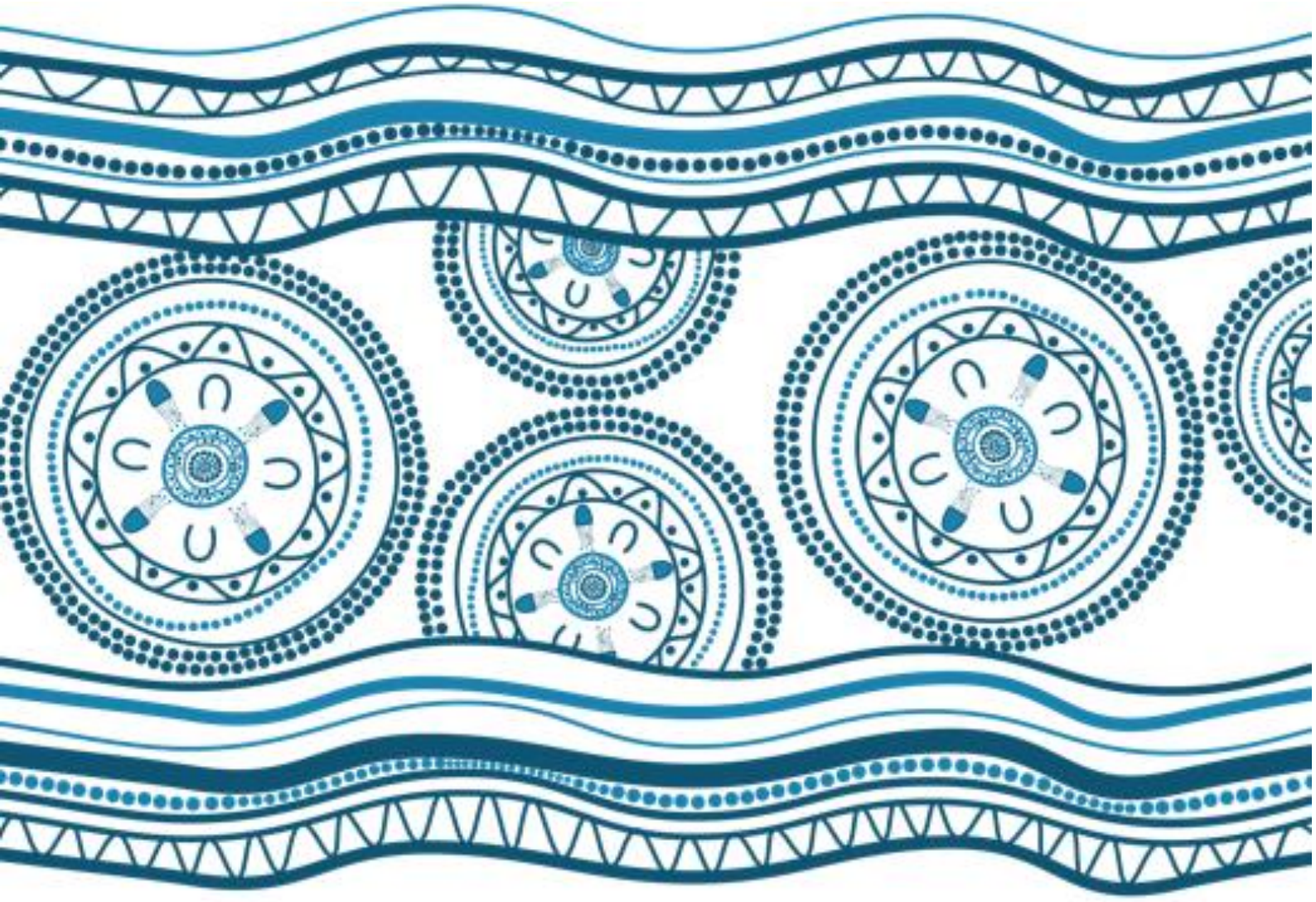
Appendix S

Surface Water Assessment Report



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Transport for NSW

Kamay Ferry Wharves Project

Surface Water Assessment Report

KFW01-ARUP-BPW-EN-RPT-000058

Final | 7 April 2021

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 273023-00

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Executive summary

Transport for New South Wales (Transport for NSW) is seeking approval to reinstate the ferry wharves at La Perouse and Kurnell in Botany Bay and operate a ferry service between them.

This report outlines the potential impacts of the project on surface water during both construction and operational phases. It includes a review of the existing topography and features of both project sites to enable assessment of proposed changes.

During the construction phase, there is potential for surface water to be affected by sediment eroded from the site or contaminated by spills or construction waste. However, these risks can be mitigated and managed through diligent application of standard construction practices.

The operational phase impacts are expected to be minimal. Minor increases to impermeable areas are not likely to have a material impact on surface water flows and flooding, or to contribute to an increase in pollutant loads entering the water system.

Residual impacts for the construction phase require careful monitoring of the application of proposed mitigation measures. This lowers the risk of impact as far as practicable.

Residual impacts during the operational phase are extremely minor. These impacts are considered acceptable and not practical or cost effective to mitigate.

Contents

1 Introduction

1.1 Purpose of this report

The purpose of this report is to assess the surface water impacts associated with the project.

1.2 Project overview

Transport for New South Wales (Transport for NSW) is seeking approval to reinstate the ferry wharves at La Perouse and Kurnell in Botany Bay (the project) under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) as State significant infrastructure. The project would allow for an alternative connection between La Perouse and Kurnell rather than by road. The primary purpose of this infrastructure would be to operate a public ferry service to service visitors to the area and by the local community for cultural and recreational purposes. It would also provide supplementary temporary mooring for tourism-related commercial vessels and recreational boating.

The project provides opportunities for significant cultural and economic benefits to the local Aboriginal community by providing improved access to culturally significant sites. It is also expected to deliver benefits and opportunities to wider communities on either side of Botany Bay such as investment opportunities in a ferry service and other new visitor/tourist experiences.

Key features of the project include:

- Two new wharves, one at La Perouse and one at Kurnell that would include:
  - Berth for ferries (to accommodate vessels up to 40m long)
  - Berth for recreational and commercial vessels (to accommodate vessels up to 20m long).
  - Sheltered waiting areas and associated furniture
  - Additional space within waiting areas to accommodate other users such as fishing and those using recreational vessels
  - Signage and lighting
- Landside paving, access ramps, seating and landscaping at the entrance to the wharves
- Reconfiguration of existing car parking area at La Perouse to increase the number of spaces (including provision of accessible parking and kiss-and-ride bays)
- Reconfiguration of footpaths around the new car parking area at La Perouse
- Provision for bike racks at La Perouse
- Installation of utilities to service the wharves.

The total construction period is anticipated to take up to 13 months, starting in early 2022. The construction of the two wharves will occur at the same time with landside and waterside works occurring simultaneously.

A concept design has been developed for the project, which forms the basis of this assessment. This surface water assessment supports the Environmental Impact Statement (EIS) prepared for the project.

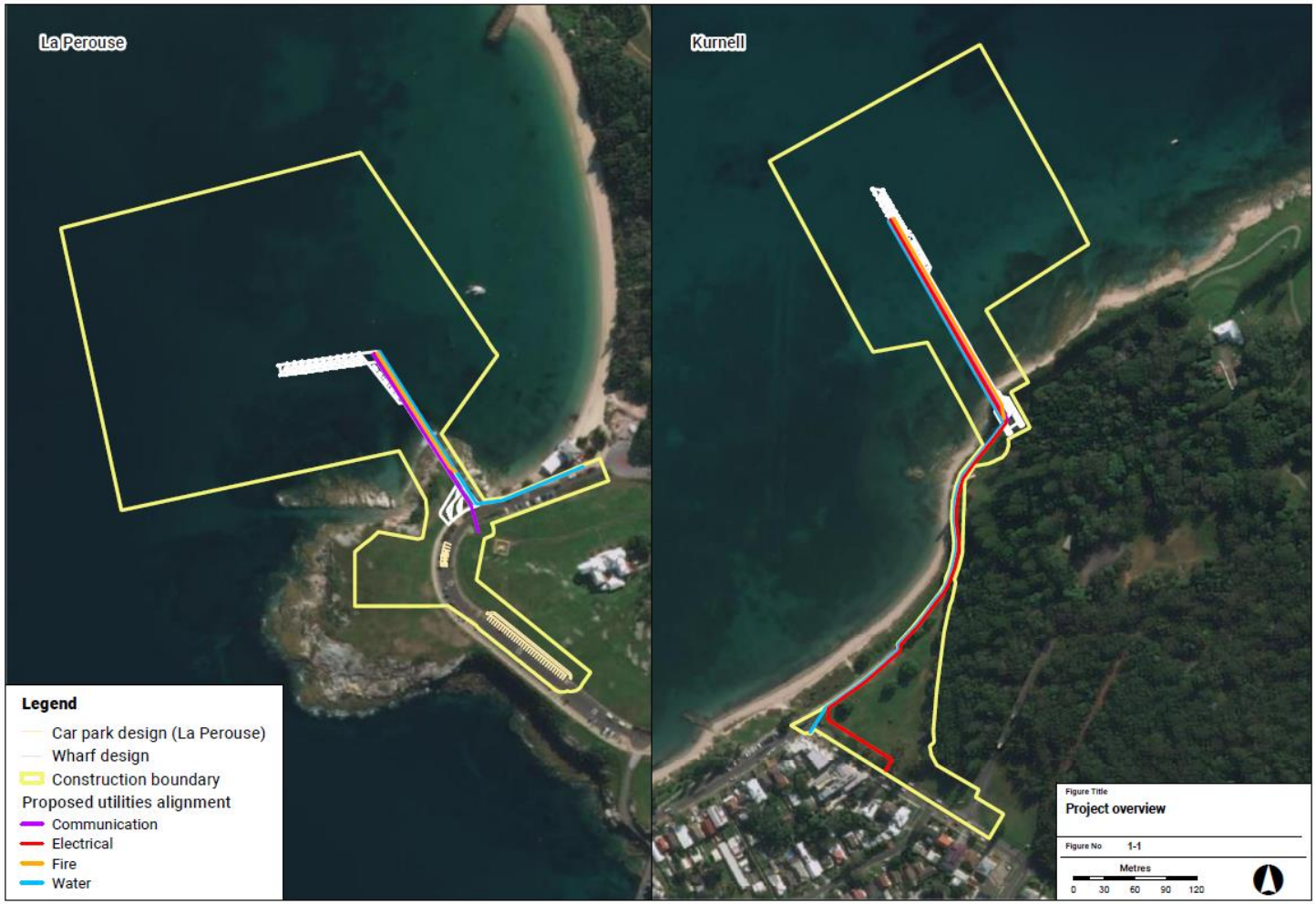

Figure 1: Project overview

1.3 SEARs relevant to this report

Table 1 identifies the SEARs which are relevant to this technical assessment.

Table 1: SEARs for surface water

SEARs relevant to this technical report	Where addressed in this technical report
2. Environmental Impact Statement The project is described in sufficient detail to enable clear understanding that the project has been developed through an iterative process of impact identification and assessment and project refinement to avoid, minimise or offset impacts so that the project, on balance, has the least adverse environmental, social and economic impact, including its cumulative impacts.	
1. The EIS must include, but not necessarily be limited to, the following: (l) a statement of the outcomes the Proponent will achieve for each key issue;	Section 7
(m) measures to avoid, minimise or offset impacts must be linked to the impact(s) they treat, so it is clear which measures will be applied to each impact;	Section 7
(n) consideration of the interactions between measures proposed to avoid or minimise impact(s), between impacts themselves and between measures and impacts;	Section 7
5. Environmentally Sensitive Lands and Processes The project is designed, constructed and operated to avoid or minimise impacts on protected and sensitive lands. The project is designed, constructed and operated to avoid or minimise future exposure to coastal hazards and processes.	
1. Environmentally sensitive land and processes (and the impact of processes on the project) including, but not limited to: (f) waterfront land as defined in the *Water Management Act 2000*;	Section 5 and Section 1
9. Soil, Water and Contamination The environmental values of land, including soils, subsoils, marine sediments and landforms, are protected. Risks arising from the disturbance and excavation/dredging of land or marine sediments and disposal of materials are minimised, including disturbance to acid sulfate soils, site contamination and water quality (surface and groundwater).	

SEARs relevant to this technical report	Where addressed in this technical report
1. Assess the potential impacts of the project on soil, water and contaminated material and marine sediments, including: (a) acid sulfate soils (including impacts of acidic runoff offsite);	Addressed in Appendix R, Groundwater Assessment Report
(b) potential for mobilisation of sediments and any contaminated sediment as a result of dredging and excavation, transportation and disposal of contaminated material/sediments; and	Section 5 and Section 1
(c) appropriate mitigation and management measures to safeguard the environment and people during construction and operation.	Section 5 addresses this as relevant to surface water
2. Assess the impacts of the project on water quality including: (a) the nature and degree of impact on receiving waters;	Section 5 and Section 1
(b) mitigating effects of proposed stormwater and wastewater management during and after construction; and	Section 7
(c) the impact of sediment plumes associated with the operation of the facility on water quality (e.g. proximity of propellers to the substrate and proximity to sensitive environs).	Addressed in Appendix T, Coastal Processes Memorandum
Agency comments	
DPIE – NRAR & Water	
• A detailed and consolidated site water balance.	Not considered necessary given the minimal changes to the land environment and minimal water consumption. A discussion of water cycle impacts is included in Section 6 6.1.3 and Section 6.2.3.
• Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts.	Surface water impacts discussed in Section 5 and Section 1. Groundwater impacts discussed in Appendix R, Groundwater Assessment Report
• Proposed surface and groundwater monitoring activities and methodologies.	Section 5 and Section 6 discuss surface water impacts. As discussed in Section 6, no surface water monitoring is proposed due to the minimal changes to the land environment. For

SEARs relevant to this technical report	Where addressed in this technical report
	groundwater refer to Appendix R, Groundwater Assessment Report
• Consideration of relevant legislation, policies and guidelines, including the NSW Aquifer Interference Policy (2012), the Guidelines for Controlled Activities on Waterfront Land (2018) and the relevant Water Sharing Plans (available at https://www.industry.nsw.gov.au/water).	NSW Aquifer Interference Policy (2012) – Not applicable, no water taken from aquifer or connected ground or surface water sources Guidelines for Controlled Activities on Waterfront Land (2018) – Controlled Activity Approval Not Required – Exempt Waterfront Land Water Sharing Plans – not applicable as no water being pumped or traded
Environment Energy and Science Group (EES) (DPIE)	
Water and soils 9. The EIS must map the following features relevant to water and soils including: (a) Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map). (b) Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method). (c) Wetlands as described in s4.2 of the Biodiversity Assessment Method. (d) Groundwater. (e) Groundwater dependent ecosystems (f) Proposed intake and discharge locations	Addressed in Appendix R, Groundwater Assessment Report and Appendix I, Biodiversity Development Assessment Report Major sub-catchments and rivers shown in Figure 3 in Section 4.
10. The EIS must describe background conditions for any water resource likely to be affected by the development, including: (a) Existing surface and groundwater. (b) Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations.	Surface water is discussed in Section 4 Groundwater is discussed in Appendix R, Groundwater Assessment Report

SEARs relevant to this technical report	Where addressed in this technical report
(c) Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters. (d) Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government. (e) Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions http://www.environment.nsw.gov.au/research-andpublications/publications-search/risk-based-framework-for-considering-waterwayhealth-outcomes-in-strategic-land-use-planning	
11. The EIS must assess the impacts of the development on water quality, including: (a) The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction. (b) Identification of proposed monitoring of water quality. (c) Consistency with any relevant certified Coastal Management Program (or Coastal Zone Management Plan).	Section 5, Section 1 and Section 7 Refer also to Appendix R, Groundwater Assessment Report
12. The EIS must assess the impact of the development on hydrology, including: (a) Water balance including quantity, quality and source. (b) Effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas. (c) Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems. (d) Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches). (e) Changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water. (f) Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options.	Due to minimal changes to the land environment and water consumption water balance, water quality and hydrological modelling not deemed necessary. A discussion of stormwater and water cycle impact is included in Section 6.

SEARs relevant to this technical report	Where addressed in this technical report
(g) Identification of proposed monitoring of hydrological attributes.	
Flooding and coastal hazards 13. The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including: (a) Flood prone land (a) Flood planning area, the area below the flood planning level. (b) Hydraulic categorisation (floodways and flood storage areas) (c) Flood Hazard.	Section 4
14. The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 5% Annual Exceedance Probability (AEP), 1% AEP, flood levels and the probable maximum flood, or an equivalent extreme event.	Council flood studies are discussed in Section 4. Due to minimal changes to the land environment flood modelling has not been undertaken for the project.
15. The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios: (a) Current flood behaviour for a range of design events as identified in 14 above. This includes the 0.5% and 0.2% AEP year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.	Due to minimal changes to the land environment flood modelling has not been undertaken for the project. A general discussion of possible flood impacts is included in Section 6.
16. Modelling in the EIS must consider and document: (a) Existing council flood studies in the area and examine consistency to the flood behaviour documented in these studies. (b) The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood, or an equivalent extreme flood. (c) Impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazard categories and hydraulic categories (d) Relevant provisions of the NSW Floodplain Development Manual 2005.	Council flood studies are discussed in Section 4. Section 5 and Section 6 discuss impacts of the project, but due to minimal changes to the land environment flooding impacts are expected to be minimal and flood modelling has not been undertaken for the project.
17. The EIS must assess the impacts on the proposed development on flood behaviour, including:	Section 1

SEARs relevant to this technical report	Where addressed in this technical report
(a) Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure. (b) Consistency with Council floodplain risk management plans. (c) Consistency with any Rural Floodplain Management Plans. (d) Compatibility with the flood hazard of the land. (e) Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land. (f) Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site. (g) Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses. (h) Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the NSW SES and Council. (i) Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the NSW SES and Council. (j) Emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the NSW SES. (k) Any impacts the development may have on the social and economic costs to the community as consequence of flooding.	
Environment Protection Authority	
Water - Quality The Proponent must: (a) 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; (b) 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	Discussion of potential water quality impacts is included in Section 5 and Section 1. Due to minimal changes to the land environment water quality modelling has not been undertaken for the project.

SEARs relevant to this technical report	Where addressed in this technical report
receiving environment, including consideration of all pollutants that pose a risk of non-trivial harm to human health and the environment; (c) identify the rainfall event that any water quality protection measures will be designed to cope with; (d) assess the significance of any identified impacts including consideration of the relevant ambient water quality outcomes; (e) demonstrate how construction and operation of the project will, to the extent that the project can influence, ensure that: − where the NSW WQOs for receiving waters are currently being met they will continue to be protected; and − where the NSW WQOs are not currently being met, activities will work toward their achievement over time; (f) justify, if required, why the WQOs cannot be maintained or achieved over time; (g) demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented; (h) identify sensitive receiving environments (which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments; (i) identify proposed monitoring locations, monitoring frequency and indicators of surface and groundwater quality; (j) consider turbidity curtains around the immediate works site that contain any plume strictly within the work site area to limit the impacts on the surrounding water quality and environs; (k) provide a water quality monitoring plan which also identifies the thresholds which would result in ceasing activities; and (l) consider the impact of sediment plumes associated with the operation of the facility on water quality (e.g. proximity of propellers to the substrate and proximity to sensitive environs).	
Soil and water The Proponent must: (a) assess the impact of the project on acid sulfate soils (including impacts of acidic runoff offsite) in accordance with the current guidelines (b) characterise contaminated sediments and pore water within the proposal area, including the assessment of the volume of sediment materials to be dredged, potential for mobilisation of contaminated sediment and pore water (c) describe the manner sediment and any contaminated sediments will be dredged and/or excavated	Addressed in Appendix R, Groundwater Assessment Report

SEARs relevant to this technical report	Where addressed in this technical report
(d) assess the impacts on soil and land resources (including erosion risk or hazard). Particular attention must be given to soil erosion and sediment and contaminant transport consistent with the practices and principles in the current guidelines. (e) identify appropriate mitigation and management measures to safeguard the environment and people during construction and operation (f) identify potential risk to human health, aquaculture activities, seagrasses or the environment; (g) sampling and characterisation of the distribution of contamination should take into account the National Assessment Guidelines for Dredging 2009.	
Sutherland Shire Council	
Acid Sulphate Soils The wharf head is located on a class 5 acid sulphate soils area, but the remainder of the wharf will be located in a class 1 acid sulphate soils area. They need to investigate steps to avoid impacting acid sulphate soils, or management them if impacts can't be avoided.	Addressed in Appendix R, Groundwater Assessment Report

2 Policy and planning context

The following polices, guidelines and plans have been considered when undertaking the surface water impact assessment:

- Sea Level Rise Policy (Sutherland Shire Council, 2016)
- Local Environmental Plan (LEP) (Sutherland Shire Council, 2015)
- Private Stormwater Code (Randwick City Council, 2003)
- LEP (Randwick City Council, 2012)
- Derivation of the NSW Government's Sea Level Rise Planning Benchmarks. Technical Note (Department of Environment, Climate Change and Water [DECCW], 2009)
- Flood Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments (DECCW, 2010)
- Floodplain Development Manual (Department of Infrastructure, Planning and Natural Resources [DIPNR], 2005)
- Coastal Planning Guideline – Adapting to Sea Level Rise (Department of Planning [DoP], 2010)
- Australian Rainfall and Runoff: A Guide to Flood Estimation (Ball *et al*, 2019)
- Guidelines for Controlled Activities on Waterfront Land (Natural Resources Access Regulator [NRAR], 2018)
- Managing Urban Stormwater: Soils & Construction Volume 1 (Landcom, 2004) (referred to as the Blue Book) and Volume 2 (where relevant)
- Managing Urban Stormwater: Treatment Techniques (NSW EPA, 1997)
- Managing Urban Stormwater: Source Control (NSW EPA, 1997)
- Charter: National Water Quality Management Strategy (Commonwealth of Australia, Department of Agriculture and Water Resources [DAWR], 2018)
- Monitoring and evaluation plan: National Water Quality Management Strategy (Commonwealth of Australia, DAWR, 2018)
- Standard operating procedure for guideline management: National Water Quality Management Strategy (Commonwealth of Australia, DAWR, 2018)
- Using the ANZECC Guideline and Water Quality Objectives in NSW (Department of Environment and Conservation [DEC], 2006)
- State Water Management Outcomes Plan (Department of Natural Resources, 2005)
- NSW Government Water Quality and River Flow Environmental Objectives (DECC, 2006)

- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC, 2004)
- Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decision (Office of Environment and Heritage [OEH], Environment Protection Authority [EPA] 2017).

3 Methodology

This desktop assessment has been undertaken by reviewing the concept design and considering any potential impacts on surface water at La Perouse and Kurnell. Both construction and operation phases have been considered in this assessment.

The assessment considers existing topography and built infrastructure, including review of the following items:

- Tidal conditions and susceptibility to tidal flooding
- Existing water quality and pollutant levels
- Existing topography at both wharf locations
- Existing drainage infrastructure and overland flow conditions at both wharf locations
- Existing flood studies and potential flooding issues at both wharf locations.

Due to the limited changes to the land environment, no water quality or hydraulic modelling has been undertaken as part of this assessment.

Based on the review of existing conditions and proposed changes during construction and operation, the likely impacts of the project have been assessed. In response to these potential impacts, a range of mitigation measures have been proposed to eliminate them or reduce their severity or likelihood.

4 Existing environment

This section describes the existing surface water conditions at La Perouse and Kurnell within the project boundary. Figure 2 shows the location of both wharves in the context of Botany Bay and the Cooks and Georges Rivers.

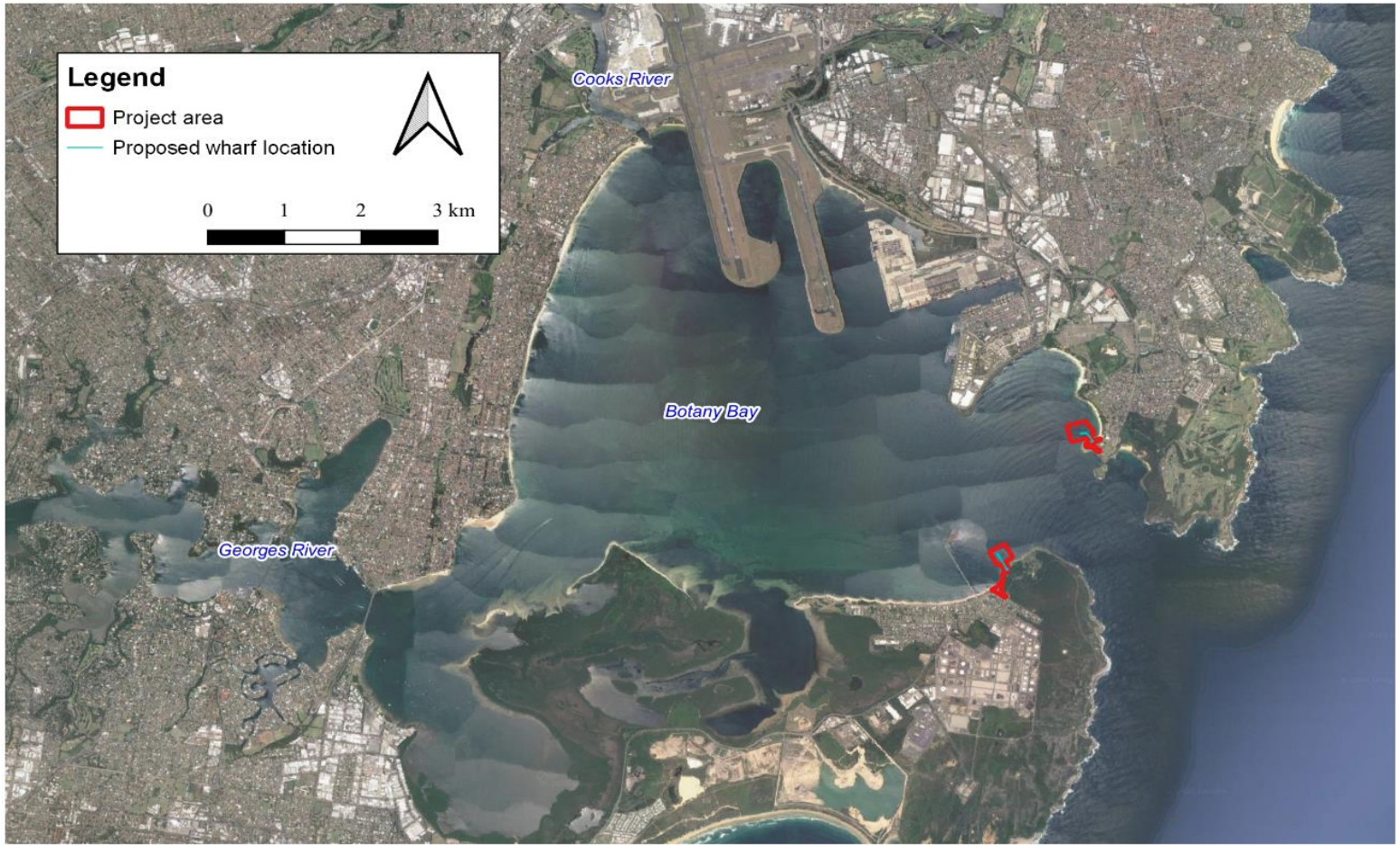

Figure 2: Location of proposed ferry wharves in Botany Bay

4.1 Botany Bay

4.1.1 Tidal flooding

Both proposed wharf locations have the potential to be affected by tidal flooding. Estimated tide levels at both locations is discussed in the following sections.

Astronomical tide levels

Water levels at Fort Denison tide gauge are considered a reliable approximation of tide levels at Kurnell and La Perouse as they have a longer dataset and have been shown to be representative of coastal water levels along the NSW central coast from a statistical perspective.

The present-day astronomical tide levels presented in Table 2. Predicted tide levels for the year 2075 incorporating projected sea level rise of 0.47m are also provided.

Table 2: Present day and future tide levels at Fort Denison, Sydney (2019 and 2075 projections).

Tide Level	Present Day (2020)		Year 2075	
	(CD[1])	(AHD)	(CD)	(AHD)
Highest Astronomical Tide (HAT)	2.04	1.11	2.51	1.58
Mean High Water Springs (MHWS)	1.61	0.69	2.08	1.16
Mean High Water Mark (MHWM)	1.48	0.56	1.95	1.03
Mean High Water Neaps (MHWN)	1.36	0.44	1.83	0.91
Mean Sea Level (MSL)	0.93	0.01	1.4	0.48
Mean Low Water Neaps (MLWN)	0.54	-0.39	1.01	0.08
Mean Low Water Springs (MLWS)	0.29	-0.64	0.76	-0.17
Lowest Astronomical Tide (LAT)	0.00	-0.93	0.47	-0.46

1. CD = Chart Datum which approximates to LAT and is approximately 0.93m below AHD.
Source = Kamay Wharves Project Coastal Modelling Report, Cardno 2020.

Extreme water levels

Present day extreme design still water levels at Fort Denison based on a statistical analysis of measured historical records are presented in in Table 3. These values are aligned with the outputs from the *Fort Denison Sea Level Rise Vulnerability Study (Watson and Lord, 2008)*. The extremes analysis is based on water level data measured continuously at Fort Denison for over 100 years. The data reflects the astronomical tide levels as well as anomalies or variations from the predicted tide from storm surge and freshwater flows (assumed very minimal). Similarly, the data inherently incorporates climate-change and other seasonal-induced sea level rise over this timeframe.

Table 3: Extreme water levels adopted for Fort Denison (2019 and 2075 projections).

Average Recurrence Interval (ARI) (years)	(2019) Extreme Still Water Level		2075 Extreme Still Water Level	
	m CD[1]	m AHD	m CD	m AHD
0.02	1.89	0.965	2.36	1.435
0.05	1.97	1.045	2.44	1.515
0.1	2.02	1.095	2.49	1.565
1	2.16	1.235	2.63	1.705
2	2.20	1.275	2.67	1.745
5	2.24	1.315	2.71	1.785
10	2.27	1.345	2.74	1.815
20	2.30	1.375	2.77	1.845
50	2.34	1.415	2.81	1.885
100	2.36	1.435	2.83	1.905
200	2.38	1.455	2.85	1.925
500	2.39	1.465	2.86	1.935
1000	2.40	1.475	2.87	1.945

1. CD = Chart Datum which approximates to LAT and is approximately 0.93m below AHD.
Source = Kamay Wharves Project Coastal Modelling Report, Cardno 2020.

4.1.2 Water quality

Water quality in Botany Bay at Kurnell and La Perouse is influenced by runoff from Cooks River, Georges River and other smaller tributaries that are within the Botany Bay catchment (see Figure 3). Botany Bay catchment covers an area of approximately 1,165 km^2, of which 40% is used for residential, industrial and commercial purposes. A large proportion of the reminder is still parkland or bushland.

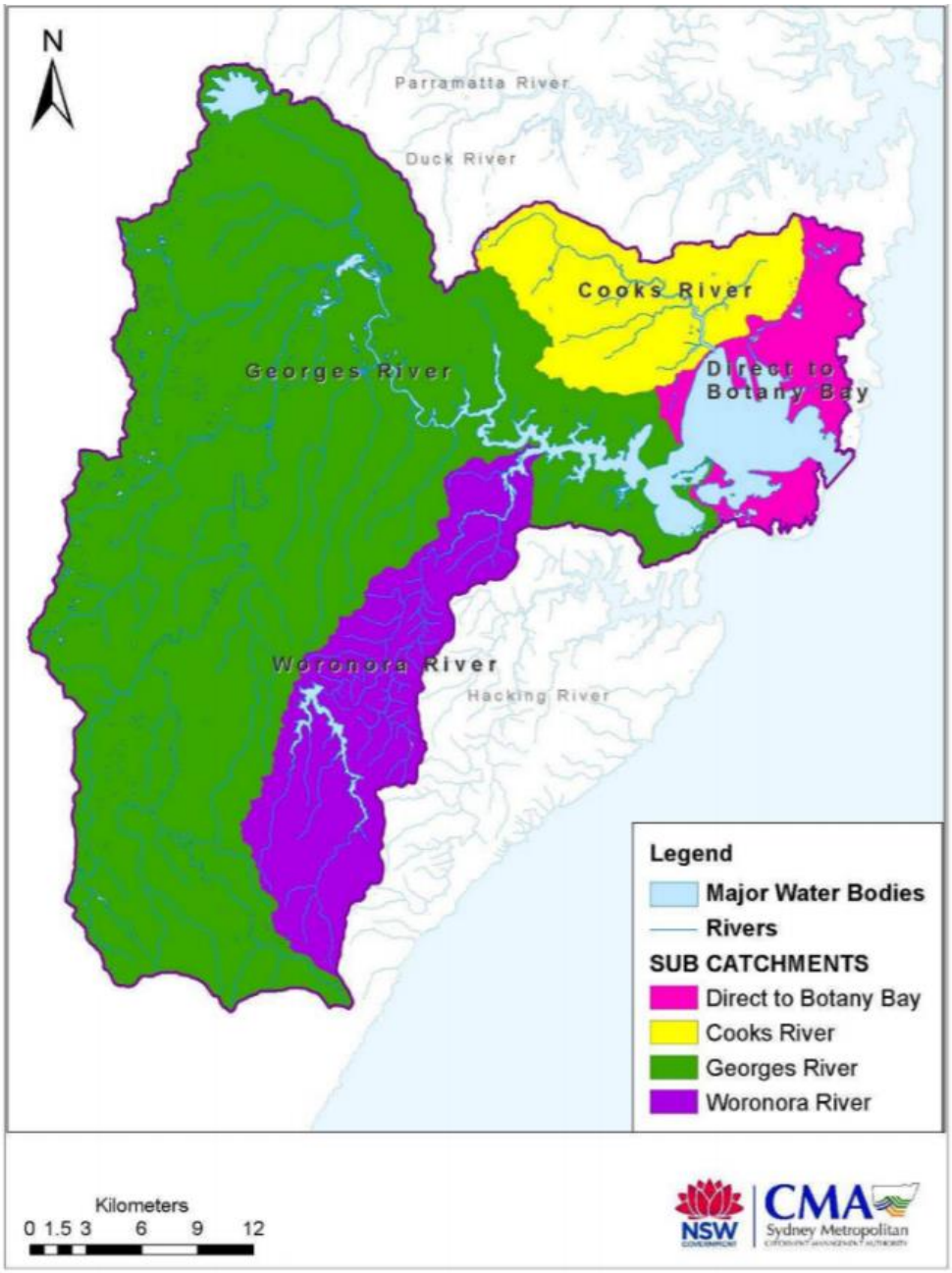

Figure 3: Botany Bay sub-catchments
(© Sydney Metropolitan Catchment Management Authority)

The NSW Department of Planning, Industry and Environment (DPIE) undertakes water quality monitoring at beaches across Sydney, including 15 sites in Botany Bay and lower Georges River. Water quality sampling occurs weekly between October and April, and monthly between May and September. In 2019-2020, 93% of Botany Bay and lower Georges River swimming sites were graded 'Good' in terms of water quality; This means the location has "generally good microbial water quality and water is considered suitable for swimming most of the time" (DPIE, 2020). This was an improvement from 80% in 2018-2019 (DPIE, 2019).

4.2 La Perouse

4.2.1 Location and topography

The topography in the vicinity of the proposed wharf is shown in Figure 4. The land portion of the project area contains a high point around 13.5 mAHD to its east, with the ground falling to sea level to the north-west. All areas of proposed landside works will be well above normal and extreme tidal levels.

The construction area will receive overland flows from the north and east from grassed area and road to the north and east beyond the construction boundary. There are no natural waterways in the project area, and natural overland flow paths are intercepted by Anzac Parade and associated drainage infrastructure. The land side of the project area is generally several metres above sea level with a steep, rocky shoreline and a section of a retaining structure between Frenchmans Bay beach and Anzac Parade. There are no depressions that are likely to accumulate significant flow during rainfall, rather overland flow is likely to take the form of shallow sheet flow until intercepted by man-made infrastructure.

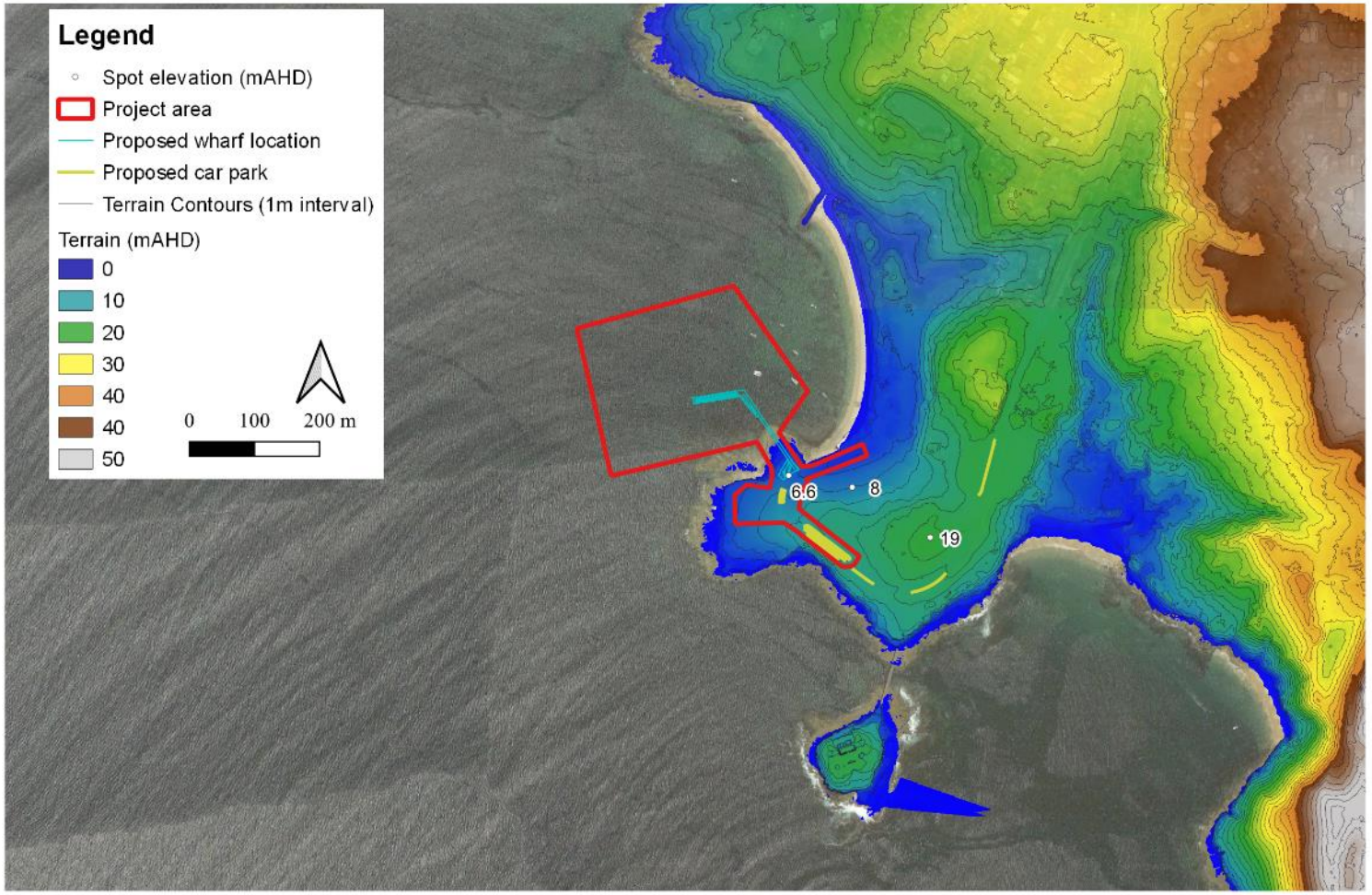

Figure 4: Digital Elevation Model of the proposed wharf site and surrounds at La Perouse

4.2.2 Stormwater drainage

Stormwater drainage at La Perouse consists of kerb inlet pits and surface drains along Anzac Parade. Drainage from these pits discharge directly to the bay at various locations.

Rain falling on footpaths in the area typically run off onto nearby grassed areas with no formal drainage.

4.2.3 Flooding

Randwick City Council (RCC) is responsible for the management of flood liable land at La Perouse. While RCC has adopted various flood studies which cover parts of the LGA, Council is yet to prepare a flood study for La Perouse that defines design flood behaviour. RCC has identified this and surrounding land as part of their strategy for future study areas within their floodplain management scope.

Arup has undertaken a preliminary assessment of topographical information to identify potential locations of higher flooding risk near the proposed parking and wharf site. This assessment has confirmed that the site is not near any watercourses that discharge into the ocean. The topography is such that there are not large catchments flowing into the site, meaning risk of flooding from overland flow is low. The land-side project area is also high enough such that it would not be impacted by tidal flooding. On this basis it can be concluded that the site is not likely to be flood affected.

Based on an assessment of the topography of the site, no external catchments flow into the project area, so flooding as a result of overland flow is unlikely.

4.3 Kurnell

4.3.1 Location and topography

The topography around the proposed ferry wharf location at Kurnell is shown in Figure 5. Captain Cook Drive is relatively low and flat at approximately 2-3mAHD. North of Captain Cook Drive in Kamay Botany Bay National Park there are three high points at approximately 16mAHD, with land falling steeply to the foreshore. The existing path between Captain Cook Drive and the proposed wharf is relatively flat and at a level of 2-3mAHD, above estimated extreme tide levels. Captain Cooks Stream, an ephemeral watercourse, is located approximately 200m northeast of the proposed wharf.

A preliminary assessment of available topographical information indicates the proposed site is outside natural depressions where local runoff may concentrate during storm events. During extreme rainfall events, it is expected that runoff will be in the form of shallow sheet flow around both proposed ferry wharf sites. As such, the provision of stormwater infrastructure to manage local overland runoff around the future ferry wharf is not expected to be onerous.

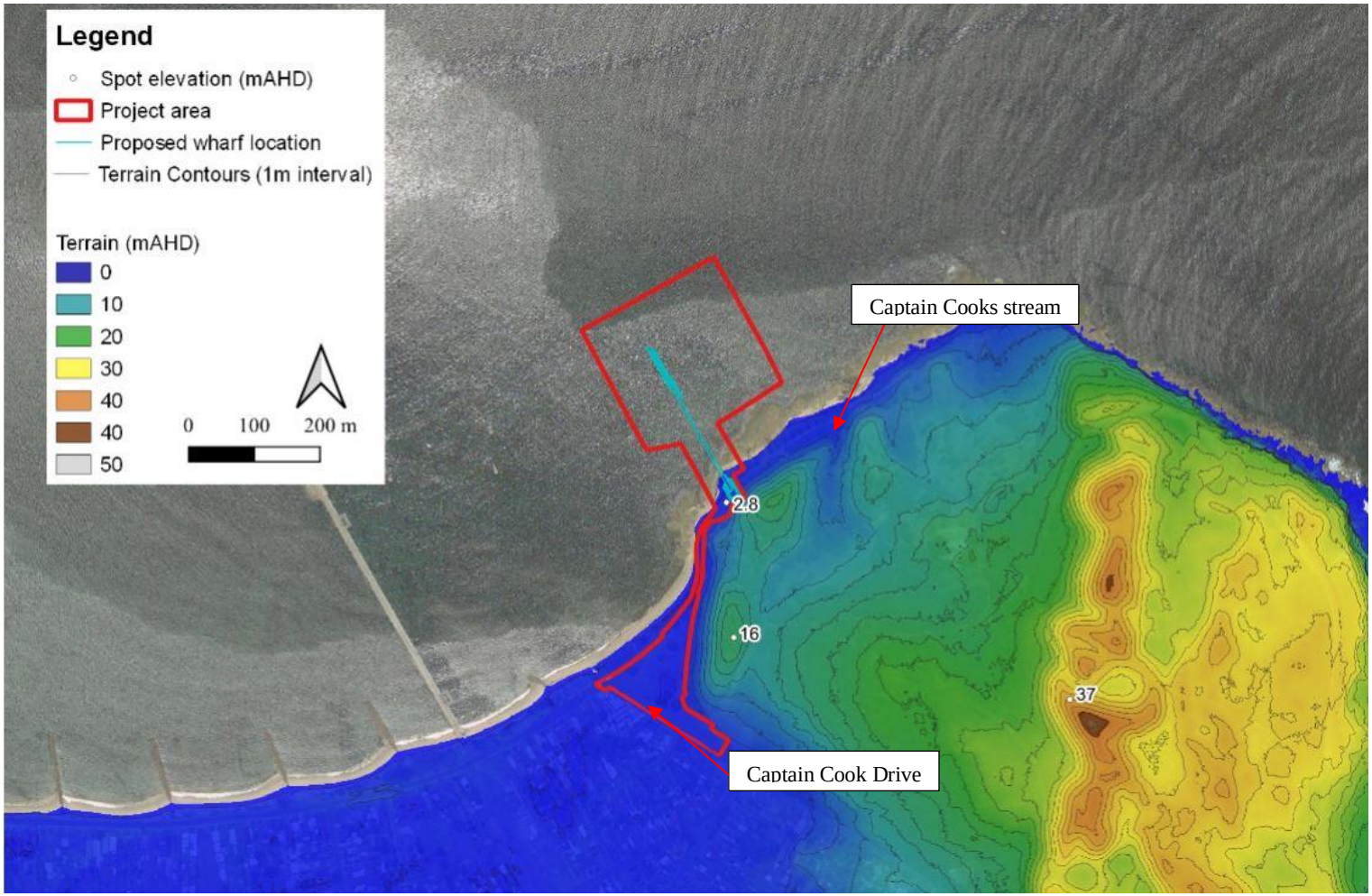

Figure 5: Digital Elevation Model of the proposed wharf site and surrounds at Kurnell

4.3.2 Stormwater drainage

Stormwater drainage at Kurnell consists of kerb inlet pits along the kerb alignment of Captain Cook Drive. Drainage from these pits is understood to discharge directly to Silver Beach.

No formal subsurface drainage infrastructure is present along Monument Track or at the proposed location of the wharf. Rain falling on footpaths in the area runs off onto nearby grassed areas.

4.3.3 Flooding

Sutherland Shire Council (SSC) has completed the Kurnell Township Flood Study (prepared by WMAwater, 2009) which identified areas of the township that are at risk of flooding (Figure 6) either from rainfall-runoff processes or tidal inundation. The study area included Captain Cook Drive but not the proposed wharf location.

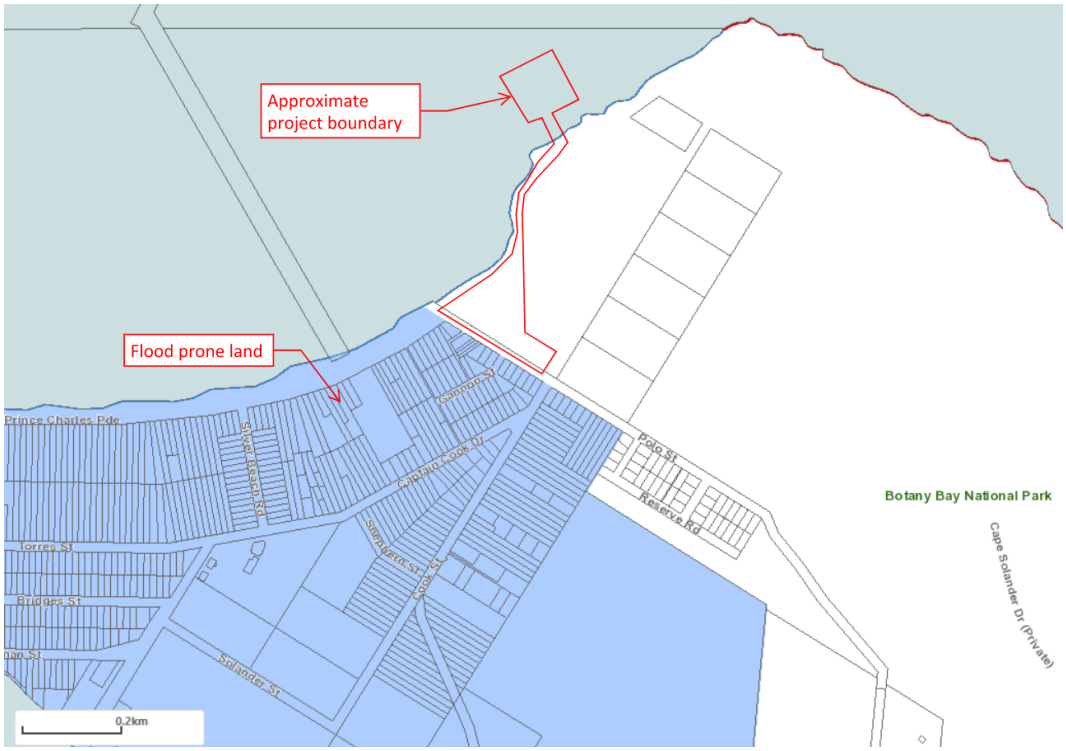

Figure 6: Flood prone land (source: Shire Maps, Sutherland Shire Council, January 2020)

The results presented in the flood study show shallow flooding up to a depth of 250 mm at Captain Cook Drive in the 20% Average Exceedance Probability (AEP) event. Flood depths are shown to exceed 250 mm and 500 mm along the eastern kerb line of Captain Cook Drive in the 5% AEP and 1% AEP flood events respectively. Excerpts of the Council flood maps are included in Figure 7, Figure 8 and Figure 9.

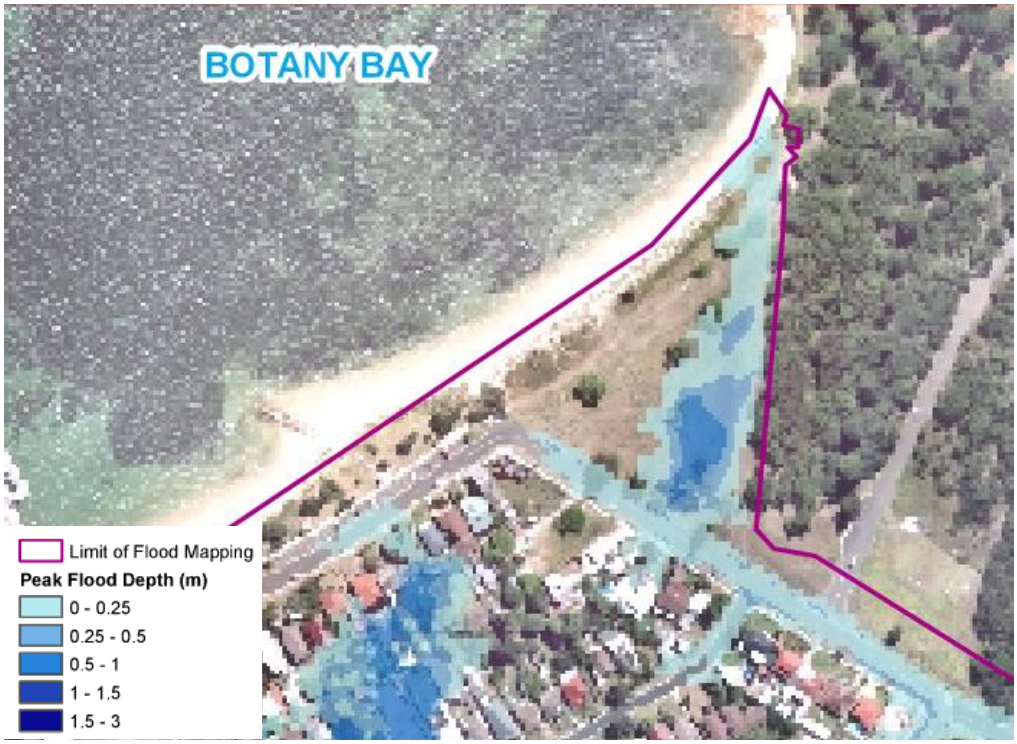

Figure 7: Excerpt of 20% AEP flood depth map at Captain Cook Drive (source: Kurnell Township Flood Study, WMAwater, 2009)

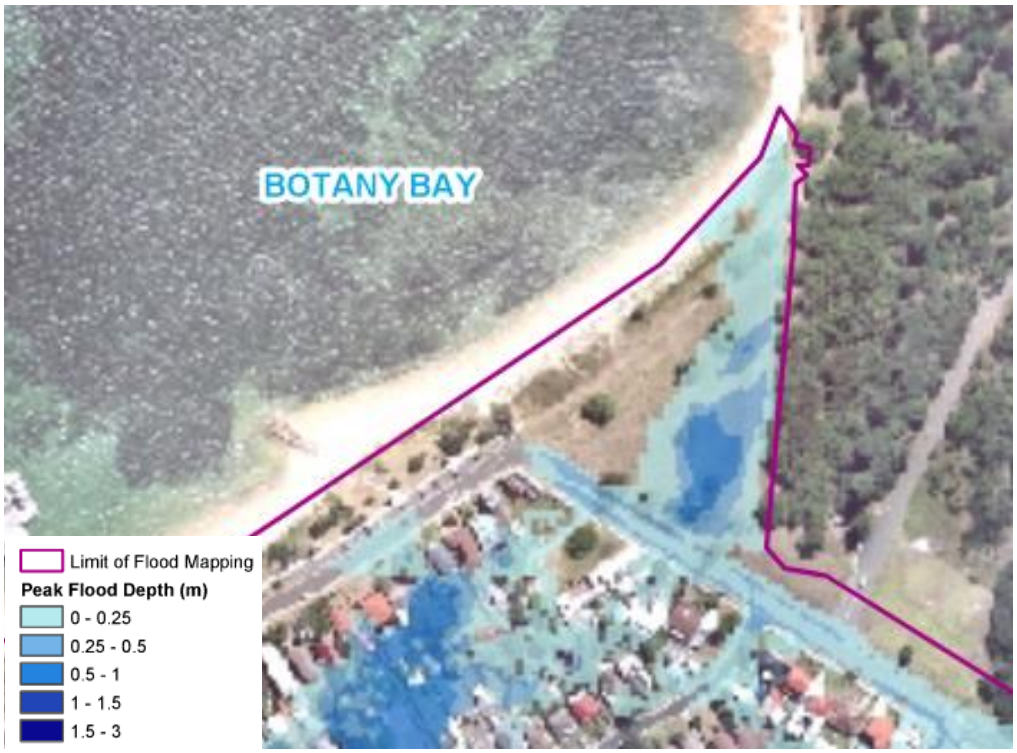

Figure 8: Excerpt of 5% AEP flood depth map at Captain Cook Drive (source: Kurnell Township Flood Study, WMAwater, 2009)

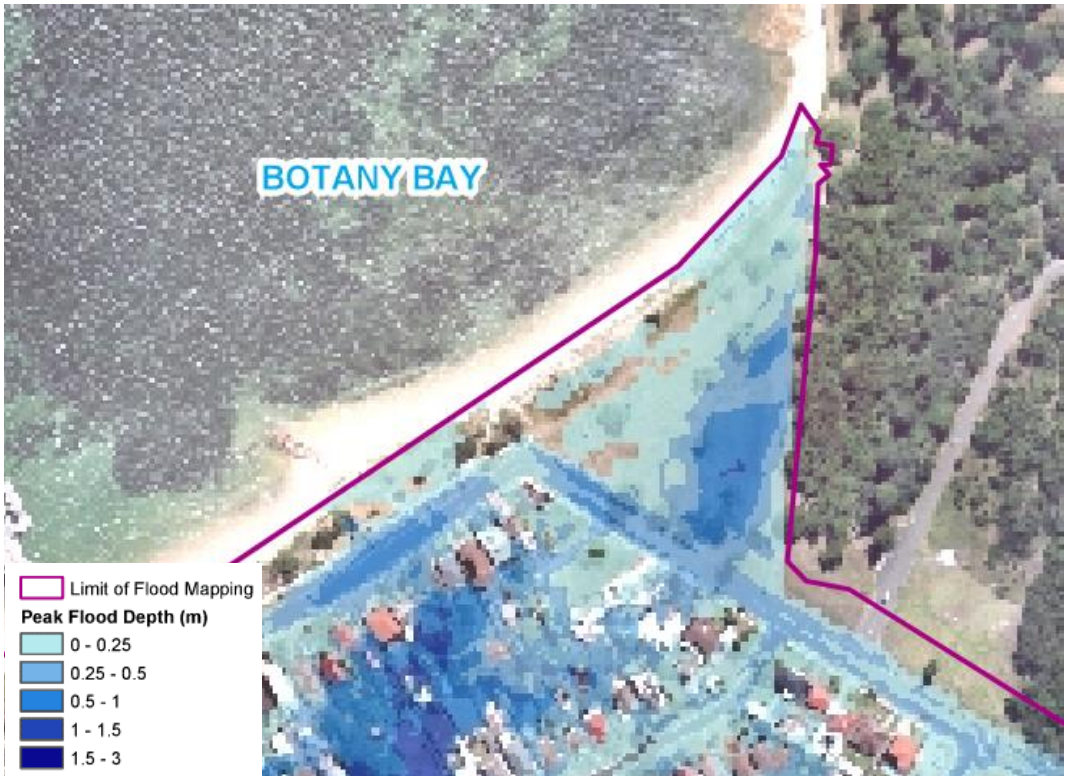

Figure 9: Excerpt of 1% AEP flood depth map at Captain Cook Drive (source: Kurnell Township Flood Study, WMAwater, 2009)

The proposed wharf location is not at a natural depression so local runoff would not be expected to concentrate at this location. During extreme rainfall events it is expected that stormwater runoff from this area would be in the form of shallow sheet flow. On this basis it is not anticipated that the proposed paved area adjacent to the wharf would be affected by severe flooding.

5 Assessment of potential construction impacts

Potential surface water impacts during construction associated with proposed works at La Perouse and Kurnell are discussed in this section. Construction impacts on the marine environment is considered in the Coastal Processes Memorandum (Appendix T) and Marine Biodiversity Assessment Report (Appendix H).

5.1 La Perouse and Kurnell

The areas of proposed construction activity will be focused on the landings of the two wharves, at the car parking area at La Perouse, and along the utility supply routes. A temporary causeway is also proposed during construction at Kurnell, although this would involve minimal land-side construction works.

The primary potential construction impacts related to surface water are similar for both sites and relate to erosion and sediment control and potential spills or

construction waste exiting the site and entering the surface water system (i.e. overland flow and drainage infrastructure). Erosion and sediment movement is a common potential issue on any construction site where the existing surface (paved or natural, such as grass) is removed and soils are exposed. Unprotected soils are more prone to erosion during rain, in which case they enter the surface water system. Similarly, with many construction projects there is a risk of spills or excess construction material escaping the site and entering the surface water system. In either case, waste may enter formal drainage systems (i.e. pits, pipes, swales) or may be captured by general overland flow. Given the proximity of the sites to Botany Bay, and that the stormwater systems discharge to the Bay directly, any waste not captured will quickly enter Botany Bay.

Examples of erosion and sediment control measures include:

- Sediment fences
- Diversion of surface water around the site
- Controlled site entry/exit
- Protection of water inlets (e.g. kerb inlets) with sandbags or similar
- Stabilisation or covering of stockpiled material.

6 Assessment of potential operational impacts

6.1 La Perouse

The proposed land-side surface changes at La Perouse are shown in Figure 10. The potential operational surface water impacts of each change are discussed in this section. Operational impacts on the marine environments is considered in the Coastal Processes Assessment and Marine Biodiversity Assessment.

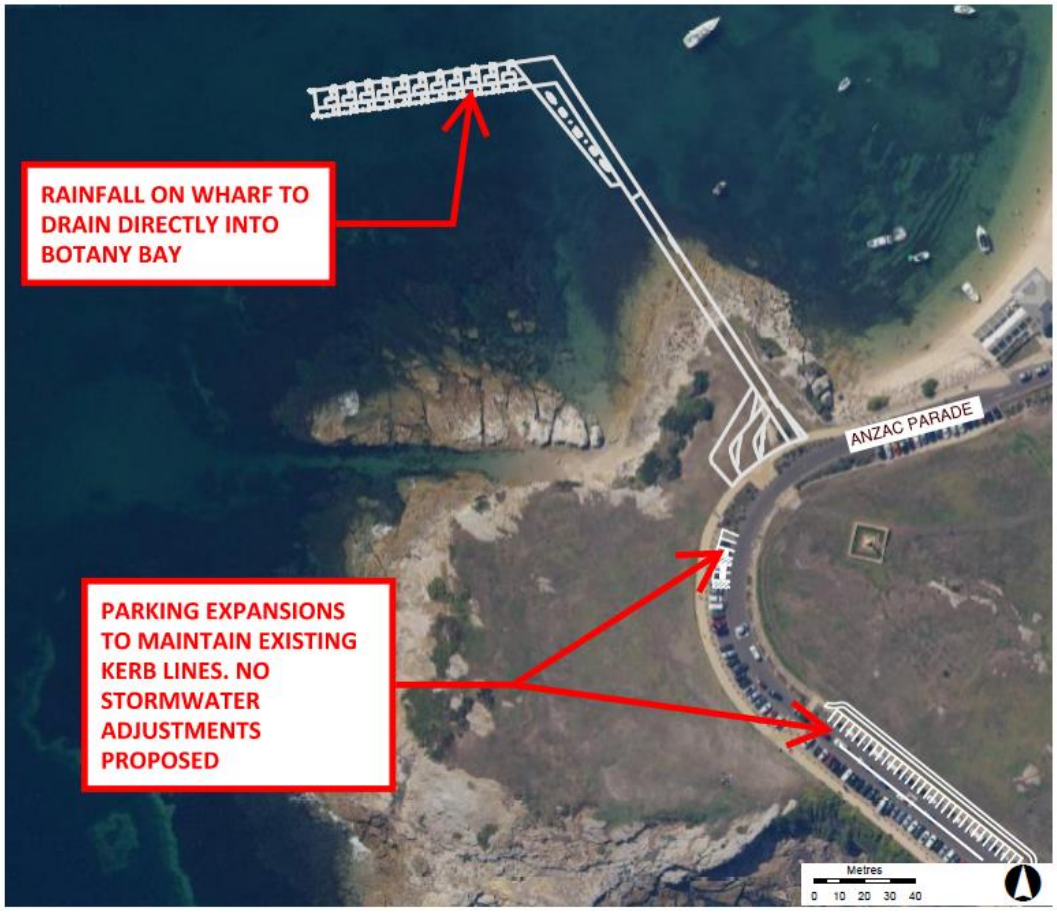

Figure 10: Proposed land-side changes to existing surfaces at La Perouse

6.1.1 Stormwater impacts

The proposed southern parking expansion zone includes adjustments to parking bays which require the relocation of the 1.5 m-wide footpath for a section of approximately 80 m. Stormwater from this path would run off onto the grass in between the path and the car parking area at Anzac Parade. This path is currently at-grade with the road, with both draining to the same infrastructure. No material stormwater quality or flooding impacts are expected due to the relocation of this footpath. The existing kerb line at the back of the path is to be retained, and current drainage infrastructure is not affected.

The proposed northern parking expansion zone includes changes to line marking only, and therefore no changes to impervious areas or stormwater drainage are proposed in this area.

A small paved area of approximately 400 m^2 is also proposed at the wharf landing adjacent to Anzac Parade. Stormwater runoff from this area with flow onto adjacent grassed areas. Due to the location of the project next to Botany Bay and the small, this small increase in impervious area does not have the potential to result in material flooding impacts.

Grassed areas will act as buffer strips and will limit the discharge of pollutants from the small paved area. The additional paved area is for pedestrian use only as per existing use, so pollutant load is unlikely to change significantly. Given the small size of the additional paved area relative to the 1,165 km^2 catchment area draining to Botany Bay, it is not considered to have the potential to result in material water quality impacts on Botany Bay.

Rainfall on the wharf will flow directly into Botany Bay. Due to its small area relative to Botany Bay, and the proposed pedestrian use, this is not anticipated to result in material impacts on marine water quality.

Due the limited potential for water quality impacts associated with the project and absence of water courses which runoff would discharge to in vicinity of construction area, no specific ongoing water quality monitoring is proposed.

6.1.2 Tides

Wharf levels have been designed such that the ferry service can operate in a range of tidal conditions. The wharf structure has also been designed to withstand tidal surges and wave action.

6.1.3 Water cycle impacts

Due to the minor nature of impacts on the water cycle associated with the La Perouse wharf, a detailed water balance assessment has not been undertaken. Water cycle impacts from the small increases in impervious areas would not be expected to have a material impact on stormwater runoff volumes from the area.

The potable water consumption at the proposed La Perouse wharf will be minimal with water services limited to two hose taps. Allowing for an average total operation of 20 minutes per day, potable water consumption is estimated to be 360 litres per day. No discharge to sewer is proposed and excess water from taps would flow into the ocean.

6.2 Kurnell

The proposed land-side surface changes at Kurnell are shown in Figure 11. An assessment of the potential operational surface water impacts of each change is discussed in this section.

Figure 11: Proposed land-side changes to existing surfaces at Kurnell

6.2.1 Stormwater impacts

No material stormwater quality or flooding impacts are expected due to the small increases in impervious areas given the size of adjacent pervious area and the proximity to the discharge into Botany Bay, which has a much larger catchment area.

A small paved area of approximately 400 m^2 is also proposed at the wharf landing area. Stormwater runoff from this area with flow onto adjacent grassed areas. A concrete path already exists at this location, therefore the net increase in impervious area is estimated to be less than 300 m^2. Due to the location adjacent to Botany Bay and small size, this increase in impervious area does not have the

potential to cause material flooding impacts. Grassed areas will act as buffer strips and will limit the discharge of pollutants from the small paved area. The additional paved area is for pedestrian use only as per existing use, so pollutant load is unlikely to change significantly.

Rainfall on the jetty will flow directly into Botany Bay. Due to its small area relative to Botany Bay, and pedestrian-only use, this is not anticipated to result in material impacts on marine water quality.

Due the limited potential for water quality impacts associated with the project and absence of water courses which runoff would discharge to in the vicinity of the construction area, no specific ongoing water quality monitoring is proposed.

6.2.2 Tides

Wharf levels have been designed such that the ferry service can operate in a range of tidal conditions. The wharf structure has also been designed to withstand tidal surges and wave action.

6.2.3 Water cycle impacts

Due to the minor nature of impacts on the water cycle associated with the Kurnell wharf, a detailed water balance assessment has not been undertaken. Water cycle impacts from the small increases in impervious areas would not be expected to have a material impact on stormwater runoff volumes from the area.

The potable water consumption at the proposed Kurnell wharf will be minimal with water services limited to three hose taps. Allowing for an average total operation of 20 minutes per day, potable water consumption is estimated to be 360 litres per day. No discharge to sewer is proposed and excess water from taps would flow into the ocean.

7 Environmental management measures

This section provides a summary of the construction and operational risks pre-mitigation described in Section 5 and 6 and the appropriate mitigation measures required for these risks. These are summarised further in Table 4.

Table 4: Environmental management measures for surface water impacts

Impacts	Mitigation	Responsibility	Timing
Water pollution at Botany Bay through discharge of sediment and other pollutants from construction compound and works areas	**Soil and Water Management Plan** A Soil and Water Management Plan will be prepared in accordance with QA Specification G38 and implemented as part of the CEMP. The Plan will identify all reasonably foreseeable risks relating to soil erosion and water pollution associated with undertaking the activity and describe how these risks will be managed and minimised during construction. That will include arrangements for managing pollution risks associated with spillage or contamination on the site and adjoining areas. The plan will incorporate controls such as: • Sediment fencing • Sediment socks at existing stormwater pits • Scour protection • Shaker pads • Spill management plan • Spoil and fill management plan. Given the proximity of the sites to Botany Bay, with much of the overland flow from the sites directly entering the Bay, particular care will be applied to ensure the site is fully protected.	Transport for NSW / Contractor	Pre-construction / Detailed design
Water pollution at Botany Bay through discharge of	**Install erosion, sediment and water quality controls** Consistent with the Soil and Water Management Plan, control measures will	Transport for NSW / Contractor	Construction

Impacts	Mitigation	Responsibility	Timing
sediment and other pollutants from construction compound and works areas	be implemented to minimise risks associated with erosion and sedimentation and entry of materials to drainage lines and waterways. These may include, but not necessarily be limited to: • Sediment management devices, such as fencing, hay bales or sandbags • Measures to divert or capture and filter water prior to discharge, such as drainage channels and first flush and sediment basins • Scour protection and energy dissipaters at locations of high erosion risk • Installation of measures at work entry and exit points to minimise movement of material onto adjoining roads, such as rumble grids or wheel wash bays • Appropriate location and storage of construction materials, fuels and chemicals, including bunding where appropriate.		
Localised stormwater flooding	**Surface Grading Design** All new paved areas are to be designed to grade freely with no low-points.	Transport for NSW / Designer	Detailed design
Localised water quality impacts	**Surface Grading Design** All new footpaths are to be designed to drain to grassed areas to promote infiltration and cleansing of pollutants.	Transport for NSW / Designer	Detailed design

8 Summary of residual impacts

This section provides a summary of the construction and operational risks both pre-mitigation and any residual impacts remaining after the implementation of the management measures describe in Section 7. Pre-mitigation and residual impacts are summarised in Table 5.

Table 5: Summary of pre-mitigation and residual impacts

Potential pre-mitigation adverse impact	Relevant management measures	Potential residual impact after implementation of management measures	Comment on how any residual impacts would be managed
Construction			
Water pollution at Botany Bay through discharge of sediment and other pollutants from construction compound and works areas	Implementation of approved Soil and water management plan	Water pollution may occur if the Soil and water management plan is not implemented correctly.	Soil and water management plan implementation will be monitored throughout construction phase.
Operation			
Localised stormwater flooding	All new paved areas are to be designed to grade freely with no low points.	Slight increase in runoff due to small increase in paved area.	None required
Localised water quality impacts	All new footpaths are to be designed to drain to grassed areas to promote infiltration and cleansing of pollutants.	Slight increase in runoff due to small increase in paved area.	None required

9 References

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