have not been included as ANZECC (2000) contains no relevant values for background concentrations in marine water.

Trigger values for non-bioaccumulative and bioaccumulative toxicants are based on 80% and 95% species protection levels respectively.

Table A-1 Trigger values for Alexandra Canal and Cooks River

Pollutant		Unit	LOD	Aquatic ecosystems (80% protection level)	Secondary Contact Recreation	Primary contact recreation	Aquatic foods	Adopted default trigger value
Notes: *bioaccumulative toxin 95% protection level instead of 80% protection adopted; +no values recommended in ANZECC (2000), values adopted from the National Environmental Management Plan (NEMP) and since PFAS is a bioaccumulative toxin 95% protection level instead of 80% protection level adopted.								
Inorganics	Nitrate (as N)	mg/L	0.002		10	10	100	10
	Nitrite (as N)	mg/L	0.002		1	1	0.1	0.1
	Nitrogen (Total Oxidised)	mg/L	0.002	0.015				0.015
	Nitrogen (Total)	mg/L	0.01	0.3				0.3
	pH (Lab)	pH units	0.01	7.0-8.5	6.5-8.5	5.0-9.0		7.0-8.5
	TSS	mg/L	5				10	10
	Turbidity NTU	NTU	0.1	0.5-10				0.5-10
Metals	Aluminium (filtered)	mg/L	0.005		0.2	0.2	0.01	0.01
	Arsenic (Filtered)	mg/L	0.0002		0.05	0.05	0.03	0.03
	Cadmium (Filtered)	mg/L	0.00005		0.005	0.005	0.0005-0.005	0.005
	Chromium (CrVI) (Filtered)	mg/L	0.0002	0.085	0.05	0.05	0.02	0.02
	Copper (Filtered)	mg/L	0.0005	0.008	1	1	0.005	0.005

Pollutant		**Unit**	**LOD**	**Aquatic ecosystems (80% protection level)**	**Secondary Contact Recreation**	**Primary contact recreation**	**Aquatic foods**	**Adopted default trigger value**
	Iron (Filtered)	mg/L	0.002		0.3	0.3	0.01	0.01
	Lead (Filtered)	mg/L	0.0001	0.0044*	0.05	0.05		0.0044
	Manganese (Filtered)	mg/L	0.0005		0.1	0.1	0.01	0.01
	Mercury (Filtered)	mg/L	0.00001	0.0004*	0.001	0.001	0.001	0.0004
	Nickel (Filtered)	mg/L	0.0005	0.56	0.1	0.1	0.1	0.1
	Zinc (Filtered)	mg/L	0.001	0.043	5	5	0.005	0.005
Nutrients	Ammonia	mg/L	0.005	1.7	0.01	0.01	0.1	0.01
	Total Phosphorus	mg/L	0.005	0.03				0.03
Organochlorine Pesticides	Aldrin	µg/L	0.2		1	1		1
	chlordane	µg/L	0.5				0.004	0.004
	DDT+DDE+DDD	µg/L	0.5		3	3		3
	Endosulfan I	µg/L	0.2	0.05	40	40	0.001	0.001
	Endrin	µg/L	0.2	0.02	1	1	0.02	0.02
	Heptachlor	µg/L	0.2		3	3		3
Organophosporous pesticides	Ethion	µg/L	0.2		6	6		6
	Fenitrothion	µg/L	0.2		20	20		20
PAH	Acenaphthene	µg/L	1				20	20
PFAS	Perfluorooctane sulfonic acid (PFOS)	µg/L	0.0002	0.13+				0.13
	Perfluorooctanoate (PFOA)	µg/L	0.0002	220+				220

Pollutant		Unit	LOD	Aquatic ecosystems (80% protection level)	Secondary Contact Recreation	Primary contact recreation	Aquatic foods	Adopted default trigger value
Phenols	Phenol	µg/L	1	720				720
TBT	Tributyltin as SN	µg/L	0.002				0.01	0.01
TPH	F2-NAPHTHALENE	mg/L	0.05	120				120
BTEXN	Benzene	µg/L	1	1300	10	10		10
	Ethylbenzene	µg/L	2				250	250
	Toluene	µg/L	2				250	250
Halogenated Benzenes	1,2,4-trichlorobenzene	µg/L	1	80*				80

A2. Default trigger values for Mill Stream

Table A-2 shows the trigger values for Mill Stream. Trigger values for physical and chemical stressors are based on the ANZECC (2000) default trigger values. The table only includes parameters for which trigger values are currently provided in ANZECC (2000). Also, trigger values for chloride, sodium, calcium, magnesium, potassium and sulfate have not been included as ANZECC (2000) contains no relevant values for background concentrations in marine water. For comparison purposes, the final column shows the accepted limits of contamination specified in Schedule 2 of the Airports (Environment Protection) Regulation 1997.

Trigger values for non-bioaccumulative and bioaccumulative toxicants are based on 80% and 95% species protection levels respectively.

Table A-2 Trigger values for Mill Stream

Pollutant		Unit	LOD	Aquatic ecosystems 80%	Secondary Contact Recreation	Primary contact recreation	Aquatic foods	Adopted default trigger value	Airport Environment regulation 1997
Notes: *bioaccumulative toxin 95% protection level instead of 80% protection adopted; +no values recommended in ANZECC (2000), values adopted from the National Environmental Management Plan (NEMP) and since PFAS is a bioaccumulative toxin 95% protection level instead of 80% protection level adopted.									
Inorganics	Cyanide	mg/L	na					None	0.005
	Nitrate (as N)	mg/L	0.002		10	10	100	10	0.01
	Nitrite (as N)	mg/L	0.002		1	1	0.1	0.1	
	Nitrogen (Total)	mg/L	0.01	0.3				0.3	
	Phosphate (as P)	mg/L	0.005					None	0.005
	pH (Lab)	pH units	0.01	7.0-8.5	6.5-8.5	5.0-9.0		7.0-8.5	Change < 0.2
	Sulphide	mg/L	na					None	0.002
	TSS	mg/L	5				10	10	
	Turbidity NTU	NTU	0.1	0.5-10				0.5-10	
Metals	Aluminium (Filtered)	mg/L	0.005		0.2	0.2	0.01	0.01	
	Antimony	mg/L	na					None	0.5

Pollutant		Unit	LOD	Aquatic ecosystems 80%	Secondary Contact Recreation	Primary contact recreation	Aquatic foods	Adopted default trigger value	Airport Environment regulation 1997
	Arsenic (Filtered)	mg/L	0.0002		0.05	0.05	0.03	0.03	0.05
	Cadmium (Filtered)	mg/L	0.00005	0.036	0.005	0.005	0.0005-0.005	0.005	0.002
	Chromium (CrVI) (Filtered)	mg/L	0.0002	0.085	0.05	0.05	0.02	0.02	0.05
	Copper (Filtered)	mg/L	0.0005	0.008	1	1	0.005	0.005	0.005
	Iron (Filtered)	mg/L	0.002		0.3	0.3	0.01	0.01	
	Lead (Filtered)	mg/L	0.0001	0.0044*	0.05	0.05		0.0044	0.005
	Manganese (Filtered)	mg/L	0.0005		0.1	0.1	0.01	0.01	
	Mercury (Filtered)	mg/L	0.00001	0.0004*	0.001	0.001	0.001	0.0004	0.0001 (0.000025 for methylmercury)
	Nickel (Filtered)	mg/L	0.0005	0.56	0.1	0.1	0.1	0.1	0.015
	Selenium	mg/L	na					None	0.07
	Silver	mg/L	na					None	0.001
	Thallium	mg/L	na					None	0.02
	Tin (tributyltin)	mg/L	na					None	0.00002
	Zinc (Filtered)	mg/L	0.001	0.043	5	5	0.005	0.005	0.05
Nutrients	Ammonia	mg/L	0.005	1.7	0.01	0.01	0.1	0.01	0.005
	Total Phosphorus	mg/L	0.005	0.03				0.03	
Organochlorine Pesticides	Acrolein	µg/L	na					None	0.2
	Aldrin	µg/L	0.2		1	1		1	0.01

Pollutant		Unit	LOD	Aquatic ecosystems 80%	Secondary Contact Recreation	Primary contact recreation	Aquatic foods	Adopted default trigger value	Airport Environment regulation 1997
	chlordane	µg/L	0.5				0.004	0.004	0.004
	DDE	µg/L	na					None	0.014
	DDT	µg/L	0.2					None	0.001
	DDT+DDE+DDD	µg/L	0.5		3	3		3	
	Dieldrin	µg/L	0.2					None	0.002
	Endosulfan I	µg/L	0.2	0.05	40	40	0.001	0.001	0.01
	Endrin	µg/L	0.2	0.02	1	1	0.02	0.02	0.003
	g-BHC (Lindane)	µg/L	0.2					None	0.003
	Heptachlor	µg/L	0.2		3	3		3	0.01
	Lindane	µg/L	na					None	0.003
	Methoxychlor	µg/L	0.2					None	0.04
	Mirex	µg/L	na					None	0.001
Organophosporous pesticides	Chlorpyrifos	µg/L	0.2					None	0.001
	Ethion	µg/L	0.2		6	6		6	
	Fenitrothion	µg/L	0.2		20	20		20	
	Malathion	µg/L	0.2					None	0.1
PAH	Acenaphthene	µg/L	1				20	20	
PFAS	Perfluorooctane sulfonic acid (PFOS)	µg/L	0.0002	0.13+				0.13	
	Perfluorooctanoate (PFOA)	µg/L	0.0002	220+				220	

Pollutant		Unit	LOD	Aquatic ecosystems 80%	Secondary Contact Recreation	Primary contact recreation	Aquatic foods	Adopted default trigger value	Airport Environment regulation 1997
Phenols	Phenol	µg/L	1	720				720	50
TBT	Tributyltin as SN	µg/L	0.002				0.01	0.01	
TPH	F2-NAPHTHALENE	mg/L	0.05	120				120	
BTEXN	Benzene	µg/L	1	1300	10	10		10	300
	Ethylbenzene	µg/L	2				250	250	140
	Toluene	µg/L	2				250	250	300
Chlorinated Hydrocarbons	Hexachlorobutadiene	µg/L	1					None	0.3
Halogenated Benzenes	1,2,4-trichlorobenzene	µg/L	1	80*				80	
Halogenated Phenols	2,4,5-trichlorophenol	µg/L	1					None	8
	Pentachlorophenol	µg/L	2					None	0.2
Phthalate esters	di-n-butylphthalate	µg/L						None	4
	di(2-ethylhexy) phthalate	µg/L						None	0.6
	other phthalate esters	µg/L						None	0.2
Polycyclic aromatic hydrocarbons	Polychlorinated biphenyls	µg/L						None	0.001
	Polycyclic aromatic hydrocarbons	µg/L						None	3

Appendix B
Indicative site specific trigger values and discharge criteria

Table B-1 Indicative site specific trigger values for Alexandra Canal, Cooks River and Mill Stream for monitoring in the short term

Pollutants\Location	Unit	Alexandra Canal Trigger value	Cooks River Trigger Value	Mill Stream Trigger Value
Aluminium (Filtered)	µg/L	27.40	23.60	10.00
Arsenic (Filtered) ++	µg/L	30.00	30.00	30.00
Barium++	mg/L	2	2	2
Boron+	µg/L	5100	5100	5100
Cadmium (Filtered)*	µg/L	36	36	36
Chromium (CrVI) (Filtered)*	µg/L	85.00	85.00	20.00
Copper (Filtered)*	µg/L	8.00	8.00	5.00
Cobalt (Filtered)	µg/L	150	150	150
Iron (Filtered)	µg/L	48.8	36.80	10.00
Lead (Filtered)*	µg/L	12.00	12.00	4.40
Manganese (Filtered)	µg/L	20.26	17.40	10.00
Mercury (Filtered)**	µg/L	0.40	0.40	0.40
Nickel (Filtered)*	µg/L	560.00	560.00	100
Zinc (Filtered)*	µg/L	43.00	43.00	5.00
pH (Lab)*	pH Units	7-8.5	7-8.5	7-8.5
Total Suspended Solids	mg/L	15.20	10.00*	10.00
Turbidity	NTU	11.48	10.00*	10.00
Bicarbonate Alkalinity as $CaCO_3$	mg/L	124.00	125.00	To be determined from future monitoring data
Ammonia	mg/L	1.7	1.7	1.7
Nitrate (as N) ++	mg/L	10.00	10.00	10.00
Nitrite (as N) ++	mg/L	0.10	0.10	0.10
Total Nitrogen (as N)	mg/L	0.90	0.93	0.30
Total Phosphorus	mg/L	0.07	0.07	0.03
PFOA^	µg/L	220	220	220
PFOS^	µg/L	0.13	0.13	0.13
TPH – C_6-C_9 fractions+++	µg/L	150	150	150
TPH – Mineral Oil (>C_9 fractions)+++	µg/L	600	600	600
F2-NAPHTHALENE	mg/L	120	120	120
Ethylbenzene	µg/L	250	250	250
Total Xylenes+	µg/L	625	625	625

Pollutants\Location	Unit	Alexandra Canal Trigger value	Cooks River Trigger Value	Mill Stream Trigger Value
p-Xylene+	µg/L	200	200	200
m-Xylene+	µg/L	75	75	75
o-Xylene+	µg/L	350	350	350
Naphthalene+	µg/L	70	70	70
Anthracene+	µg/L	0.4	0.4	0.4
Phenanthrene+	µg/L	2	2	2
Fluoranthene+	µg/L	1.4	1.4	1.4
Benzo(a)pyrene+	µg/L	0.2	0.2	0.2

Notes:

The above table contains pollutants that have not been detected in the surface or groundwater monitoring but which are potential contaminants of concern if detected in future monitoring data.

Trigger values for all watercourses should be revised as future monitoring data is collected.

*80th percentile site monitoring value is lower than 80% protection level for aquatic ecosystems

**bioaccumulative toxin 95% protection level was above the 80th percentile monitoring value

$^{++}$ No aquatic ecosystems value available and default trigger value in Appendix A is higher than 80th percentile value so Appendix A value is adopted

^no values recommended in ANZECC (2000), values adopted from the PFAS NEMP

+Low reliability trigger values from ANZECC (2000) adopted

++Australian Drinking Water Guidelines (NHMRC 2011) trigger value adopted in absence of value available from ANZECC (2000)

+++Airports (Environment Protection) Regulations 1997 freshwater trigger values adopted in absence of values available from ANZECC (2000) and monitoring data

Table B-2 Indicative discharge criteria for Alexandra Canal

Pollutants	Unit	Alexandra Canal discharge criteria
Aluminium (Total)	µg/L	356.8
Aluminium (Filtered)	µg/L	27.40
Arsenic (Filtered) ++	µg/L	30.00
Barium++	µg/L	2
Boron+	µg/L	5100
Cadmium (Filtered)*	µg/L	36
Chromium (CrVI) (Filtered)*	µg/L	85.00
Copper (Filtered)*	µg/L	8.00
Cobalt (Filtered)	µg/L	150
Iron (Total)	µg/L	489.8
Iron (Filtered)	µg/L	48.8
Lead (Filtered)**	µg/L	12.00
Manganese (Total)	µg/L	27.82
Manganese (Filtered)	µg/L	20.26
Mercury (Filtered)**	µg/L	0.40
Nickel (Filtered)*	µg/L	560.00
Zinc (Total)*	µg/L	46.10
Zinc (Filtered)*	µg/L	43.00
pH (Lab)*	pH Units	7-8.5
Total Suspended Solids	mg/L	15.20
Turbidity	NTU	11.48
Bicarbonate Alkalinity as $CaCO_3$	mg/L	124.00
Ammonia	mg/L	1.7
Nitrate (as N) ++	mg/L	10.00
Nitrite (as N) ++	mg/L	0.10
Total Nitrogen (as N)	mg/L	0.90
Total Phosphorus	mg/L	0.07
PFOA^	µg/L	220
PFOS^	µg/L	0.13
TPH – C_6-C_9 fractions+++	µg/L	150
TPH – Mineral Oil (>C_9 fractions)+++	µg/L	600
F2-NAPHTHALENE	mg/L	120

Pollutants	Unit	Alexandra Canal discharge criteria
Ethylbenzene	µg/L	250
Total Xylenes	µg/L	625
p-Xylene	µg/L	200
m-Xylene	µg/L	75
o-Xylene	µg/L	350
Naphthalene+	µg/L	70
Anthracene+	µg/L	0.4
Phenanthrene+	µg/L	2
Fluoranthene+	µg/L	1.4
Benzo(a)pyrene+	µg/L	0.2

Note: The above table contains pollutants that have not been detected in the surface or groundwater monitoring but which are potential contaminants of concern if detected in future monitoring data.

*80th percentile site monitoring value is lower than 80% protection level for aquatic ecosystems

++ No aquatic ecosystems value available and default trigger value in Appendix A is higher than 80th percentile value so Appendix A value adopted

**bioaccumulative toxin - 95% protection level adopted

^no values recommended in ANZECC (2000), values adopted from the PFAS NEMP and since PFAS is bioaccumulative toxin 95% protection level instead of 80% protection level adopted

+Low reliability trigger values from ANZECC (2000) adopted

++Australian Drinking Water Guidelines (NHMRC 2011) trigger value adopted in absence of value available from ANZECC (2000)

+++Airports (Environment Protection) Regulations 1997 freshwater trigger values adopted in absence of values available from ANZECC (2000) and monitoring data

Appendix C
MUSIC model inputs and method

C1. Project footprint only

C1.1 MUSIC model set up

MUSIC modelling was undertaken to assess the pollutant loads and pollutant load reduction potential for the project. MUSIC is the Model for Urban Storm Water Conceptualisation and predicts the performance of storm water quality management systems.

C1.1.1 source node

The impervious surface area of the project was found and separated for the catchment area that drained to Alexandra Canal (27 ha) and Mill Stream (1 ha through Engine Pond).

In existing the 'sealed roads' MUSIC node was used to represent existing roads and hardstand areas (100% impervious), the 'Industrial' MUSIC node was used to represent the commercial land (95% impervious) and the 're vegetated land' MUSIC node was used to represent the green space (100% pervious) within the design road surface footprint (Table C-1).

In design the 'sealed roads' MUSIC node was used to represent the road design.

Table C-1 Pollutant concentrations (BMT WBM, 2015)

	Alexandra Canal				Mill Stream		
	Existing nodes			Design nodes	Existing nodes		Design node
Catchment name	**Existing pavement**	**Existing commercial**	**Existing Green***	**Design pavement**	**Existing pavement**	**Existing Green***	**Design pavement**
Total area ha	13.03	11.17	2.80	27.00	1.03	0.13	1.16
%impervious*	100	95	0	100	100	0	100
%pervious	0	5	100	0	0	100	0
rainfall threshold (mm/day)	1.5	1	1	1.5	1.5	1	1.5
soil storage capacity**		107	142			142	
initial storage (%capacity)		25	25			25	
field capacity		70	94			94	
infiltration capacity coefficient a		250	180			180	
infiltration capacity coefficient b		1.3	3			3	
groundwater initial depth		10	10			10	
daily recharge rate		60	25			25	
daily baseflow rate		45	25			25	
daily deep seepage rate		0	0			0	

	Alexandra Canal				Mill Stream		
	Existing nodes			Design nodes	Existing nodes		Design node
Catchment name	**Existing pavement**	**Existing commercial**	**Existing Green***	**Design pavement**	**Existing pavement**	**Existing Green***	**Design pavement**
	Sealed road	Industrial	Re-vegetated land	Sealed road	Sealed road	Re-vegetated land	Sealed road
baseflow pollutant concentrations							
TSS mean	1.2	1.2	1.15	1.2	1.2	1.15	1.2
TSS SD	0.17	0.17	0.17	0.17	0.17	0.17	0.17
TP mean	-0.85	-0.85	-1.22	-0.85	-0.85	-1.22	-0.85
TP SD	0.19	0.19	0.19	0.19	0.19	0.19	0.19
TN mean	0.11	0.11	-0.05	0.11	0.11	-0.05	0.11
TN SD	0.12	0.12	0.12	0.12	0.12	0.12	0.12
stormflow pollutant concentrations							
TSS mean	2.43	2.15	1.95	2.43	2.43	1.95	2.43
TSS SD	0.32	0.32	0.32	0.32	0.32	0.32	0.32
TP mean	-0.3	-0.6	-0.66	-0.3	-0.3	-0.66	-0.3
TP SD	0.25	0.25	0.25	0.25	0.25	0.25	0.25
TN mean	0.34	0.3	0.3	0.34	0.34	0.3	0.34
TN SD	0.19	0.19	0.19	0.19	0.19	0.19	0.19

SD = standard deviation

*clayey sand properties adopted for pervious parameters (MUSIC guidelines)

C1.1.2 Treatment nodes

A treatment train of GPT and fine sediments removal device (HumeCeptor) have been applied to 15 locations within the project (see Figure 6-1 in body of report). Treated road catchment for each device is shown in Table C-2 for Alexandra Canal and Table C-3 for Mill Stream Catchment.

Table C-2 Treatment device and catchment area treated Alexandra Canal

Name	Discharge pt	Location	Catchment area treated ha
GPT and HumeCeptor 1	3	Canal road	0.3
GPT and HumeCeptor 2	4a	North 4a Channel	1.4
GPT and HumeCeptor 3	4b	North 4b Underpass (trap sag)	0.4
GPT and HumeCeptor 4	4c	North 4c	0.2
GPT and HumeCeptor 5	4d	South 4d 1st sags (trap sag)	1.2
GPT and HumeCeptor 6	4e	South 4e 2nd sags (trap sag)	2.2
GPT and HumeCeptor 7	5a	west channel	2.8
GPT and HumeCeptor 8	5b	swamp road	0.2
GPT and HumeCeptor 9	5c	To pump sag (trap sag)	1.3
GPT and HumeCeptor 10	5d	Under bridge	0.4
GPT and HumeCeptor 11	8	Tempe Landfill before bridge	0.3
GPT and HumeCeptor 12	10	Airport Dr (1500mm)*	0.7
GPT and HumeCeptor 13	11	Airport Dr (300mm to be upgraded)*	0.2
GPT and Hume Ceptor 14	11a	Airport Dr	0.6
GPT and Hume Ceptor 15	12	SUP next to canal	1.8
Total treated design pavement			**13.9**

Table C-3 Mill Stream Catchment treatment device and location

Name	Design Road Catchment area treated ha
GPT and HumeCeptor 1	0.17
GPT and HumeCeptor 2	0.80*

*combination of road and bridge

C1.1.3 Gross Pollutant Trap

A gross pollutant trap (GPT) can remove litter and vegetation which are transported by stormwater runoff.

A HumeGard GPT was modelled in MUSIC, the GPT the removal efficiencies in Table C-4 were applied to the MUSIC model node as recommended by Humes.

Table C-4 HumeGard GPT pollutant removal efficiency (HUMES, 2017a)

Pollutant	Removal efficiency
Gross pollutants	90%
TSS	49%
TP	40%
TN	26%

Sizing of HumeGard or other type of GPT is recommended in detail design. The GPT was modelled with a highflow bypass of 1 EY.

C1.1.4 HumeCeptor

HumeCeptors by Humes are an underground, precast concrete system designed to remove hydrocarbons and suspended solids from stormwater runoff. They have been adopted and modelled as the fines sediment removal device in MUSIC.

Based on field and laboratory research Humes has provided MUSIC inputs for the HumeCeptor shown in Table C-5. The GPT and HumeCeptor MUSIC node does not have a high flow bypass, however the 1 EY was applied as the high flow bypass to each catchment to the GPT and HumeCeptor treatment train.

Table C-5 HumeCeptor pollutant removal efficiency (HUMES, 2017)

Pollutant	Removal efficiency
TSS	80%
TP	30%
TN	30%

Sizing of HumeCeptor or similar product is recommended in detail design.

Swales

Vegetated swales are typically trapezoidal open channels that convey and filter stormwater runoff through vegetation to remove coarse sediment (i.e. reduce TSS). The performance of swales is largely dependent on the vegetation height and the gradient and length of the swale.

The swales are:

- 137 metre-long swale treating 0.4 hectares current commercial space near the roundabout
- 315 metre-long swale on the northbound side of the road
- 235 metre-long swale (split into two) on either side of the entrance to the Qantas Drive extension on the southbound side of the road to treat 1.8 hectares of design pavement north and south of the roundabout.

The adopted swale properties are shown in the table below.

Table C-6 Swale properties combined

Swale properties	Adopted values
Length (m)	545
Bed Slope (%)	1
Base width (m)	1
Top Width (m)	5
Depth (m)	0.5
Vegetation Height (m)	0.2
Exfiltration rate (mm/hr)	0

C1.2 Climate data

Climate data used in the MUSIC model was from Sydney airport AMO rainfall station. Six-minute rainfall data from 6 July 1962 – 31 December 1993 was input into the model. The modelling period selected was selected following MUSIC guidelines (2015) recommendation to use long periods (10–20 years plus) of continuous data with minimal to no missing data. As a check the monthly rainfall data for all years of data and the modelling period were compared and found to have comparable values for dry and wet periods (Table C-7).

Table C-7 Rainfall statistical comparison

	Statistic	Mean (mm/month)	5th %ile (mm/month)	10th %ile (mm/month)	Median (mm/month)	90th %ile (mm/month)
Jan	All years	94.6	13.4	26.0	71.7	186.1
	1962-1993	113.5	24.6	26.7	93.7	222.0
Feb	All years	111.4	14.4	22.6	82.5	243.6
	1962-1993	115.0	10.8	24.2	86.4	229.8
Mar	All years	117.0	25.1	33.4	85.7	235.4
	1962-1993	143.6	19.5	47.4	130.5	295.2
Apr	All years	107.8	18.7	21.3	81.4	221.2
	1962-1993	114.4	17.3	19.0	87.1	261.6
May	All years	96.0	13.4	16.6	76.4	183.8
	1962-1993	81.2	18.1	20.0	67.5	140.7
Jun	All years	124.2	16.0	26.1	100.5	279.8
	1962-1993	136.9	21.2	36.5	100.2	277.1
Jul	All years	69.6	8.0	12.1	51.7	156.7
	1962-1993	54.6	5.0	8.9	49.4	114.7

	Statistic	Mean (mm/month)	5th %ile (mm/month)	10th %ile (mm/month)	Median (mm/month)	90th %ile (mm/month)
Aug	All years	76.8	5.1	7.8	43.9	181.6
	1962-1993	80.5	8.1	11.0	36.4	180.6
Sep	All years	59.7	5.8	10.4	46.4	129.8
	1962-1993	56.8	1.6	3.3	51.3	129.8
Oct	All years	69.7	8.5	13.7	47.4	170.2
	1962-1993	75.9	0.6	2.3	55.9	158.2
Nov	All years	80.4	13.8	15.9	66.8	149.0
	1962-1993	90.1	15.5	31.7	67.4	148.8
Dec	All years	73.6	15.2	19.4	59.8	150.7
	1962-1993	80.5	14.6	21.8	67.3	162.0

C2. Assumptions and limitations

Below are a list of assumptions and limitations that were considered during this assessment.

- Only the road impervious surface footprint was considered for the assessment
- Land use types for existing were determined from aerial photo
- Treatment train of GPT and HumeCeptor locations was based on Rev3 design
- Swale has default MUSIC properties
- GPT and HumeCeptors have a 1 EY high flow bypass
- Standard pollutant export rates recommended in MUSIC guideline (BMT WBM, 2015) for industrial and commercial land uses were applied. The industrial and commercial areas in the project catchment are highly contaminated with both nutrients and toxicants, with the pollutant export rate likely to be much higher than the standard recommended pollutant rates. This means the existing conditions pollutant export rate is likely to be higher than the magnitude found.

Appendix D
New M5 Project water quality data summary table

Table D-1 New M5 construction phase water quality data (80th percentiles)

	Units	Environmental value relating to default trigger value (refer to Appendix A)	Adopted default trigger value (refer to Appendix A)	SW-02 80th percentile	SW-06 80th percentile	SW-07 80th percentile
Nitrite as N	mg/L	Aquatic foods	0.1	0.02	0.02	0.02
Nitrate as N	mg/L	Primary contact	10	0.25	0.11	0.17
Total Nitrogen as N	mg/L	Aquatic ecosystems	0.3	1.4	1	1
pH	pH units	Aquatic ecosystems	7.0-8.5	7.86	7.97	8.06
Suspended Solids	mg/L	Aquatic foods	10	17	10	16
Arsenic	mg/L	Aquatic foods	0.03	0.01	0.01	0.01
Cadmium	mg/L	Aquatic foods	0.005	0.001	0.001	0.001
Copper	mg/L	Aquatic foods	0.005	0.01	0.01	0.01
Iron	mg/L	Aquatic foods	0.01	0.5	0.12	0.1
Lead	mg/L	Aquatic ecosystems	0.0044	0.01	0.01	0.01
Manganese	mg/L	Aquatic foods	0.01	0.0288	0.024	0.016
Mercury	mg/L	Aquatic foods	0.0004	0.00004	0.0001	0.00019
Nickel	mg/L	Aquatic foods	0.1	0.01	0.01	0.01
Zinc	mg/L	Aquatic foods	0.005	0.105	0.05	0.05
Ammonia	mg/L	Primary contact	0.01	0.27	0.332	0.364
Total Phosphorus as P	mg/L	Aquatic ecosystems	0.03	0.27	0.1	0.07

Values in red indicate exceedance of default trigger values

Appendix E
Water quality summary tables

Table E-1, Table E-2, Table E-3 and Table E-4 show the average, median, maximum and 80th percentile (80%iles) monitored values at each sampling point compared to the adopted default trigger values (refer to Appendix A). Values shown in red highlight indicate those that exceed the default trigger values.

Table E-1 Statistics of water quality data for selected parameters at SW1, SW2, SW3

Pollutant	Units	LoD	Trigger value	SW1				SW2				SW3			
				Average	Median	Max	80%iles	Average	Median	Max	80%iles	Average	Median	Max	80%iles
Aluminium	µg/L	5	10.00	214.94	165.00	498.00	380.60	188.76	174.00	429.00	300.20	191.18	140.00	542.00	318.20
Aluminium (Filtered)	µg/L	0.2	10.00	26.29	22.00	68.00	34.20	26.53	24.00	53.00	40.80	23.76	21.00	57.00	30.80
Arsenic	µg/L	0.2	30.00	2.02	2.00	2.90	2.34	2.02	2.00	2.80	2.40	2.04	2.10	2.60	2.40
Arsenic (Filtered)	µg/L	0.2	30.00	1.65	1.70	2.20	1.94	1.61	1.60	2.20	1.94	1.63	1.70	2.30	1.84
Chromium	µg/L	0.2	20.00	0.74	0.60	1.60	1.00	0.79	0.60	1.60	1.18	0.88	0.50	3.20	1.18
Chromium (Filtered)	µg/L	0.5	20.00	0.54	0.50	1.10	0.50	0.58	0.50	1.50	0.54	0.56	0.50	1.10	0.54
Copper	µg/L	0.5	5.00	3.71	2.00	11.00	7.60	3.59	2.00	11.00	6.20	3.53	2.00	10.00	6.40
Copper (Filtered)	µg/L	2	5.00	1.59	1.00	4.00	2.80	1.47	1.00	4.00	2.40	1.53	1.00	4.00	2.40
Iron	µg/L	2	10.00	338.35	338.00	583.00	495.20	316.06	279.00	536.00	492.80	303.35	282.00	571.00	441.60
Iron (Filtered)	µg/L	2	10.00	41.47	22.00	150.00	70.00	38.24	22.00	154.00	58.60	36.06	20.00	169.00	54.80
Lead	µg/L	0.1	4.40	4.10	3.50	9.30	6.72	3.78	3.00	10.60	5.60	3.65	2.90	9.50	5.92
Lead (Filtered)	µg/L	0.1	4.40	0.71	0.30	3.30	0.96	0.71	0.30	3.20	0.98	0.61	0.20	3.20	0.88
Manganese	µg/L	0.5	10.00	28.63	26.40	59.20	38.52	27.31	29.40	52.80	36.54	26.83	25.20	52.70	37.44
Manganese (Filtered)	µg/L	0.5	10.00	24.55	25.50	52.90	32.56	24.15	24.60	51.80	32.26	21.88	21.90	48.90	30.12
Mercury	µg/L	0.005	0.40	0.89	0.01	13.00	0.02	0.83	0.01	9.00	0.01	0.54	0.01	8.00	0.01
Mercury (Filtered)	µg/L	0.005	0.40	0.48	0.01	7.00	0.02	0.42	0.01	6.00	0.01	0.48	0.01	7.00	0.01
Nickel	µg/L	0.5	100	1	1	1.50	1.30	0.94	0.90	1.50	1.14	0.99	1.00	1.90	1.38

Pollutant	Units	LoD	Trigger value	SW1				SW2				SW3			
				Average	Median	Max	80%iles	Average	Median	Max	80%iles	Average	Median	Max	80%iles
Nickel (Filtered)	µg/L	0.5	100	1	1	1.30	1.04	0.89	0.80	1.40	1.24	0.82	0.80	1.40	1.00
Zinc	µg/L	1	5.00	39.94	32.00	109.00	58.40	38.00	29.00	110.00	51.80	37.76	26.00	119.00	58.00
Zinc (Filtered)	µg/L	1	5.00	27.88	21.00	61.00	47.20	27.59	21.00	64.00	48.80	27.00	20.00	74.00	46.40
pH (Lab)	pH Units	0.01	7-8.5	7.59	7.70	8.07	7.82	7.65	7.71	8.17	7.84	7.68	7.82	8.19	7.85
Total Suspended Solids	mg/L	5	10.00	11.19	8.50	33.00	16.60	9.81	9.00	24.00	13.80	11.25	8.50	25.00	20.40
Turbidity	NTU	0.1	10.00	6.59	3.60	21.20	13.26	6.08	3.30	20.50	11.04	6.34	4.00	22.40	12.26
Ammonia (as N)	mg/L	0.005	0.01	0.12	0.08	0.32	0.23	0.13	0.08	0.66	0.23	0.12	0.07	0.48	0.21
Nitrate (as N)	mg/L	0.002	10.00	0.163	0.133	0.42	0.30	0.17	0.10	0.41	0.31	0.16	0.11	0.42	0.28
Nitrite (as N)	mg/L	0.002	0.10	0.016	0.017	0.03	0.02	0.02	0.01	0.04	0.02	0.01	0.01	0.03	0.02
Total Nitrogen (as N)	mg/L	0.01	0.30	0.86	0.67	2.53	1.21	0.78	0.66	2.00	1.23	0.80	0.77	1.89	1.10
Total Phosphorus	mg/L	0.005	0.03	0.06	0.06	0.28	0.08	0.06	0.05	0.26	0.07	0.05	0.05	0.18	0.07
PFOA	µg/L	0.0005	220	0	0	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.01
PFOS	µg/L	0.0002	0.13	0.0161	0.0127	0.04	0.02	0.01	0.01	0.03	0.02	0.01	0.01	0.03	0.02

Table E-2 Statistics of water quality data for selected parameters at SW4, SW5, SW6

Pollutant	Units	LoD	Trigger value	SW4				SW5				SW6			
				Average	Median	Max	80%iles	Average	Median	Max	80%iles	Average	Median	Max	80%iles
Aluminium	µg/L	0.2	10.00	186.65	117.00	648.00	318.00	202.94	116.00	621.00	433.20	232.53	93.00	1,460.00	356.80
Aluminium (Filtered)	µg/L	0.2	10.00	22.82	18.00	58.00	37.40	18.82	14.00	51.00	27.20	19.53	14.00	80.00	27.40
Arsenic	µg/L	0.2	30.00	2.04	2.10	2.70	2.28	2.05	1.90	2.90	2.34	2.02	2.00	2.40	2.24
Arsenic (Filtered)	µg/L	0.2	30.00	1.69	1.70	2.40	2.00	1.65	1.70	2.10	2.04	1.72	1.70	2.20	2.10
Chromium	µg/L	0.2	20.00	0.80	0.50	2.10	1.12	0.78	0.50	2.20	1.34	0.75	0.50	2.20	0.88
Chromium (Filtered)	µg/L	0.5	20.00	0.53	0.50	0.90	0.50	0.52	0.50	0.80	0.50	0.52	0.50	0.80	0.50
Copper	µg/L	0.5	5.00	3.35	2.00	13.00	5.60	3.88	2.00	15.00	8.80	3.06	2.00	11.00	5.20
Copper (Filtered)	µg/L	2	5.00	1.41	1.00	4.00	2.00	1.35	1.00	4.00	2.00	1.24	1.00	3.00	1.40
Iron	µg/L	2	10.00	284.65	213.00	760.00	463.60	312.71	172.00	901.00	671.20	282.12	155.00	1,020.00	489.80
Iron (Filtered)	µg/L	2	10.00	35.12	14.00	212.00	55.20	33.18	12.00	181.00	74.00	29.88	13.00	138.00	48.80
Lead	µg/L	0.1	4.40	3.28	2.40	8.50	4.92	3.40	2.10	8.80	7.80	3.71	1.80	16.00	7.06
Lead (Filtered)	µg/L	0.1	4.40	0.53	0.20	2.20	0.80	0.45	0.20	2.10	0.56	0.42	0.30	1.40	0.62
Manganese	µg/L	0.5	10.00	22.45	19.30	43.30	37.74	30.11	13.70	201.00	33.28	16.03	11.00	43.00	27.82
Manganese (Filtered)	µg/L	0.5	10.00	18.68	16.40	37.20	28.30	15.25	11.60	39.10	24.06	12.14	9.80	33.90	20.26
Mercury	µg/L	0.005	0.40	0.83	0.01	9.00	0.02	0.54	0.01	6.00	0.02	0.83	0.01	9.00	0.02

Pollutant	Units	LoD	Trigger value	SW4				SW5				SW6			
				Average	Median	Max	80%iles	Average	Median	Max	80%iles	Average	Median	Max	80%iles
Mercury (Filtered)	µg/L	0.005	0.40	0.65	0.01	10.00	0.02	0.30	0.01	4.00	0.01	0.42	0.01	5.00	0.01
Nickel	µg/L	0.5	100	0.92	0.80	1.70	1.38	1.04	0.80	3.80	1.48	19.38	0.50	317.00	1.32
Nickel (Filtered)	µg/L	0.5	100	0.81	0.70	1.40	1.14	0.79	0.70	1.90	0.90	0.71	0.60	1.60	1.00
Zinc	µg/L	1	5.00	29.94	20.00	105.00	39.80	34.29	20.00	172.00	51.80	44.47	13.00	385.00	46.20
Zinc (Filtered)	µg/L	1	5.00	21.59	15.00	60.00	30.80	18.18	13.00	52.00	25.40	14.59	13.00	36.00	21.80
pH (Lab)	pH Units	0.01	7-8.5	7.75	7.85	8.15	7.93	7.78	7.88	8.20	7.98	7.80	7.90	8.16	8.00
Total Suspended Solids	mg/L	5	10.00	9.25	6.00	21.00	16.60	9.13	5.00	26.00	14.80	9.94	5.00	47.00	15.20
Turbidity	NTU	0.1	10.00	6.41	3.20	22.20	13.22	6.44	2.20	27.90	13.20	7.86	1.80	44.20	11.48
Ammonia (as N)	mg/L	0.005	0.01	0.09	0.06	0.36	0.18	0.07	0.04	0.22	0.14	0.06	0.02	0.20	0.15
Nitrate (as N)	mg/L	0.002	10.00	0.15	0.09	0.46	0.27	0.13	0.08	0.40	0.23	0.15	0.06	0.84	0.24
Nitrite (as N)	mg/L	0.002	0.10	0.01	0.01	0.03	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.02
Total Nitrogen (as N)	mg/L	0.01	0.30	0.65	0.57	1.32	1.07	0.58	0.50	1.43	0.98	0.52	0.37	1.62	0.90
Total Phosphorus	mg/L	0.005	0.03	0.05	0.04	0.10	0.07	0.04	0.03	0.10	0.06	0.04	0.03	0.12	0.07
PFOA	µg/L	0.0005	220	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01
PFOS	µg/L	0.0002	0.13	0.01	0.01	0.03	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.01

Table E-3 Statistics of water quality data for selected parameters at SW7 and SW8

Pollutant	Units	LoD	Trigger value	SW7				SW8			
				Average	Median	Max	80%iles	Average	Median	Max	80%iles
Aluminium	µg/L	5	10.00	256.96	146.50	1,610.00	295.60	203.41	101.00	1,820.00	190.80
Aluminium (Filtered)	µg/L	0.2	10.00	26.15	16.00	174.00	24.80	20.11	13.00	101.00	29.40
Arsenic	µg/L	0.2	30.00	2.03	2.10	2.60	2.26	2.05	2.00	2.60	2.24
Arsenic (Filtered)	µg/L	0.2	30.00	1.70	1.80	2.50	1.96	1.78	1.80	2.70	2.00
Chromium	µg/L	0.2	20.00	0.95	0.60	3.30	1.22	0.73	0.50	2.90	1.00
Chromium (Filtered)	µg/L	0.5	20.00	0.52	0.50	1.00	0.50	0.55	0.50	1.00	0.50
Copper	µg/L	0.5	5.00	3.62	2.00	16.00	5.60	3.04	1.00	20.00	3.40
Copper (Filtered)	µg/L	2	5.00	1.42	1.00	4.00	2.00	1.33	1.00	3.00	2.00
Iron	µg/L	2	10.00	373.08	225.00	1,400.00	616.40	255.52	164.00	1,360.00	339.60
Iron (Filtered)	µg/L	2	10.00	39.92	16.50	166.00	83.80	26.11	10.00	139.00	43.80
Lead	µg/L	0.1	4.40	3.64	2.40	13.40	4.06	2.30	1.60	11.00	3.28
Lead (Filtered)	µg/L	0.1	4.40	0.43	0.30	1.60	0.80	0.47	0.20	1.90	0.94
Manganese	µg/L	0.5	10.00	22.60	16.80	68.70	35.82	15.75	9.60	40.80	29.24
Manganese (Filtered)	µg/L	0.5	10.00	18.99	12.05	67.60	31.72	11.73	7.70	38.00	21.64
Mercury	µg/L	0.005	0.40	0.51	0.01	7.00	0.01	0.53	0.01	9.00	0.02
Mercury (Filtered)	µg/L	0.005	0.40	0.35	0.01	5.00	0.01	0.42	0.01	6.00	0.02
Nickel	µg/L	0.5	100	1.03	0.85	3.10	1.32	0.83	0.60	2.40	1.20
Nickel (Filtered)	µg/L	0.5	100	0.80	0.80	1.70	0.90	0.68	0.60	1.00	0.94

Pollutant	Units	LoD	Trigger value	SW7				SW8			
				Average	Median	Max	80%iles	Average	Median	Max	80%iles
Zinc	µg/L	1	5.00	25.81	17.00	80.00	35.00	20.37	12.00	72.00	39.00
Zinc (Filtered)	µg/L	1	5.00	16.58	14.00	37.00	24.60	14.26	9.00	42.00	26.20
pH (Lab)	pH Units	0.01	7-8.5	7.76	7.82	8.11	7.94	7.82	7.95	8.24	8.05
Total Suspended Solids	mg/L	5	10.00	10.33	6.50	47.00	13.00	9.04	5.00	52.00	10.00
Turbidity	NTU	0.1	10.00	6.94	3.40	47.00	8.26	6.27	2.20	53.50	7.26
Ammonia (as N)	mg/L	0.005	0.01	0.09	0.07	0.40	0.16	0.06	0.01	0.30	0.12
Nitrate (as N)	mg/L	0.002	10.00	0.17	0.06	1.27	0.19	0.13	0.05	0.93	0.19
Nitrite (as N)	mg/L	0.002	0.10	0.01	0.01	0.03	0.02	0.01	0.01	0.02	0.02
Total Nitrogen (as N)	mg/L	0.01	0.30	0.66	0.45	2.18	1.13	0.54	0.37	1.85	0.93
Total Phosphorus	mg/L	0.005	0.03	0.05	0.04	0.14	0.08	0.04	0.02	0.10	0.07
PFOA	µg/L	0.0005	220	0.01	0.01	0.05	0.01	0.01	0.00	0.05	0.01
PFOS	µg/L	0.0002	0.13	0.01	0.01	0.05	0.01	0.01	0.01	0.05	0.02

Table E-4 Statistics of water quality data for selected parameters at SW9, SW10, SW11

Pollutant	Units	LoD	Trigger value	SW9				SW10				SW11			
				Average	Median	Max	80%iles	Average	Median	Max	80%iles	Average	Median	Max	80%iles
Aluminium	µg/L	5	10.00	1,620.38	185.00	18,500.00	400.80	227.23	164.50	846.00	389.60	1,269.52	778.00	5,740.00	1,522.00
Aluminium (Filtered)	µg/L	0.2	10.00	20.15	19.00	44.00	25.40	29.88	26.00	67.00	42.00	131.68	110.00	268.00	189.00
Arsenic^	µg/L	0.2	30.00	15.79	1.80	168.00	6.46	3.76	2.90	12.30	4.66	2.03	1.80	5.20	2.50
Arsenic (Filtered)	µg/L	0.2	30.00	0.94	0.90	1.60	1.30	2.31	1.90	8.20	2.86	1.22	1.10	2.10	1.60
Chromium^	µg/L	0.2	20.00	2.93	0.50	31.50	1.12	1.71	1.15	7.90	1.96	2.28	1.60	11.80	2.16
Chromium (Filtered)	µg/L	0.5	20.00	0.23	0.20	0.40	0.30	0.35	0.20	1.10	0.40	0.66	0.70	0.90	0.80
Copper	µg/L	0.5	5.00	12.21	2.30	127.00	5.60	5.05	4.30	12.10	8.18	9.81	4.50	50.40	12.94
Copper (Filtered)	µg/L	2	5.00	1.63	1.40	3.80	2.76	1.45	1.15	4.00	2.12	2.12	1.60	5.60	3.16
Iron	µg/L	2	10.00	12,989.31	688.00	143,000.00	5,056.00	768.27	496.50	3,030.00	1,294.00	1,691.48	932.00	6,720.00	2,822.00
Iron (Filtered)	µg/L	2	10.00	208.00	206.00	356.00	302.40	182.42	198.50	318.00	268.40	272.40	276.00	433.00	353.40
Lead	µg/L	0.1	4.40	24.75	3.00	278.00	7.52	8.91	5.95	28.00	12.10	11.04	4.20	68.50	17.78
Lead (Filtered)	µg/L	0.1	4.40	0.39	0.20	1.80	0.60	0.97	0.85	2.00	1.38	0.72	0.60	1.90	1.16
Manganese	µg/L	0.5	10.00	856.71	70.80	8,650.00	580.80	81.25	33.85	410.00	168.20	45.28	34.90	152.00	54.92
Manganese (Filtered)	µg/L	0.5	10.00	38.01	38.20	80.30	65.68	16.49	8.45	102.00	20.04	24.87	24.80	66.40	29.58
Mercury^	µg/L	0.005	0.40	15.78	0.01	193.00	2.43	0.66	0.01	12.00	0.02	0.49	0.01	9.00	0.02
Mercury^ (Filtered)	µg/L	0.005	0.40	0.62	0.01	6.00	0.41	0.24	0.01	5.00	0.01	0.24	0.01	5.00	0.01
Nickel	µg/L	0.5	100	1.92	0.50	17.80	0.82	0.80	0.60	2.40	1.12	1.52	1.00	6.00	2.04
Nickel (Filtered)	µg/L	0.5	100	0.57	0.50	0.90	0.66	0.56	0.50	1.40	0.50	0.69	0.70	1.00	0.80
Zinc	µg/L	1	5.00	112.85	30.00	1,090.00	60.60	27.85	19.50	110.00	43.00	84.00	42.00	364.00	117.80

Pollutant	Units	LoD	Trigger value	SW9				SW10				SW11			
				Average	Median	Max	80%iles	Average	Median	Max	80%iles	Average	Median	Max	80%iles
Zinc (Filtered)	µg/L	1	5.00	17.77	15.00	39.00	22.40	6.77	5.00	25.00	9.60	29.40	27.00	68.00	34.80
pH (Lab)	pH Units	0.01	7-8.5	7.07	7.04	7.57	7.31	7.58	7.43	9.62	7.93	7.13	7.11	7.55	7.36
Total Suspended Solids	mg/L	5	10.00	213.62	12.00	2,150.00	126.80	39.28	28.00	149.00	54.00	39.67	18.50	394.00	46.00
Turbidity	NTU	0.1	10.00	118.41	4.40	1,290.00	53.32	14.38	7.85	56.60	27.84	17.90	11.30	142.00	18.32
Ammonia (as N)	mg/L	0.005	0.01	0.13	0.10	0.48	0.22	0.03	0.02	0.17	0.04	0.18	0.18	0.43	0.25
Nitrate (as N)	mg/L	0.002	10.00	0.38	0.37	0.62	0.53	0.09	0.04	0.49	0.16	0.56	0.52	1.93	0.70
Nitrite (as N)	mg/L	0.002	0.10	0.01	0.01	0.02	0.01	0.00	0.00	0.02	0.01	0.01	0.01	0.03	0.02
Total Nitrogen (as N)	mg/L	0.01	0.30	0.80	0.81	1.21	0.93	0.91	0.61	3.08	1.47	1.12	0.93	2.74	1.40
Total Phosphorus	mg/L	0.005	0.03	0.02	0.01	0.09	0.04	0.06	0.03	0.26	0.06	0.06	0.03	0.34	0.06
PFOA	µg/L	0.0005	220	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.02
PFOS	µg/L	0.0002	0.13	0.02	0.02	0.03	0.02	0.04	0.04	0.07	0.05	0.06	0.06	0.13	0.07

^Further review of data required as exceedance may be due to outliers

Appendix F

Comparison of SW9, SW10 and SW11 data statistics with accepted limits of Airports (Environment Protection) Regulations 1997

Table F-1 Comparison of Mill Stream water quality monitoring data with trigger values based on acceptable limits set in Schedule 2 of the Airport (Environmental) Regulation 1997

Pollutants\Location	Unit	Trigger Value (Airport 1997)	SW9			SW10			SW11		
			Average	Median	Max	Average	Median	Max	Average	Median	Max
Arsenic	µg/L	50.00	15.79	1.80	168.00	3.76	2.90	12.30	3.10	1.80	5.20
Arsenic (Filtered)	µg/L	50.00	0.94	0.90	1.60	2.31	1.90	8.20	1.91	1.10	2.10
Chromium	µg/L	50.00	2.93	0.50	31.50	1.71	1.15	7.90	2.07	1.60	11.80
Chromium (Filtered)	µg/L	50.00	0.23	0.20	0.40	0.35	0.20	1.10	0.50	0.70	0.90
Copper	µg/L	5.00	12.21	2.30	127.00	5.05	4.30	12.10	7.33	4.50	50.40
Copper (Filtered)	µg/L	5.00	1.63	1.40	3.80	1.45	1.15	4.00	1.81	1.60	5.60
Lead	µg/L	5.00	24.75	3.00	278.00	8.91	5.95	28.00	10.17	4.20	68.50
Lead (Filtered)	µg/L	5.00	0.39	0.20	1.80	0.97	0.85	2.00	0.88	0.60	1.90
Mercury	µg/L	0.10	15.78	0.01	193.00	0.66	0.01	12.00	0.77	0.01	9.00
Mercury (Filtered)	µg/L	0.10	0.62	0.01	6.00	0.24	0.01	5.00	0.32	0.01	5.00
Nickel	µg/L	15.00	1.92	0.50	17.80	0.80	0.60	2.40	1.15	1.00	6.00
Nickel (Filtered)	µg/L	15.00	0.57	0.50	0.90	0.56	0.50	1.40	0.63	0.70	1.00
Zinc	µg/L	50.00	112.85	30.00	1,090.00	27.85	19.50	110.00	54.59	42.00	364.00
Zinc (Filtered)	µg/L	50.00	17.77	15.00	39.00	6.77	5.00	25.00	17.38	27.00	68.00
Ammonia (as N)	mg/L	0.005	0.13	0.10	0.48	0.03	0.02	0.17	0.10	0.18	0.43
Nitrate (as N)	mg/L	0.01	0.384	0.370	0.624	0.090	0.039	0.492	0.314	0.520	1.930

Red highlighted means trigger value exceeded.

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