

Kurnell Terminal SSD- 5544 MOD-7

Appendix G - Updated Surface Water, Wastewater and Flooding
Report

16-Mar-2026

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Appendix G - Updated Surface Water, Wastewater and Flooding Report

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Executive summary

The Kurnell Terminal (the Site) is located on the southern side of Botany Bay, in Kurnell, New South Wales (NSW). In 2012, Ampol Refineries (NSW) Pty Ltd (Ampol) decided that the oil refinery and fuel terminal would be converted to a finished product terminal (the approved project), ceasing refinery operations in 2014.

Development consent was received to complete the approved project under State Significant Development (SSD) application reference 5544 (SSD-5544). Ampol has modified SSD-5544 six times to facilitate the conversion and demolition works.

Ampol intends to consolidate operational infrastructure, remove redundant assets, and undertake remediation. Completion of these works (the proposed modification, MOD-7) would continue the viable, safe, reliable, and sustainable operation of the Kurnell Terminal. The location within the Site that these works would occur is referred to as the Project Area.

The Stormwater, Wastewater and Flooding Report for the proposed modification was one of a number of technical documents that formed part of the Modification Report and supported the modification application. This Updated Stormwater, Wastewater and Flooding Report has been produced to address submissions received by agencies during the exhibition of the Modification Report and refinements to the proposed modification. It has been prepared to support the Submissions Report.

This report has reviewed the updated proposed modification and identified the potential surface water, wastewater, and flooding impacts. Specifically, this report has been prepared to assess the potential impacts of the construction and operation of the proposed modification on the receiving environment, and to identify appropriate safeguards and management measures to mitigate impacts. Existing stormwater management across the Site would be altered by the proposed Stage 2 works, particularly where current sections of infrastructure associated with the oily water system (OWS) in Zones 2 and 3 would be removed and flows redirected to the surface water system (SWS).

Recommended safeguards and management measures for the construction phase of the proposed modification, including temporary erosion and sediment controls, flow diversion measures, and stockpile locations, would be captured in the Construction Environmental Management Plan (CEMP) and associated subplans and supporting documents, including the Soil and Water Management Plan (SaWMP), the Surface Water Management Plan (SWMP) and Erosion and Sediment Control Plan(s) (ESCP). Recommended safeguards and management measures for the construction phase, such as temporary sediment and erosion controls, flow diversion measures, and stockpile locations, would be captured in the CEMP. The CEMP would document the design, installation, and operation of these temporary controls required during the construction phase.

The safeguards and management measures for the operational phase of the proposed modification (i.e. the modified terminal) would include:

- With the exception of the area colloquially known as Refining Process Improvement Project (RPIP) Mountain and Source Area Excavation 5, activities associated with the proposed modification would not alter existing landform or finished surface levels across the Site. Existing bunding around former bunded OWS areas would remain, thereby retaining surface water storage across the Site. The bunding at Source Area Excavation 5 would be removed to allow remediation activities to occur; this area does not currently retain large amounts of water and its removal would result in a negligible change in surface flows. Excavations required as part of the proposed modification would be reinstated to existing finished surface levels, with the exception of RPIP Mountain, which would be regraded.
- Existing surface finishes (in terms of imperviousness) would also not be altered. Excavations would be reinstated surface finish would be no less impervious than the current scenario. The surface of RPIP Mountain would be hydromulched (or fixed using another appropriate method) to help prevent surface water flows from this land being impacted by sediment following the works.
- Surface water runoff from the existing bunded OWS areas in Catchments B and F, where removal of OWS lines is proposed, would be redirected to the existing SWS in Catchment B via low-flow outlet pipes. These outlet pipes would slowly release surface water runoff that accumulates within

these bunded areas, utilising existing storage within these bunded areas to minimise peak flows to the existing drainage infrastructure within Catchment B. The diversion of flows to Catchment B would also prevent any alteration in flows entering the southern natural retention basin and protected coastal wetland. If required, operational controls would be used to manage flow volumes from the bunded areas.

- The increase in surface water flow coming from Catchment B, as a result of the proposed low-flow outlet pipes from existing bunded OWS areas, would be managed by existing surface water detention and retention systems across Catchment B. These existing detention/ retention systems would have sufficient capacity to contain this additional inflow, whilst still maintaining pre-modification discharge rates to Quibray Bay in all storm events up to and including the 1% AEP event.
- Two separate onsite detention (OSD) systems are proposed in Catchment E to maintain existing, pre-modification discharge rates entering the existing roadside channel along Sir Joseph Banks Drive in all storm events up to and including the 1% AEP event. This would also maintain existing peak discharge rates entering the downstream Towra Point Nature Reserve (Ramsar site) and Quibray Bay. The former Caltex Lubricating Oil Refinery (CLOR) pipeways would be utilised for stormwater detention at the northwestern corner of Catchment E and additional OSD storage would be included within the existing open channel that runs along the western side of RPIP Mountain, at the southeastern corner of Catchment E.
- Sediment loads in stormwater during the operational phase of the proposed modification are expected to be low, given there would be minor changes to the landform (at RPIP Mountain only), surface levels (at Source Area Excavation 5 only), and surface finishes. However, in order to further protect sensitive receiving environments permanent sediment control measures are proposed to be installed within, or at the downstream end of, the two proposed OSD systems. This is in addition to the existing water quality treatment measures in place, which would be retained through both the construction and operational phases. The combination of water quality treatment measures would mitigate potential water quality impacts on downstream sensitive receptors.

Several measures have been recommended to mitigate and/or eliminate potential impacts related to surface water, wastewater, water quality and flooding; alternative approaches may also be considered during the detailed design phase. Any such alternative measure would align with applicable legislation, policies, and guidelines, while maintaining the water quality and river flow objectives for the Georges River catchment, as outlined in this report.

To verify the effectiveness of these mitigation measures, short-term monitoring would be conducted following site stabilisation. This monitoring would confirm that expected environmental outcomes are achieved, while also allowing for adaptive management strategies where necessary.

1.0 Introduction

1.1 Overview

The Kurnell Terminal (the Site) is located on the southern side of Botany Bay, in Kurnell, New South Wales (NSW) (Figure 1-1). In 2012, Ampol Refineries (NSW) Pty Ltd (Ampol) decided that the oil refinery and fuel terminal would be converted to a finished product terminal (the approved project), ceasing refinery operations in 2014.

Development consent was received to complete the approved project under State Significant Development (SSD) application reference 5544 (SSD-5544). Ampol has modified SSD-5544 six times to facilitate the conversion and demolition works.

Currently, the operational infrastructure is primarily located in the northern part of the Site (Zones 1 and 1A, as shown in Figure 1-1). Other parts of Ampol's landholdings at Kurnell include largely vacant areas of previously developed land (Zones 2 and 3) and areas of undeveloped land containing extensive native vegetation (Zones 4 and 5).

Ampol intends to consolidate operational infrastructure, remove redundant assets, and undertake remediation. Completion of these works (the proposed modification, MOD-7) would continue the viable, safe, reliable, and sustainable operation of the Kurnell Terminal. The location within the Site that these works would occur is referred to as the Project Area.

A Modification Report was prepared to support a modification application to SSD-5544 and was placed on public exhibition for 23 days from Thursday 10 July 2025 until Friday 1 August 2025 in accordance with the EP&A Act.

The Stormwater, Wastewater and Flooding Report for the proposed modification was one of a number of technical documents that formed part of the Modification Report. This Updated Stormwater, Wastewater and Flooding Report has been produced to address submissions received by agencies during the exhibition of the Modification Report and refinements to the proposed modification. It has been prepared to support the Submissions Report.



Legend

- Site Boundary
- Ampol Ownership
- Project Area
- Former Refinery Area
- Operational Fuel Terminal
- Undeveloped Land
- Watercourse
- Primary Road
- Local Road



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Source: Neermap, 2022

Figure 1-1 Ampol Kurnell Terminal (the Site)

1.2 The proposed modification

1.2.1 Key elements of the proposed modification

To support the continued viable, safe, reliable, and sustainable operation of the Kurnell Terminal, the proposed modification works involve:

- **Stage 1 – Preparation works:** Preparing the Project Area for proposed modification works
- **Stage 2 – Removal, relocation and/or augmentation of infrastructure,** including:
 - Relocation and/ or augmentation of firewater system (FWS) and oily water sewer (OWS) systems and construction of new operational facilities, including replacement warehouses
 - Decommissioning and removal of non-operational assets, redundant structures and electrical assets
- **Stage 3 – Remediation:** Addressing legacy ground contamination in specific locations across the Site
- **Stage 4 – Demobilisation:** Demobilisation of construction and remediation equipment.

Depending on where different works are required across the Site, these stages may be completed sequentially or concurrently.

A summary of project elements requiring modification and how they relate to the approved project is provided in Table 1-1. Infrastructure to be removed is presented in Figure 1-2, whilst infrastructure to be relocated or upgraded is presented in Figure 1-3. The proposed modification works would be undertaken within the Project Area.

All activities would adhere to the Kurnell Terminal permit to work system to maintain compliance with environmental and safety protocols.

Table 1-1 Modified project summary table

Stage	Element	Approved project	Modified project
Stage 1	Project Area	Project Area delineation	<ul style="list-style-type: none"> • Prepare the Project Area for the proposed modification works required under Stages 2 and 3 and exclude other parts of the Site from workers completing these works as required.
Stage 2	Oily water sewer (OWS)	Maintain location in Zones 2 and 3	<ul style="list-style-type: none"> • Divert surface water runoff from potentially contaminated areas in Zone 2 to OWS system in Zone 1 via new OWS interception pits/ lines until Stage 3 remediation is complete • Divert potential leachate from Asbestos Contaminated Soils (ACS) Containment Cell in Zone 2 to Zone 1 OWS system • Install one new pump station and emergency storage tank adjacent to the ACS Containment Cell. Two indicative site options have been identified (refer to Figure 1-3) with specific siting to be selected during detailed design. • Once Stage 3 remediation is complete in each specified area, isolate and remove redundant OWS infrastructure from identified areas in Zone 2 and Zone 3. Where complete removal is not feasible, existing pipes would be left in-situ.

Stage	Element	Approved project	Modified project
	Firewater systems (FWS)	Maintain location in Zones 1, 2, and 3	<ul style="list-style-type: none"> • Augment FWS infrastructure in Zone 1 and the centre of Zone 2 • Excavate and install footings for the new firewater tank, pumphouse, and pipelines • Construct new firewater tank and pumphouse within the FWS Relocation Area. Two indicative site options have been identified (refer to Figure 1-3) with specific siting to be selected during detailed design. • Connect relocated firewater tank and pumphouse to existing FWS via new pipework • Commission new firewater tank, pumphouse, and pipework to confirm operation of amended FWS • Isolate and remove redundant FWS infrastructure from Zones 2 and 3 when appropriate.
	Electrical assets	Maintain location in Zone 2 and 3	<ul style="list-style-type: none"> • Isolate and remove redundant electrical assets in Zones 2 and 3, including five substations.
	Structures	Maintain location in Zone 2 and 3	<ul style="list-style-type: none"> • Construct new 'fit for purpose' warehouse to house maintenance supplies and activities in Zone 1 • Construct new Oil Spill Equipment Storeroom within Zone 1 • Construct new storage shed to house boats and emergency aquatic spill response equipment in Zone 1A. • Demolish identified structures in Zones 2 and 3.
Stage 3	Remediation	Removal of ACS from pipeways and either containment onsite or offsite disposal	<ul style="list-style-type: none"> • Remediate identified land in Zone 1 to reduce operational site safety risks (refer to Figure 1-3) • If required, remediate land in Zone 1 where infrastructure is proposed to be relocated or augmented • Undertake targeted remediation in Zones 2 and 3 (refer to Figure 1-3) • Return excavated areas to existing ground levels, with the exception of RPIP Mountain (which would be regraded) and removal of the bund at Source Area Excavation 5.
Stage 4	Demobilisation	Demobilisation of construction equipment.	<ul style="list-style-type: none"> • Demobilisation of construction and remediation equipment.



- Legend**
- Site
 - Ampol ownership
 - Project area
 - Zone 1 and 1A
 - Zone 2
 - Zone 3
 - Waste management area
 - ▲ Project Area access location
 - ▲ Temporary site access to Zones 2 and 3
- Infrastructure to be removed**
- Structures
 - Substations
 - Existing firewater tank and pumphouse
 - Oily water system
 - Fire water system
 - Former CLOR area fire water system

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Source: Mapmap, 2024

Figure 1-2 Proposed modification – Infrastructure to be removed (Stage 2)

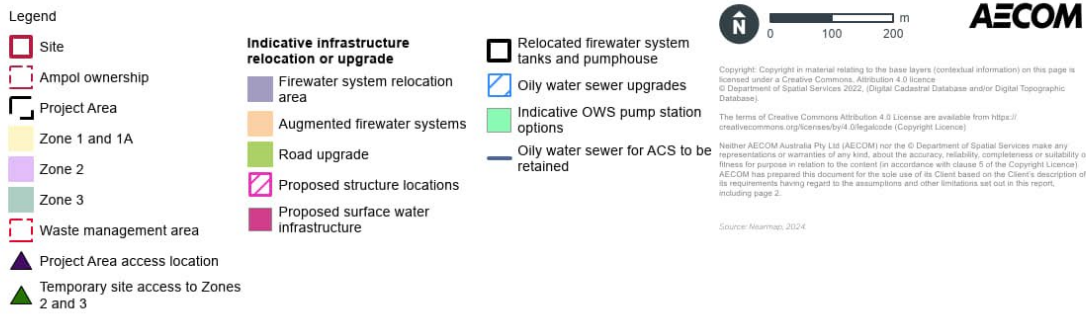


Figure 1-3 Proposed modification – Infrastructure to be relocated/ upgraded (Stage 2)



Figure 1-4 Targeted remediation activities (Stage 3)

Once the modification works are complete, the Site would continue to operate as described in the SSD documentation for the approved project and would be consistent with the development consent for SSD-5544 (as modified).

In line with Figure 1-3, relocated equipment would operate in the new locations.

1.2.2 Construction timeline and equipment

Works would be staged in accordance with the indicative program in Table 1-3. Construction and remediation are anticipated to commence in 2026 and be completed by 2030.

Plant and equipment that would be used to deliver the modification works is shown in Table 1-2.

Table 1-2 Indicative plant and equipment

Plant/ equipment	Maximum number of plant and equipment required per day		
	All stages except Stage 3		Stage 3 (Remediation) only
	Entire Site	Zone 1A	
Front end loader	6	2	6
Excavator	-	2	6
Excavator (including large hydraulic hammer)	6	-	-
Dump truck	6	2	6
Grader (up to 7 m blade)	2	1	4
Large crane (60 t)	4	1	-
Elevated work platform	6	4	-
Franna crane (30 t)	6	1	-
Cement truck	6	2	-
Bobcat	6	2	2
Water cart	6	2	6
Concrete crusher	1	-	-
Telehandler	6	-	-
Truck and dog (offsite disposal)	6	6	6
Truck and dog (imported fill)	-	6	12
Generator	2	1	2
Biopiling blower	-	-	8
Dewatering pump	6	-	6

1.2.3 Other relevant elements of the proposed modification

Permanent surface water management measures proposed as part of the proposed modification, as detailed in Section 5.2, would be installed prior to the disconnection of redundant OWS infrastructure. This would maintain drainage in areas currently serviced by redundant OWS infrastructure, and prevent drainage to the surrounding SWS network without formal controls in place.

1.3 Purpose of this report

This Updated Stormwater, Wastewater and Flooding Report is one of a number of technical documents that form part of the Submissions Report. The purpose of this report is to understand potential impacts of the proposed modification upon stormwater, wastewater and flooding.

2.0 Assessment methodology

2.1 General

An assessment of the potential impacts on surface water, wastewater, and flooding as a result of the proposed modification has been carried out with consideration to the relevant legislation, policies, guidelines and the Site's current Environment Protection Licence (EPL).

The adopted methodology for assessing the potential impacts on surface water, wastewater and flooding includes:

- Consideration of the legislative framework that governs the Site and proposed modification
- Review of existing information to characterise the existing environment, identify surface water receptors, and describe the existing management of surface water, wastewater, and flooding at the Site
- Assessment of potential construction, operational, and cumulative impacts relating to surface water, wastewater, and flooding
- Identification of appropriate mitigation and management measures to manage potential impacts on the environment.

The relevant legislation, policies, and guidelines used to inform this impact assessment, as well as assumptions and limitations to this assessment, have been summarised in the following sections.

2.2 Hydrologic and hydraulic modelling

Hydrologic and hydraulic modelling of the sitewide SWS under both pre- and post-modification conditions was completed in DRAINS – an industry standard urban stormwater modelling package. The modelling results were used to compare pre- and post-modification stormwater discharge rates at all of the stormwater discharge points, under both present-day and future climate conditions that were modelled in accordance with the latest Version 4.2 of Australian Rainfall and Runoff (ARR) guidelines (Ball et al., 2019).

Comparison of the pre- and post-modification discharge rates were then used to develop a stormwater management strategy that when implemented would allow the proposed modification to not increase stormwater discharge rates from the Site.

The DRAINS modelling for this assessment was based on a previous model that was developed by Manly Hydraulics Laboratory (MHL) as part of their Caltex Kurnell – Stormwater Management Options Report (MHL, 2016). This previous DRAINS model was supplied by Ampol in August 2024.

Further detail regarding DRAINS modelling is presented in Annexure A.

2.3 Flood modelling

Flood modelling for the Site was undertaken by AECOM in 2026. The following activities were undertaken for the flooding assessment:

- Data collection and review
- Direct rainfall hydrological modelling applying the methods of ARR: A Guide to Flood Estimation (Commonwealth of Australia, 2019) Version 4.2
- Development of a two-dimensional TUFLOW hydraulic model including infiltration pits, basins, trunk drainage and pumping infrastructure
- Simulations of the 20%, 5% and 1% Annual Exceedance Probability (AEP) events for both the baseline and post-modification scenarios in both present day (2030) and future climate (2100) conditions.

Further detail regarding flood modelling is presented in Annexure B.

2.4 Legislation, policies and guidelines

Various legislation, policies, and guidelines apply to the proposed modification. Those relevant to the management of surface water, wastewater and flooding have informed this assessment.

2.4.1 Relevant legislation and policies

The key legislation and policies have been summarised in Table 2-1.

Table 2-1 Relevant legislation and policies

Legislation/ policy	Relevance
<p><i>Protection of the Environment Operations Act 1997</i> The <i>Protection of the Environment Operations Act 1997</i> (POEO Act) is the key piece of environment protection legislation used by the NSW Environment Protection Authority (EPA) and other public authorities to prevent, control and investigate pollution in NSW.</p>	<p>The POEO Act provides for the issue of an EPL for scheduled development and activities listed under Section 43 of the Act including scheduled activities pursuant to Section 48 of the POEO Act, in relation to pollution and waste disposal caused by development or the operation of developments.</p> <p>Ampol has an existing EPL (No. 837) for the Site that authorises the scheduled activities, including the treatment requirements for polluted waters prior to discharging offsite.</p> <p>The proposed modification would not change the requirements of the existing EPL and would not introduce a new scheduled activity to the Site.</p> <p>Section 120 of the POEO also contains a provision prohibiting the pollution of waters. This is relevant to stormwater discharges from the Site.</p>
<p><i>Contaminated Land Management Act 1997</i> The general objective of the <i>Contaminated Land Management Act 1997</i> (CLM Act) is to establish a process for investigating and (where appropriate) remediating land that the NSW EPA considers to be contaminated enough to require regulation under Division 2 of Part 3 of the CLM Act.</p>	<p>As stated above, the Site operates under an existing EPL 837 and is regulated under the POEO Act.</p> <p>Disturbance of material within the Site as part of the proposed modification has the potential to liberate contaminants. For the purposes of this assessment, it is assumed that remediation activities undertaken as part of the proposed modification will be undertaken in accordance with the CLM Act and auditor endorsed remedial Action Plan, including relevant controls for the prevention of release of contaminants to surface water. As a result, this assessment does not consider potential impacts of contaminated land to surface water.</p>
<p><i>Water Management Act 2000 (NSW)</i> The <i>Water Management Act 2000</i> (WM Act) governs the issue of water access licences and approvals for those water sources (rivers, lakes, estuaries, and groundwater) in New South Wales where water sharing plans have commenced. If an activity results in a net loss of either groundwater or surface water from a source covered by a water sharing plan, then an approval and/or licence is required.</p>	<p>Under Section 4.41 of the EP&A Act, certain approvals under the WM Act are not required for SSD. These include a water use approval under Section 89 of the WM Act, a water management work approval under Section 90, or an activity approval (other than an aquifer interference approval) under Section 91.</p> <p>A Water Access Licence would be required for the proposed modification. Refer to the Soils, Groundwater, and Contamination Assessment (Appendix F of the Submissions Report).</p>

Legislation/ policy	Relevance
<p>State Environmental Planning Policy (Resilience and Hazards) 2021 The objective of the <i>State Environmental Planning Policy (Resilience and Hazards) 2021</i> (Resilience and Hazards SEPP) is to provide state-wide planning approach to resilience and hazards.</p>	<p>The chapters of the Resilience and Hazard SEPP relevant to the proposed modification, include:</p> <ul style="list-style-type: none"> • Chapter 2 Coastal management • Chapter 4 Remediation of land. <p>Chapter 2 aims to promote an integrated and coordinated approach to land use planning in the coastal zone in a manner consistent with the objectives of the <i>Coastal Management Act 2016</i>.</p> <p>The proposed modification would involve contaminated land remediation. It would also involve the modification of the existing OWS system which could potentially lead to contamination of surface water flows.</p> <p>Section 2.8 of the Resilience and Hazards SEPP states that development consent must not be granted on land identified as a 'Proximity Area for Coastal Wetlands' unless the consent authority is satisfied that the proposed development would not significantly impact on:</p> <ol style="list-style-type: none"> (a) <i>the biophysical, hydrological, or ecological integrity of the adjacent coastal wetland or littoral rainforest, or</i> (b) <i>the quantity and quality of surface and ground water flows to and from the adjacent coastal wetland or littoral rainforest.</i> <p>Parts of the Site are located within land zoned as 'Proximity Area for Coastal Wetlands,' as defined by the CM Act. Specifically, these include areas in proximity to Marton Park Wetland and the wetland in Zone 4.</p>
<p>Coastal Management Act 2016 (NSW) The <i>Coastal Management Act 2016</i> (CM Act) establishes a framework for coastal management in NSW. The purpose of the CM Act is to manage the use and development of the coastal environment in an ecologically sustainable manner. Part 2 of the CM Act described the coastal zone and management objectives for coastal management areas. Coastal management areas are identified through the Resilience and Hazards SEPP (see above).</p>	<p>As described above, parts of the Site are located within land zoned as 'Proximity Area for Coastal Wetlands'. Under the CM Act, proximity areas are considered to be part of the coastal wetlands. Section 6(2) states that the management objectives for the coastal wetlands and littoral rainforests area are as follows:</p> <ol style="list-style-type: none"> (a) <i>to protect coastal wetlands and littoral rainforests in their natural state, including their biological diversity and ecosystem integrity,</i> (b) <i>to promote the rehabilitation and restoration of degraded coastal wetlands and littoral rainforests,</i> (c) <i>to improve the resilience of coastal wetlands and littoral rainforests to the impacts of climate change, including opportunities for migration,</i> (d) <i>to support the social and cultural values of coastal wetlands and littoral rainforests,</i> (e) <i>to promote the objectives of State policies and programs for wetlands or littoral rainforest management.</i>

Legislation/ policy	Relevance
<p><i>Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)</i> The <i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act) provides a framework for protection of the Australian environment, including its biodiversity and its natural and culturally significant places.</p>	<p>Part 3 of the EPBC Act states that an action which has, will have, or is likely to have a significant impact on a Matter of National Environmental Significance (MNES) may not be undertaken without prior approval of the Commonwealth Minister for Environment under the provisions of Part 9 of the Act.</p> <p>Kurnell Terminal is located approximately 150 m from the Towra Point Nature Reserve – a listed Ramsar Wetland of international significance and national heritage place (listing number: 106162). The Kurnell Peninsula Headland is also included in the National Heritage List (NHL) (listing number: 105812).</p> <p>The NHL was established under the EPBC Act to protect places that have outstanding significance to the nation. Approval from the Minister is required under the EPBC Act for controlled actions which are deemed would have a significant impact on items and places listed under the NHL and on Ramsar Wetlands.</p>
<p><i>Sutherland Shire Local Environmental Plan 2015</i> The Sutherland Shire Local Environmental Plan (LEP) 2015 guides planning decisions across the local government area (LGA) of the Sutherland Shire Council through zoning and development controls. More specifically, it provides a local framework for the way land can be developed and used within the LGA.</p>	<p>The Site is located within the Sutherland Shire Council LGA and is therefore subject to the planning controls set out in this LEP. The Site is zoned as 'E5 Heavy Industrial' under this LEP. The LEP has the following surface water requirements:</p> <ul style="list-style-type: none"> • To provide areas for industries that need to be separated from other land uses. • To ensure the efficient and viable use of land for industrial uses. • To minimise adverse effect of industry on other land uses.
<p><i>Sutherland Shire Council Development Control Plan 2015</i> The Sutherland Shire Development Control Plan (DCP) 2015 supports the above LEP and expands on its principal development standards. It provides detailed guidelines for developments located in the Sutherland Shire Council LGA, including specific guidelines for the management of drainage, flooding and water quality.</p> <p>The DCP also references the <i>Sutherland Shire Environmental Specification – Stormwater Management</i> (Stormwater Specification) which includes the stormwater management requirements for developments located in the Sutherland Shire Council LGA (Sutherland Shire Council, 2009).</p>	<p>As per Section 2.10 of the <i>State Environmental Planning Policy (Planning Systems) 2021</i>, the DCP does not apply to the proposed modification given it is a SSD.</p>

2.4.2 Guidelines

The key guidelines have been summarised in Table 2-2.

Table 2-2 Relevant guidelines

Guidelines	Relevance
<p>National Water Quality Management Strategy (Department of Agriculture and Water Resources, 2018) & Australian and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality (ANZG, 2018)</p> <p>The National Water Quality Management Strategy (NWQMS) provides nationally agreed policies, processes and guidelines that form part of the national water reform agenda. Its overarching objective is to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development.</p> <p>One of the primary guidelines for managing water quality under the NWQMS is the Australian and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality (ANZG, 2018). These guidelines provide a water quality management framework to protect the community values of waterways.</p> <p>These guidelines were first published in 1992 by the Australian and New Zealand Environment and Conservation Council (ANZECC). They were later revised in 2000, in conjunction with the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (ANZECC & ARMCANZ, 2000). This version was then updated and replaced in 2018, in the form of an online platform (ANZG, 2018).</p>	<p>The proposed modification has the potential to impact the quality of water discharging offsite to receiving waterbodies. The water quality values and management goals for these downstream waterbodies have been reviewed in order to identify suitable management strategies for the proposed modification in order to protect receiving water resources systems. Water quality management strategies would adhere to requirements of the relevant ANZG and satisfy the objectives of the NWQMS.</p>
<p>Managing Urban Stormwater: Soils and Construction (Landcom, 2004)</p> <p>These guidelines, commonly known as the 'Blue Book', provide support for councils and industry to reduce the impacts of land disturbance activities on waterways by better management of soil erosion and sediment control.</p> <p>Enhanced management contributes to the reduction of pollution in receiving waters, minimises land degradation, identifies and implements principles of ecologically sustainable development, and improves the health, ecology, and amenity of urban waterways.</p>	<p>Relevant erosion and sediment controls and water quality management approaches outlined in the Blue Book would be included as appropriate to help mitigate potential impacts on downstream receiving waterways during construction of the proposed modification.</p>
<p>Australian Runoff Quality – A guide to Water Sensitive Urban Design (Engineers Australia, 2006)</p> <p>The Australian Runoff Quality guide provides an overview of best practices for water sensitive urban design (WSUD) in Australia. It includes design guidelines for surface water quality and quantity management practices, procedures for water quality modelling, and advice for integrated urban water cycle management practices.</p>	<p>Expected surface water runoff qualities from the proposed modification, in conjunction with recommendations from these guidelines, were used to inform the recommended mitigation and management measures.</p>
<p>Australian Rainfall and Runoff (ARR): A Guide to Flood Estimation (Ball et al., 2019)</p> <p>ARR is the primary technical publication for guiding hydrological estimates and design considerations. The latest issue was finalised in 2019 and was the result of a number of years of updates to the previous version of ARR (Engineers Australia, 1987). The 2019 release had a recent revision (Version 4.2) to include additional guidance on climate change considerations for surface water design and assessment.</p>	<p>Hydrological assessments and reviews conducted herein were carried out in accordance with the latest ARR guidelines.</p>

2.5 Assumptions and limitations

The following assumptions and limitations apply to this assessment:

- This stormwater, wastewater and flooding impact assessment addresses the potential impacts associated with the proposed modification described in Section 1.0.
- Hydrologic and hydraulic (DRAINS) modelling was conducted during this assessment as a means to quantify potential changes in stormwater flows and identify suitable mitigation measures. The results from this modelling, including any sizing of mitigation measures, would be refined during subsequent design phases.
- DRAINS modelling completed as part of this assessment was based on, and included updates to, the supplied DRAINS model that was initially developed by Manly Hydraulics Laboratory (MHL) for their Caltex Kurnell – Stormwater Management Options Report (MHL, 2016). More details on these updates and any assumptions/ limitations associated with the modelling methodology are included in Annexure A.
- Assumptions and limitations associated with the flood modelling undertaken for this project are set out in Annexure B.

3.0 Environmental setting

This section provides a description of the existing Site and surrounding environment as it relates to surface water, wastewater, and flooding.

3.1 The Site

3.1.1 Location

The Site is located on Sir Joseph Banks Drive, Kurnell NSW, at the eastern end of Kurnell Peninsula, approximately 15 km due south of Sydney's Central Business District (CBD). The Site covers a total area in the order of 187 hectares (ha) and is within the Sutherland Shire Council (Council) Local Government Area (LGA).

The Site is bounded by public land first and then Kamay Botany Bay National Park to the east and south east, industrial land to the west, Captain Cook Drive to the north west and St Joseph Banks Drive to the south west. The northern boundary of the Site is bounded by Solander Street, Marton Park, and the community of Kurnell, which includes light industry and residences. The Kurnell residential area is generally located north and north west of the Site. There is a fenced Right of Way (Zone 1A) through this residential area, which contains pipelines that connect the terminal to the Kurnell Wharf.

3.1.2 Operational activities

Between 1956 and 2014, the Site was used as both an oil refinery and fuel terminal. It was considered to be a highly disturbed site during that time and, as such, there are few remaining areas of ecological significance within the Site. Since the oil refining operations ceased in 2014, the Site has primarily been used as a finished fuel import terminal.

Ampol receives refined petroleum products at Kurnell Wharf, stores these products at the Site, and then distributes them via pipelines to various terminals in Sydney and Newcastle and to Sydney Kingsford Smith Airport.

The Kurnell Terminal operates under the approved SSD-5544, which was issued in January 2014.

3.1.3 Zoning

The Kurnell Terminal is categorised as a 'liquid fuel depot' under the *Standard Instrument – Principal Local Environment Plan* based on current operations which is a permissible land use under the 'E5 Heavy Industrial' land use zoning for the Site defined by the *Sutherland Shire Local Environmental Plan 2015*. (LEP)

3.2 Climate

A review of nearby weather stations was carried out to determine the regional climatic conditions for the Site. The review was based on historical records at the nearest weather station.

The nearest weather station to the Site, with a continuous record of monthly rainfall, evaporation, and temperature data, is located at the Sydney Airport (station number: 66037) which is approximately 8.5 km north of the Site. Climatic statistics and patterns observed at this weather station over the past 95 years (from 1929 to present) were accessed through the BoM's online climate database and are presented in both Table 3-1 and Figure 3-1 (BoM, 2024).

Table 3-1 Regional climatic statistics

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall and evaporation													
Mean rainfall (mm)	94	118	123	107	96	122	72	75	60	72	80	73	1,092
Highest rainfall (mm)	400	597	489	476	422	466	344	397	249	271	396	359	-
Mean no. of rain days	11	12	13	11	11	11	9	9	9	11	11	11	129
Mean evaporation (mm) ¹	226	184	167	126	93	75	84	115	147	186	198	229	1,830
Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Temperature													
Mean maximum (°C) ²	27	27	25	23	20	18	17	19	21	23	24	26	27
Mean minimum (°C) ²	19	19	18	14	11	9	7	8	11	13	16	18	7

Notes:

1 – mean evaporation statistics are only based on 50 years of recorded data, from 1974 to 2024.

2 – mean temperature statistics are only based on 85 years of recorded data, from 1939 to 2024.

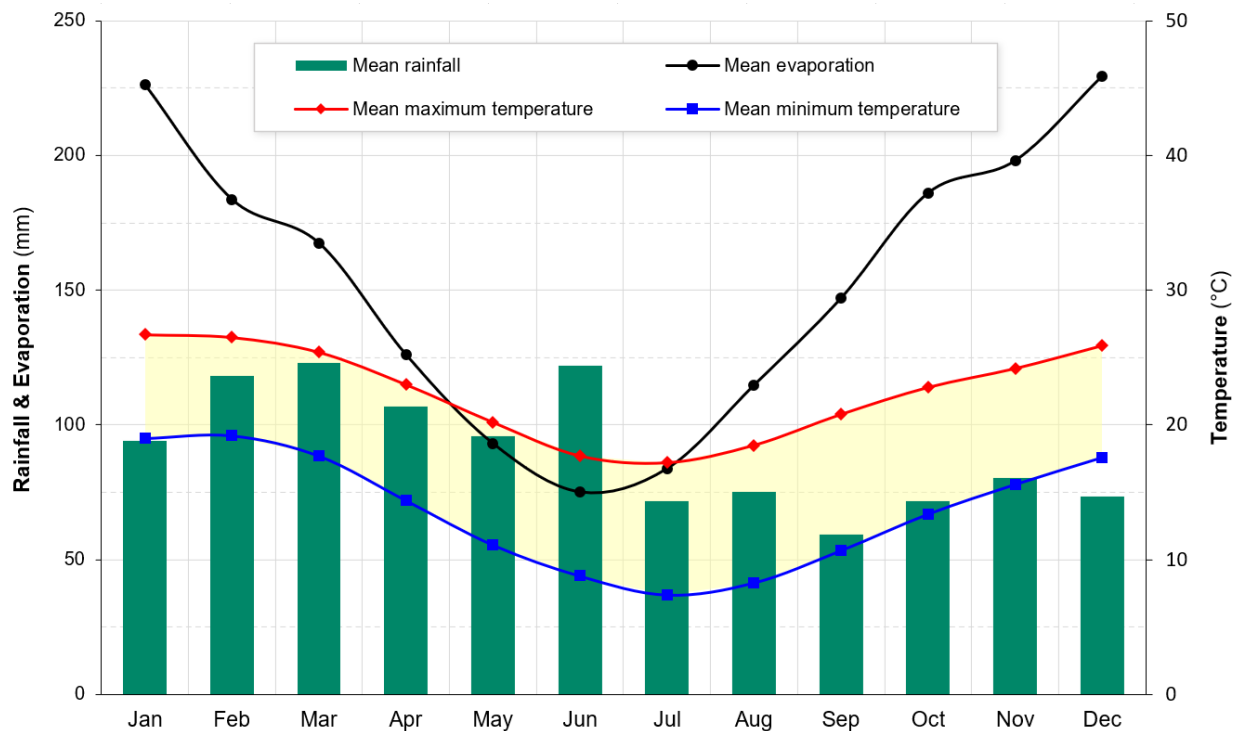


Figure 3-1 Regional climatic patterns

The Site is located within a 'temperate' climate zone which is characterised by warm summers and consistent rainfall over the calendar year. While rainfall is heavier during earlier months (from January to June), there are no 'dry' periods with zero rainfall. The region has reliable rainfall all year round, with a total average rainfall of 1,092 mm per annum.

Temperatures near the coastline are moderated by the ocean's heat capacity, with moderate to warm summers and slightly cooler temperatures during the winter. Mean maximum and minimum temperatures range between 18 and 27°C during summer months and 7 and 19°C in winter months. Remaining spring and autumn months experience milder temperatures, with averages ranging between 11 and 25°C.

Regional net water balance can be demonstrated through a comparison of rainfall versus evaporation. Since evaporation (average of 1,830 mm per annum) exceeds total rainfall (average of 1,092 mm per annum) by more than half, there is a water deficit across the region. Pools of water would experience net drying conditions in most months, from July to April, where evaporation exceeds rainfall. Net wetting conditions would only occur in the remaining two months of the year (May and June).

3.3 Catchment

The Site is part of the Georges River catchment, which encompasses all areas draining the Georges River and tributaries to Botany Bay. The Georges River catchment spans approximately 960 square kilometres (km²). The Georges River originates about 60 km southwest of the Sydney Central Business District near the town of Appin and flows north towards Liverpool, before turning east at Chipping Norton Lakes to the mouth of the river at Botany Bay (Georges Riverkeeper, 2024a). The river has a number of key tributaries like Bunbury Curran Creek, Cabramatta Creek, Prospect Creek, Mill Creek and Woronora River. The Site is located within an area identified as "Waterways affected by urban development" and is bordered by estuaries and National Park areas, as shown in Figure 3-2.

Botany Bay and its catchment waterways have been subject to ongoing threats arising from polluted surface waters originating at non-agricultural land uses. This is a result of the substantial development across the catchment, with almost 40% of its land being used for urban, industrial, or commercial uses. The main surface water pollutants of concern include nitrogen, phosphorus, and total suspended solids.

Numerous studies and plans have been commissioned through the Botany Bay Water Quality Improvement Program (BBWQIP). This has included the development and implementation of the Botany Bay and Catchment Water Quality Improvement Plan which provides direction to future land use and water quality decisions, with the overarching objective of improving the quality of waters across and discharging to Botany Bay (SMCMA, 2011). The plan includes water quality controls and pollutant reduction targets for urban developments within the catchment.

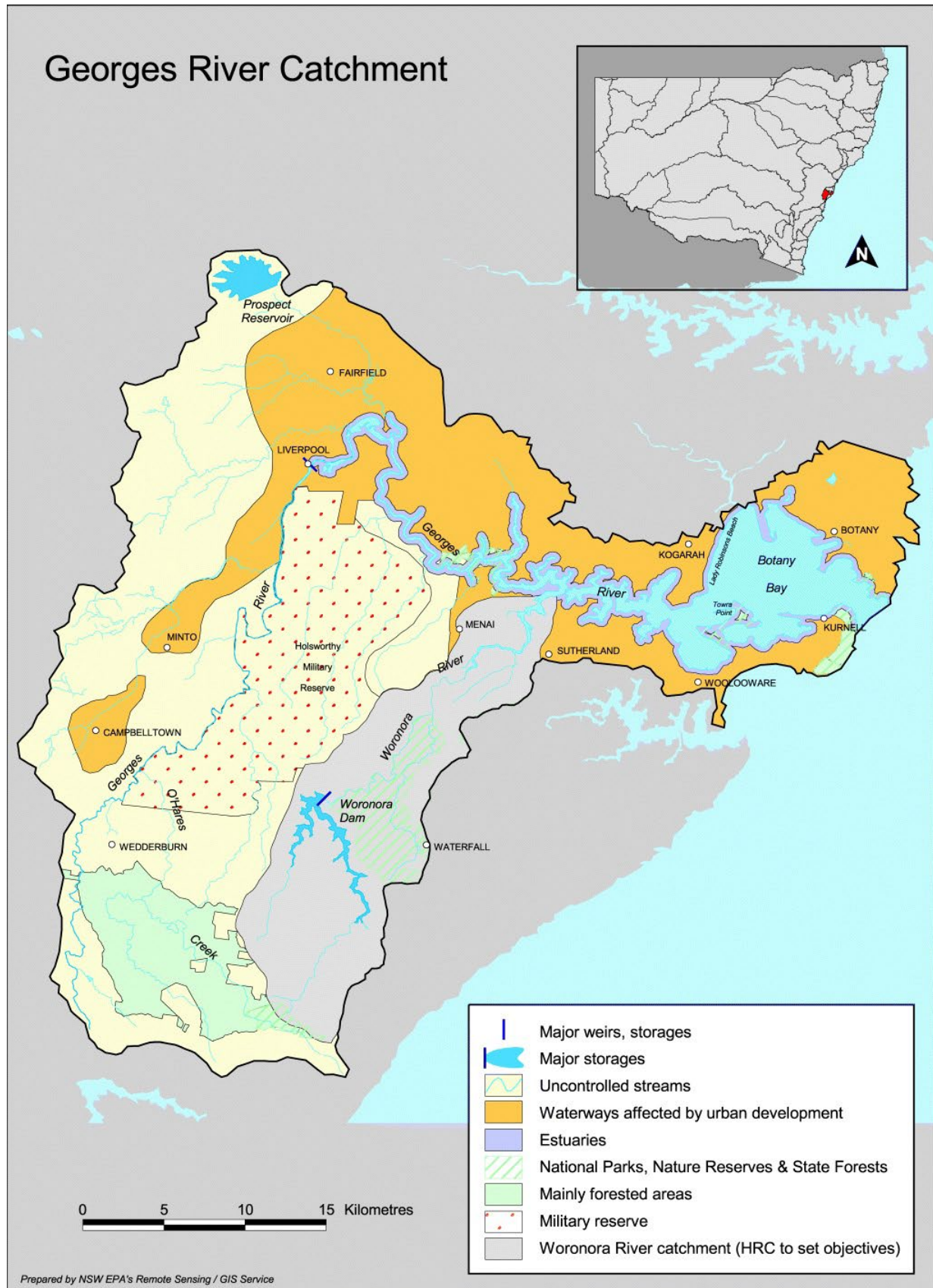


Figure 3-2 Georges River Catchment (DCEEW, 2006a)

3.4 Topography

Existing topography across the Site and surrounding areas is shown in Figure 3-3. The topography data included in this figure was sourced from the ELVIS online portal and is based on LiDAR data that was collected and processed in 2020 (ICSM, 2024).

Topography is relatively flat across most of the Site, with surface levels ranging from 3-5 m above Australian Height Datum (mAHD). There is a 400 m wide strip along the eastern boundary of the Site, where surface levels ramp up to tie-in with the higher natural elevations along the interface with the adjacent Kamay Botany Bay National Park. Peak surface levels within the Site reach up to 20 mAHD along this eastern boundary.

Natural surface levels further east, outside the Site extents and within the National Park, continue rising to a natural ridgeline that is orientated north-south. Peak elevations along this ridgeline reach 35 mAHD. Natural topography, prior to the development of this Site, would have generally fallen from this ridgeline and in a west to east direction, directing surface water runoff towards the Towra Point Nature Reserve and Quibray Bay.

It appears that the Site is generally in cut along its southern and eastern (upstream) boundaries and is in fill along the northern and western (downstream) boundaries.

3.5 Geology

Geology on the western side of the Kurnell Peninsula is characterised by Quaternary gravels, sands, silts, and clays, while the eastern side is characterised by Hawkesbury Sandstone of the Triassic period. The Hawkesbury Sandstone geology rises from west to east, starting below sea level and rising to a height of approximately 40 m above sea level along the eastern boundary of the Kurnell Peninsula where it forms steep, near vertical cliffs (NSW Government, 2024).

Soils within the Site are generally classified as sandy above the Hawkesbury Sandstone bedrock. Acid sulphate soils (ASS) have also been recorded and classified across the Site.

Potential impacts related to soil, groundwater and acid sulfate soils were assessed in the *Technical Report – Soils, Groundwater and Contamination* (Appendix F of the Modification Report).

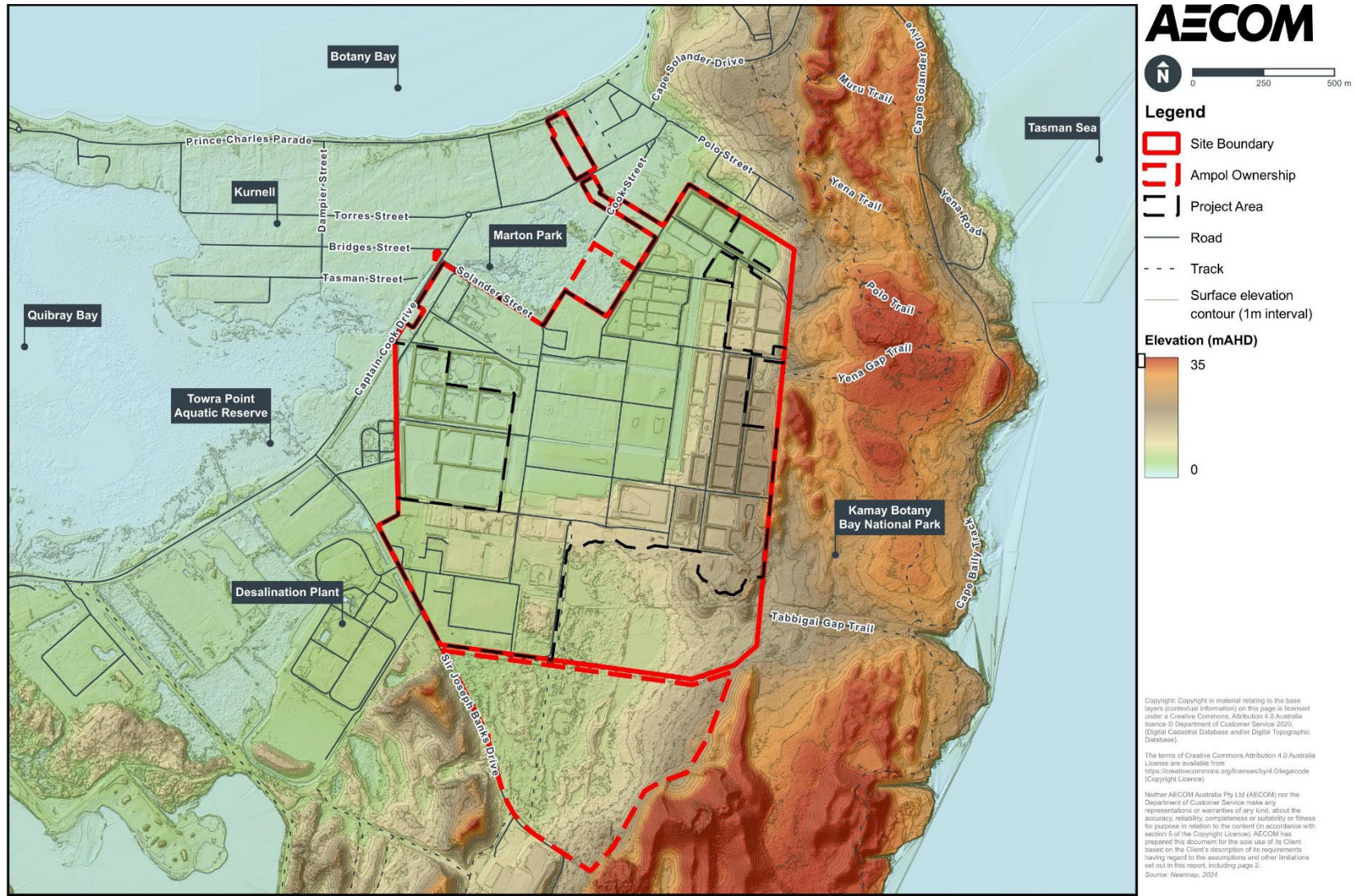


Figure 3-3 Site topography

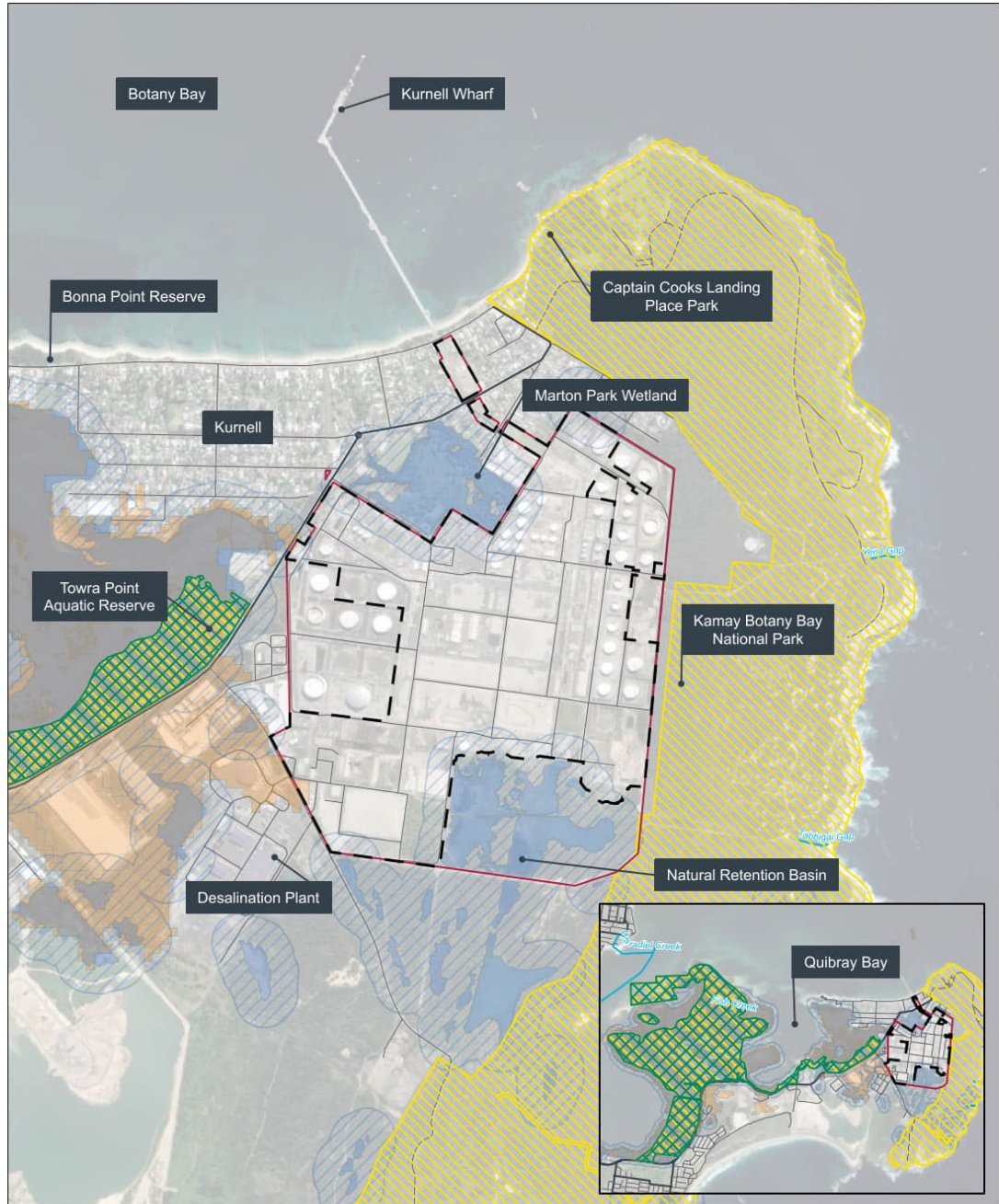
3.6 Surface water features

The Site is located near several surface water features that support a range of environmental values and sensitivities, including areas of ecological value. These surface water features, shown in Figure 3-4, and their value have been summarised in Table 3-2.

Table 3-2 Summary of receiving waters

Surface water feature	Location	Description
Botany Bay	500 m north of the Site	<p>Botany Bay is a shallow bay covering a total area of 4,600 ha, approximately 10 km south of Sydney’s CBD. It is used to access Sydney’s main commercial point (Port Botany) and is a designated Special Port Area.</p> <p>Botany Bay also contains protected areas of saltmarsh, seagrass and mangrove – particularly around the Towra Point Nature Reserve and the Towra Point Aquatic Reserve. It contains 40% of Sydney’s remaining mangrove communities and 60% of its remaining saltmarsh communities (DECCW, 2010). It is also host to many important bird species, including many listed international migratory bird agreements with Japan (Japan–Australia Migratory Bird Agreement, JAMBA), China (China–Australia Migratory Bird Agreement, CAMBA) and the Republic of Korea (Republic of Korea–Australia Migratory Bird Agreement, ROKAMBA).</p> <p>As discussed in Section 3.3, Botany Bay and its catchment waterways are subject to ongoing environmental pressures.</p>
Quibray Bay	1 km west of the Site	<p>Quibray Bay is directly connected to Botany Bay. This bay is within the Towra Point Aquatic Reserve.</p> <p>The bay, in comparison to much of Botany Bay, has a reasonable ecological condition. The bay contains significant seagrass, mangrove and saltmarsh habitat within its waters and around its shoreline (SMCMA, 2011).</p> <p>Surface water runoff from the Site is partly discharged to the Quibray Bay via drainage lines passing through the Towra Point Nature Reserve, as discussed in Section 4.1.</p>
Towra Point Nature Reserve (Ramsar wetland area)	150 m west of the Site	<p>Towra Point Nature Reserve is a Ramsar-listed wetland and comprises 600 ha of wetlands that lie on the southern shores of Botany Bay (DECCW, 2010). The most eastern extent of the Ramsar-listed reserve is located on the western side of Captain Cook Drive. The reserve extends in a narrow fringe around Quibray Bay and Weeney Bay, encompassing a band of remnant saltmarsh. The wetland is a system of seagrass, mangrove and saltmarsh communities, marine sub-tidal aquatic beds and terrestrial vegetation communities (Ramsar Sites Information Service, 2025).</p>
Towra Point Aquatic Reserve	West of Captain Cook Drive	<p>Towra Point Aquatic Reserve surrounds Towra Point and covers an area of approximately 1,400 ha. The reserve is managed by the Fisheries Section of the NSW Department of Primary Industries (DPI) and is divided into two zones: the aquatic wildlife refuge zone and the ‘no-take’ sanctuary zone. The ‘no-take’ sanctuary zone is located within Quibray Bay and Weeney Bay. The reserve supports high levels of aquatic biodiversity, with more than 230 species of fish and over 200 migratory bird species recorded within the reserve (Georges Riverkeeper, 2024b).</p>

Surface water feature	Location	Description
Coastal wetlands	North, north west, and south of the Site	<p>There are a number of protected coastal wetlands surrounding the Site. The southeastern part of the Site (Zone 4) contains coastal wetland. The Project Area within the Site does not contain any areas of coastal wetland but does contain 'Proximity Area for Coastal Wetlands,' as defined by the SEPP.</p> <p>A new firewater tank and pumphouse would be located within the FWS Relocation Area, which is located in a Proximity Area for Coastal Wetlands.</p> <p>The southern and eastern boundaries of Zones 2 and 3, respectively, are located within the Proximity Area for Coastal Wetlands, for the natural retention area immediately south of the Site. Works in this area would require excavation for remediation and installation of the OWS Pump Station.</p> <p>The CM Act and Section 2.8 of the Resilience and Hazards SEPP aim to protect and enhance sensitive coastal environments, habitats and natural processes by strategically managing the risks from coastal hazards, including those introduced by developments.</p>
Coastal zones	West and north of the Site	<p>The proposed modification is located outside the 'Coastal Use' and 'Coastal Environment' areas, as defined by the CM Act and SEPP. It is however located in proximity and would discharge to the coastal zones surrounding Quibray Bay, the Towra Point Nature Reserve, and along the southern shorelines of Botany Bay.</p> <p>The CM Act and Resilience and Hazards SEPP aim to protect and manage the natural, cultural, recreational and economic attributes of the New South Wales coast through the preservation of a range of coastal values.</p>
Marton Park Wetland	Immediately north of the Site	<p>Marton Park comprises a wetland area and a small recreational park. The wetland is approximately 10 ha in size.</p> <p>According to the Marton Park Wetland Management Plan, the wetland is currently a freshwater wetland with limited tidal influence (Molino Stewart, 2009). The wetland plays an important role in drainage of the surrounding area, including the eastern portion of Kurnell, part of the Site and the Kamay Botany Bay National Park. The wetland discharges via a piped network that connects to Quibray Bay.</p> <p>Surface water runoff from some non-industrial areas of the Site (e.g., the administration centre and some car parks) discharge to this wetland via Council owned drains, as discussed in Section 4.1. A small part of the FWS Relocation Area lies where surface water runoff discharges from the Site to the wetland.</p> <p>Marton Park Wetland is recharged by ground water seepage through the sandy bed during dry periods. The interaction between the surface water and the ground water is acknowledged to be potentially high given the sandy nature of the soil (Molino Stewart, 2009).</p>
Kamay Botany Bay National Park	Immediately east of the Site	<p>Kamay Botany Bay National Park is approximately 1 km wide and extends from north to south along the eastern coastline of the Kurnell Peninsula, facing the Tasman Sea. The eastern boundary of the Site is close to and downstream of the National Park. The National Park occupies a total area of approximately 456 ha and supports a diversity of natural resources including threatened species and ecological communities and is recognised for its significant cultural heritage values (DPIE, 2020).</p>



Legend

- | | | |
|--------------|--------------|-------------------------------------|
| Site | Primary Road | Coastal Wetlands |
| Project Area | Local Road | Proximity Area for Coastal Wetlands |
| | Watercourse | Ramsar Wetlands |
| | | Protected Areas |
| | | Wetlands NSW |

Sources:
 - Coastal Wetlands: Department of Planning, Housing and Infrastructure
 - Ramsar wetlands: Department of Climate Change, Energy the Environment and Water
 - Protected Areas: Department of Climate Change, Energy the Environment and Water
 - NSW Wetlands: NSW Government Central Resource for Sharing and Enabling Environmental Data in NSW (SEED)



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Source: Neatmap, 2022, and State Government of NSW and NSW Department of Planning, Housing and Infrastructure 2022.

Figure 3-4 Receiving waters

3.7 Water quality and river flow objectives

All surface water originating from the Site would eventually reach Botany Bay, the receiving environment of the Georges River catchment. The condition of the Georges River estuary and southern parts of Botany Bay is defined as a moderately modified environment with a desired outcome to retain or restore important natural processes/ biodiversity and protect desired public uses.

NSW Water Quality and River Flow Objectives (WQOs and RFOs) are published online by the former NSW Department of Environment, Climate Change and Water (DCEEW) (now Department of Climate Change, Energy, the Environment and Water (DCCEEW)) for each catchment in NSW. WQOs and RFOs have been developed for the Georges River catchment due to the following characteristics:

- Urbanised streams affect the estuarine system of the Georges River.
- Activities within Botany Bay, such as shipping and the airport, significantly affect the quality of water in Botany Bay. Industrial activities and previous land uses, such as waste tips, have polluted the groundwater, which can also affect water quality in the Bay.
- Parts of the lower estuarine reaches are underlain by potential acid sulfate soils, which should not be disturbed. Dredging and disturbance of bottom sediments (i.e. those below water level) can also have major impacts in these areas for the same reason.
- In the medium term (5-10 years), the environmental value of aquatic foods (cooked) may be achievable. The environmental objective of 'Commercial shellfish production' has not been recommended for the Georges River as the water quality in the catchment is such that there is marginal scope for this production to continue in the future.
- In the long term (10 years or more), primary contact recreation may be achievable
- Botany Bay has had its estuarine processes considerably modified by the building of runways at Kingsford Smith Airport, and by building and activities associated with Port Botany. These actions have caused or accelerated erosion at several locations, such as Towra Point and Lady Robinson Beach. Important fish habitat such as seagrasses has been diminished in area.
- Estuarine wetlands at Towra Point are internationally important (Ramsar-listed) and should be protected from changes to the estuarine processes.

WQOs have been identified for the Georges River catchment for the protection of the following:

- Aquatic ecosystems
- Visual amenity
- Secondary contact recreation
- Primary contact recreation, as a longer-term objective, 10 years or more
- Aquatic foods, as a medium-term objective, 5 to 10 years.

The default trigger values for each WQO specific to the estuaries in the Georges River catchment (DECCW, 2006b) are presented in Table 3-3 and are based on ANZECC & ARMCANZ (2000) values. These derived values are not designed to serve directly as regulatory standards, limits, or conditions. They should, however, be taken into consideration when making informed decisions that could potentially impact the future health of surface waterways or waterbodies.

Table 3-3 Default trigger values for estuaries within the Georges River Catchment (DECCW, 2006b)

Objective	Indicator	Default trigger value
Aquatic ecosystems: Maintaining and improving the ecological condition of waterbodies and their riparian zones over the long term	Total Phosphorus (TP)	0.03 milligrams per litre (mg/L)
	Total Nitrogen (TN)	0.30 mg/L
	Turbidity	0.5-10 Nephelometric Turbidity Unit (NTU)
	Chlorophyll-a	0.04 mg/L
	Salinity	Not applicable
	Dissolved oxygen (DO)	80-110% saturation
	pH	7.0-8.5
	Temperature	Default trigger values are defined by the upper and lower low-risk trigger values, using the 80 th and 20 th percentile, respectively, of ecosystem temperature distribution
Visual amenity: Aesthetic qualities of waters	Toxicants	Toxicant default guideline values (95% level of protection for slightly to moderately disturbed ecosystems and 99% level of protection for toxicants that bioaccumulate) unless discharge criteria are agreed with relevant authorities
	Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%. Natural hue of water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%
	Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter (no quantitative value specified)
Primary contact recreation: Maintaining or improving water quality for activities such as swimming where there is a high probability of water being swallowed	Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts (no quantitative value specified)
	Faecal coliforms, enterococci, algae and blue-green algae	As per the ANZECC & ARM CANZ (2000) guidelines for managing risks in recreational water
	Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation. Toxic substances should not exceed values in not exceed the concentrations provided in Tables 5.2.3 and 5.2.4 of the ANZECC & ARM CANZ (2000) guidelines.
	Visual clarity and colour	As per the visual amenity guidelines
Temperature	15°- 35 degrees Celsius (°C) for prolonged exposure	

Objective	Indicator	Default trigger value
Secondary contact recreation: Maintaining or improving water quality of activities such as boating and wading, where there is a low probability of water being swallowed	Faecal coliforms, enterococci, algae and blue-green algae	As per the ANZECC & ARMCANZ (2000) guidelines for managing risks in recreational water
	Nuisance organisms	As per the visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable of recreation. Toxic substances should not exceed values in Tables 5.2.3 and 5.2.4 of the ANZECC & ARMCANZ (2000) guidelines.
	Visual clarity and colour	As per the visual amenity guidelines
	Surface films	As per the visual amenity guidelines
Aquatic foods: Protecting water quality so that it is suitable for production of aquatic foods for human consumption and aquaculture activities	Algae and blue-green algae	No guideline is directly applicable, but toxins present in blue green algae may accumulated in other aquatic organisms
	Faecal coliforms	Guideline in water for shellfish: The median faecal coliform concentration should not exceed 14 Most Probable Number (MPN)/100mL; with no more than 10% of the samples exceeding 43 MPN/100mL. Standard in edible tissue: Fish destined for human consumption should not exceed a limit of 2.3 MPN E Coli/g of flesh with a standard plate count of 100,000 organisms/g
	Toxicants (as applied to aquaculture activities)	Metals: <ul style="list-style-type: none"> • Copper – less than 0.005 mg/L • Mercury – less than 0.001 mg/L • Zinc – less than 0.005 mg/L • Organochlorines: <ul style="list-style-type: none"> • Chlordane – less than 0.004 mg/L (saltwater production) • Polychlorinated biphenyls (PCBs) – less than 0.002 mg/L
	Physico-chemical indicators	Suspended solids: less than 0.04 mg/L Temperature: less than 2°C change over one hour

RFOs relevant to the Georges River catchment estuary are provided in Table 3-4.

Table 3-4 River Flow Objectives for estuaries within the Georges River Catchment (DECCW, 2025c)

Objective	Description
Protect pools in dry times: Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flow.	During dry times, some streams stop flowing and form pools. Pools and wetlands are refuges for aquatic plants and animals. Pumping water from these areas can make it more difficult for many species to recover after a drought.
Protect natural low flows: Protect natural low flows.	Water extraction and storage are high in dry times and impose long artificial droughts that increase the stress on aquatic plants and animals.
Maintain wetland and floodplain inundation: Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems.	Floodplain and wetland ecosystems develop in response to flow patterns and the nature of the landscape between the river and wetlands or floodplains. Floodplain works can change the flooding patterns, which would lead to changes in habitat and vegetation. These changes can be expected to reduce or change the diversity and abundance (or both) of species in the ecosystem. In particular, they can lead to reduced numbers of native fish and to water quality problems.
Maintain natural flow variability: Maintain or mimic natural flow variability in all streams.	Australia's rainfall and river flows are naturally variable. The way we currently store and divert river water can reduce natural pulsing of water down rivers and maintain artificially high or stable river heights. In urban areas and other places where the ability of the land to absorb or detain rainfall is reduced, more water runs off rapidly, so water levels would rise higher. These changes often create problems with streambank stability, biodiversity and signals for breeding and migration.
Minimise effects of weirs and other structures: Minimise the impact of instream structures.	Most instream structures (e.g., weirs) convert flowing water to still water, thus altering habitat and increasing the risk of algal blooms or other water quality problems. Barriers restrict the passage of plant propagules (e.g., seeds) and animals.

Oily water and process influent collected in the Site's OWS is transferred to the onsite wastewater treatment plant (WWTP) for treatment. Treated effluent must comply with the water quality criteria stipulated in EPL-837 prior to discharging offsite and into the Tasman Sea via the outfall at Yena Gap. The discharge criteria for the outfall at Yena Gap, as per the conditions of the EPL, are presented in Table 3-5. This table only includes the pollutants with a required concentration limit at the Yena Gap outfall and does not include the full list of requirements stipulated in EPL-837, such as the necessary monitoring frequency and sampling methods. The complete EPL can be found on the EPA (NSW) website (<https://apps.epa.nsw.gov.au/prpoeoapp>).

Table 3-5 Pollutant concentration limits for effluent discharge at Yena Gap as defined in the EPL-837

Pollutant	Unit of measure	50th percentile	80th percentile	90th percentile	100th percentile
Arsenic	mg/L	-	-	-	0.07
Biochemical oxygen demand (BOD)	mg/L	20	-	-	30
BOD (wet)	mg/L	-	-	-	350
Lead	mg/L	-	-	-	0.025
Nickel	mg/L	-	-	-	0.03
Nitrogen (ammonia)	mg/L	-	-	-	7.5
Oil and grease	mg/L	-	-	10	-
Oil and grease (wet)	mg/L	-	-	-	70
pH	pH	-	-	6.5-8.5	6.0-9.0
Phenols	mg/L	0.3	-	-	2.7
Phenols (wet)	mg/L	-	-	-	5
Polycyclic aromatic hydrocarbons (PAH)	mg/L	0.03	-	-	0.5
Temperature	°C	-	-	-	40
Total suspended solids (TSS)	mg/L	35	-	-	50
TSS (Wet)	mg/L	-	-	-	100

4.0 Existing conditions

This section describes the existing conditions for surface water, wastewater and flooding at the Site. These existing conditions form the baseline for the impact assessment detailed herein.

4.1 Surface water

Surface water runoff generated by the Site is captured and conveyed by one of two systems:

- Surface water system (SWS) – Collecting surface water runoff from areas (including roadways and building rooftops) that have a designated low risk potential for interaction with petroleum products. Water conveyed by this SWS is considered to be generally consistent with typical stormwater quality. This water receives some level of treatment prior to discharging offsite and to the receiving waterbodies.
- Oily water sewer (OWS) – Collecting and containing wastewater from areas containing petroleum infrastructure (such as tank bunds and pipeways) that may be impacted by petroleum products. This water is directed to the onsite WWTP for treatment before discharging to the Tasman Sea via the Yena Gap under the conditions of EPL-837.

This section describes activities associated with the onsite SWS. Details on the OWS and associated WWTP are provided in Section 4.3.

The purpose of the SWS is to collect runoff from areas of the Site that have been designated as a low-risk potential for interaction with petroleum products. This generally includes runoff from roadways, hardstand areas, roof areas, and undeveloped/ vacant land. Some external flows from the Kamay Botany Bay National Park also enter the Site via the eastern boundary and drain to the SWS.

The internal SWS comprises a network of underground pipes, pumps, open channels, and basins that safely convey surface water flow through the Site and towards one of the six main discharge points. The SWS is therefore divided into six catchments, one for each of these main discharge points. Flows approaching all of these discharge points eventually drain to Quibray Bay and Botany Bay.

The SWS catchments and their discharge points are shown in Figure 4-1. The catchment extents and their contents are described in Table 4-1.

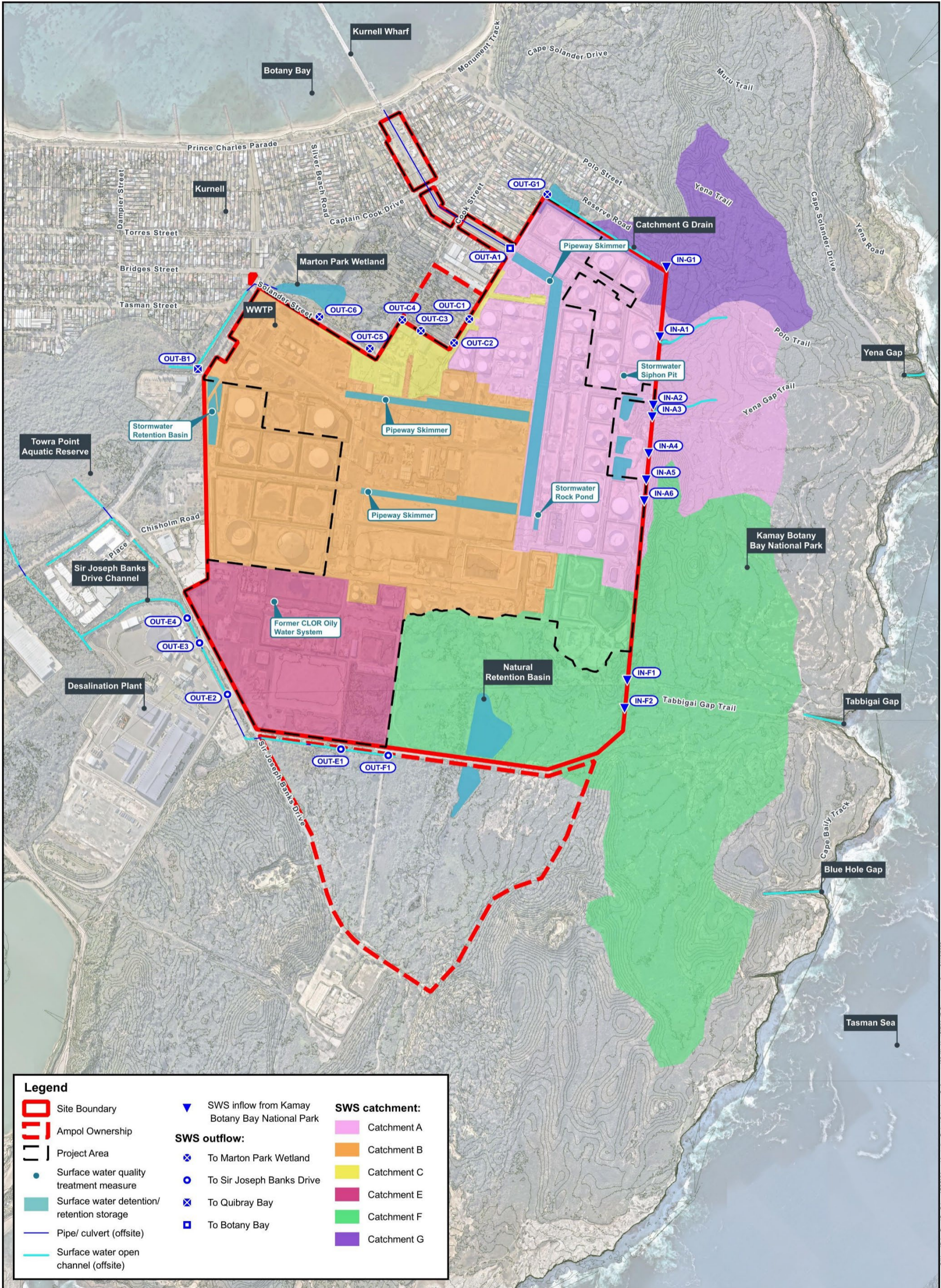
Table 4-1 Existing surface water catchments

Catchment	Area (ha)	Discharge point	Description
A	67	Botany Bay	The catchment includes part of Kamay Botany Bay National Park as surface water from this land flows on to the northern part of the Site. Within the Site, the catchment includes surface water runoff from the eastern and northern area of the terminal. Surface water flow within this catchment discharges to Botany Bay via a single piped outlet (A1) to an open drain.
B ¹	70	Quibray Bay	The catchment includes surface water runoff from the central and western portions of the Site, which contain most ex-refinery process areas as well as the central control building, warehouse, storehouses and oil spill room, and parking area. The WWTP and the Quibray Bay Stormwater Retention Basin are located within this catchment. Surface water flow within this catchment discharge to an open channel on the northern side of Captain Cook Drive at outlet B1, where this channel then directly connects to Quibray Bay.

Catchment	Area (ha)	Discharge point	Description
C	6	Marton Park Wetland	Northern corner of the Site which includes main offices, former staff houses, gardens, visitor and employee car park, and wetland. Surface water flow discharges directly to the Marton Park Wetland via six separate drainage outlets (C1 to C6). The Marton Park Wetland eventually discharges further downstream, towards Quibray Bay.
E	26	Open channel on Sir Joseph Banks Drive	South western corner of the Site. Surface water from this catchment discharges to an existing open channel along the western side of Sir Joseph Banks Drive via four separate drainage outlets (E1 to E4). This open channel drains in a northerly direction, towards the Towra Point Nature Reserve and then to Quibray Bay.
F	108	Natural Retention Basin	<p>The catchment includes a large part of Kamay Botany Bay National Park, as surface water from this land flows on to the southern part of the Site. A small area of former tank compound, the ACS Containment Cell, the former landfarm area, a recycling area, and a sludge lagoon are located in the catchments.</p> <p>Surface water flow drains to a natural retention basin located at the southern end of the Site. This retention basin overflows to an existing culvert that discharges to the existing open channel along the southern boundary of the Site at outlet F1, which then connects to the open channel that runs along Sir Joseph Banks Drive.</p>
G	19	Council-owned drains	North eastern undeveloped area mostly outside of the Site boundary, which is part of the Kamay Botany Bay National Park. This area drains along the northern side of the Site via the Catchment G drain and outlets at G1, towards a natural depression storage area at the north eastern corner of the Site. This storage discharges to a Council-owned drainage system that connects to the Marton Park Wetland.

Notes: 1 – Catchment D, as referenced in previous surface water reports, is no longer a separate catchment and is now part of Catchment B.

The proposed modification works would be spread across all catchments. However, the proposed works are only expected to have a material difference on Catchments B, E and F.



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 Source: Neamap, 2024

Figure 4-1 SWS catchment plan

The SWS is intended to collect runoff from areas of the Site that have been designated as a low-risk potential for interaction with petroleum products. In order to treat common surface water pollutants, such as sediments, nutrients and gross pollutants, there are various retention, retarding, and treatment systems incorporated along the existing SWS. Where necessary, surface water runoff is treated via American Petroleum Institute (API) standard oil/ water separators. These treatment systems are designed to treat suspended solids and remove oil and grease.

The surface water treatment measures included within each catchment and their discharge points have been summarised in Table 4-2. Some of these are also denoted on Figure 4-1.

Table 4-2 Existing surface water treatment and discharge for each catchment

Catchment	Offsite inflow	Retention	Treatment/ control	Discharge point(s)
A	Inflow from the Kamay Botany Bay National Park at six locations along the eastern boundary (inflow locations A1-A6)	There is a natural retention area present near the eastern boundary, receiving inflow from the National Park and surrounding area.	Skimmer and siphon system, followed by API oil/ water separator. Provision for pipeway isolation and use of skimmer pump to the OWS system. Retention in the south east part of the catchment.	Botany Bay via direct piped outlet A1.
B ¹	Can receive overflow from Catchment A during major storm events, due to the large National Park inflows entering that catchment	Quibray Bay Stormwater Retention Basin.	API separator, retention basin, siphon system, and final discharge pit. Provision for isolation, skimming and diversion of pipeway A and B drainage to intermediate sewer and use of skimmer pump to the oily water sewer system.	Towra Point Nature Reserve (Ramsar wetland), Quibray Bay via the piped outlet B1 that discharges to Captain Cook Drive roadway drains, then discharging into drainage lines that pass through the mangrove wetland.
C	None	Some natural surface retention in onsite portion of the Marton Park Wetland area.	None identified, though some treatment of suspended solids would naturally be provided in the onsite wetland area.	Marton Park Wetland via six piped outlets (C1 – C6), then discharging to Quibray Bay. Outlets C1 – C4 discharge on to the Ampol owned section of the Marton Park Wetland.
E	None	Some onsite infiltration occurs in the former process area.	Stormwater collected in the former CLOR OWS is pumped to the refinery OWS.	Sir Joseph Banks Drive open channel via four piped outlets (E1 to E4). This channel then leads to Towra Point Nature Reserve (Ramsar site) and Quibray Bay via roadway drains and drainage lines that pass through the mangrove wetland.

Catchment	Offsite inflow	Retention	Treatment/ control	Discharge point(s)
F	Inflow from the Kamay Botany Bay National Park via two main drainage lines along the eastern boundary at inflow locations F1 and F2.	Natural retention basin	Retention.	Southern natural retention storage and coastal wetland area (via drainage line) to the south of the Site. Flows from this area discharge to Sir Joseph Banks Drive via outlet F1 and then to Towra Point Nature Reserve (Ramsar site) and Quibray Bay.
G	Inflow from the Kamay Botany Bay National Park in the north east corner of the Site at inflow location G1.	None	None	Council owned drains via the Catchment G drainage line that outlets at G1. These drains discharge to the Marton Park Wetlands.

Notes: 1 – Catchment D, as referenced in previous surface water reports, is no longer a separate catchment and is now part of Catchment B.

Other water quality management strategies for the Site and its SWS are outlined in the Site's Stormwater Management Plan (2011) and Operational Environmental Management Plan (2021).

These water quality management strategies and existing treatment systems allow for surface water runoff conveyed by the SWS to discharge directly offsite and to the receiving environment, since this water can be treated to a standard that is suitable for urban discharge.

While these strategies significantly mitigate risks, rare extreme weather events have historically posed challenges, primarily due to the interaction between surface water and wastewater in the OWS during severe storm events. For instance, in April 2022, the Kurnell Peninsula experienced a flood event estimated to be in the order of a 1% Annual Exceedance Probability (AEP) event, caused by a rare combination of high rainfall intensity, minimal ground absorption, and high tide coinciding with the period of peak rainfall (AECOM, 2023). Stormwater runoff in Kurnell Terminal, which included significant runoff from the upstream Kamay Botany Bay National Park, inundated the area of the existing wastewater treatment plant (WWTP) and flooded the separators and associated sumps. This event led to wastewater from the OWS exiting the site with flood waters.

Significant upgrades to the Site's SWS and OWS have since been constructed as part of the Kurnell Stormwater Separation Improvement Project (SSIP) which was designed to provide resilience against this type of event occurring (AECOM, 2023). This project was completed in 2025 and has therefore been considered as part of the baseline conditions of the proposed modification. The modelling results of the Kurnell SSIP upgrades are discussed further in Section 4.4.

4.2 Receiving environment water quality

Surface water runoff from Catchments E and F discharge to the Towra Point Nature Reserve (Ramsar) and Quibray Bay via drainage lines running along the western side of Sir Joseph Banks Drive.

Council has conducted water quality monitoring across a number of streams within their LGA, as part of their Strategic Water Monitoring Plan (SWaMP). This included monitoring along the open drainage channel on Sir Joseph Banks Drive (Station No. SSC06), which provides insight into the quality of water discharging from the Site. Water quality trends at this site are provided in Figure 4-2.

Trends in collected water quality data at this station were assessed and ranked against the ANZECC & ARMCANZ (2000) Guidelines for recreational water quality in urban streams. Several pollutant concentrations were monitored over a seven-year period between 1995 and 2002. This included the monitoring of nutrients, metals, total suspended solids, and hydrocarbons. A reduction in most of these monitored pollutant concentrations was reported at this station, such that the concentration values for most of these pollutants were within the ANZECC & ARMCANZ (2000) guideline ranges at the end of the survey period.

In recent years, the overall water quality condition within the Sir Joseph Banks Drive drainage channel has been rated as ‘fair’ (Council, 2024). A decline in the overall water quality condition was recorded between 2007-2008 (Figure 4-2), which coincided with the construction of the Kurnell Desalination Plant. The condition has slowly recovered and is now returning consistent results, indicating that the quality of discharge from the Site has improved (or at least been maintained).

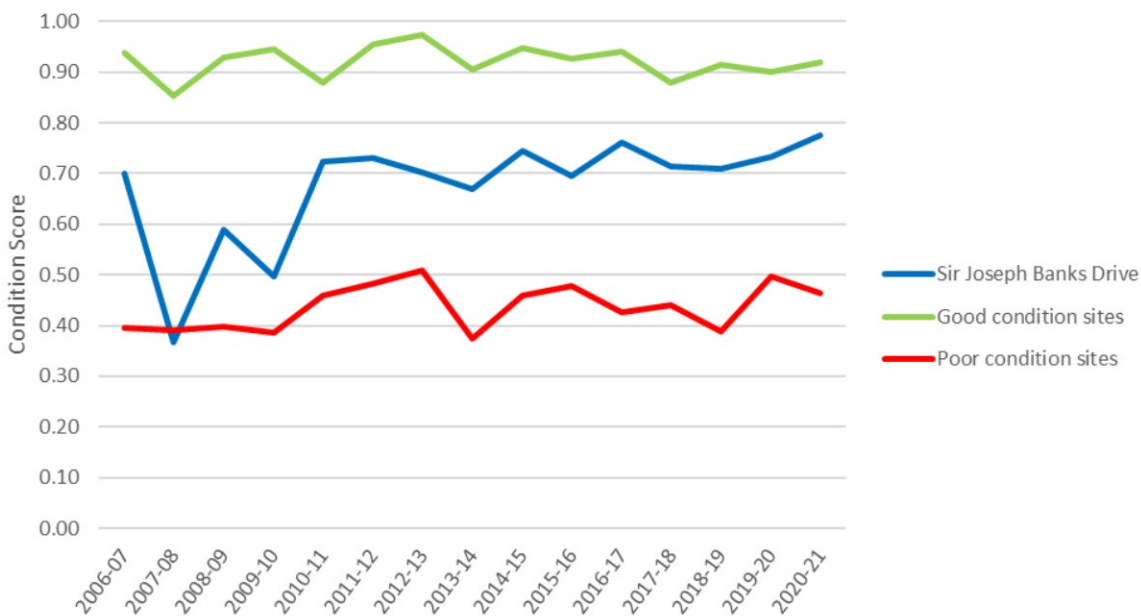


Figure 4-2 Water quality trends of Sir Joseph Banks Drive Channel, Kurnell NSW (Council, 2024)

Georges Riverkeeper’s monitoring program has assessed changes in the ecological condition of waterways across the Georges River catchment since 2009 (between the Liverpool Weir and Botany Bay). Freshwater ecological condition is determined by measuring three important ecological indicators – riparian vegetation, water quality, and macroinvertebrates. The condition value is based on a scale, with A+ indicating excellent condition and F- indicating poor condition.

The Lower Estuary Sub-catchment (including Botany Bay) achieved an overall rating of B- (Fair) in 2023/2024 (an increase from D+ (Poor) in 2021/2022). Within the Lower Estuary Sub-catchment, riparian vegetation was assigned a rating of B (Fair), water quality was assigned a rating of C (Fair) and macroinvertebrates was assigned a rating of D+ (Poor) in 2023/2024. The Botany Bay water sampling location (at the mouth of the Georges River and the closest monitoring location to the Site) was assigned a grade of A+ (Excellent) in 2023/2024 (Georges Riverkeeper, 2024a).

4.3 Oily water

The Site has a separate OWS system than collects wastewater and surface water runoff from areas where there is potential for interaction with petroleum products. This oily water is collected in the OWS and transferred to the onsite WWTP. Treated effluent is then discharged to the Tasman Sea via the Yena Gap under the conditions of EPL-837.

Sources of oily water across the Site include:

- Surface water runoff within tank bund areas, near process units and pump slabs
- Fuel entrained in water from storage tank water draws¹, which flows directly to the OWS
- Hydrocarbon contaminated groundwater from groundwater remediation system
- Waste management areas
- Tank and pipeline maintenance
- Ballast water
- Equipment wash pads.

Secondary containment structures are located around existing and former terminal (and refinery) infrastructure for the purpose of capturing accidental spills in accordance with AS 1940 (Flammable Liquids). Water that accumulates within the confines of bunded areas is drained via the existing OWS network. The rate and timing of water releases from these bunded areas is controlled via a series of valves that are operated manually so as not to drain all bunded areas at once, and to prevent overloading the downstream OWS network.

Oily water captured by the OWS is sent to the WWTP for treatment through separators and a biotreater, or is alternatively transferred to a diversion or equalisation tank for storage and treatment in the biotreater at a later time. The WWTP has a bypass system that can be activated during periods of high flow, where the treatment capacity of the plant is exceeded and there is insufficient storage capacity. Two additional induced air flotation (IAF) units provide secondary oil and suspended solids removal capacity for the wastewater that bypasses biological treatment.

The operational maximum treatment capacity for the WWTP is notionally 600 kilolitres per hour (kL/hr), with a supplementary wastewater treatment system with capacity of approximately 1,000 kL/hr (including all treatment steps except the biotreater).

Under EPL-837, all wastewater is treated using the WWTP. Treated effluent must meet the strict EPL pollutant concentration levels with samples sent to a National Association of Testing Authorities (NATA) accredited lab, independent of Ampol. Treated effluent is discharged to the Tasman Sea via the Yena Gap outfall and is also monitored under the conditions of the EPL.

The most recent monitoring data for effluent discharge at the Yena Gap is provided in Annexure B.

4.4 Flooding

The entire suburb of Kurnell is susceptible to flooding as it sits within a large, localised depression and has low-lying topography relative to water levels within Botany Bay and Quibray Bay. Flooding within the Kurnell township catchment and at the Site can occur as a result of the following mechanisms, which may occur in combination or in isolation:

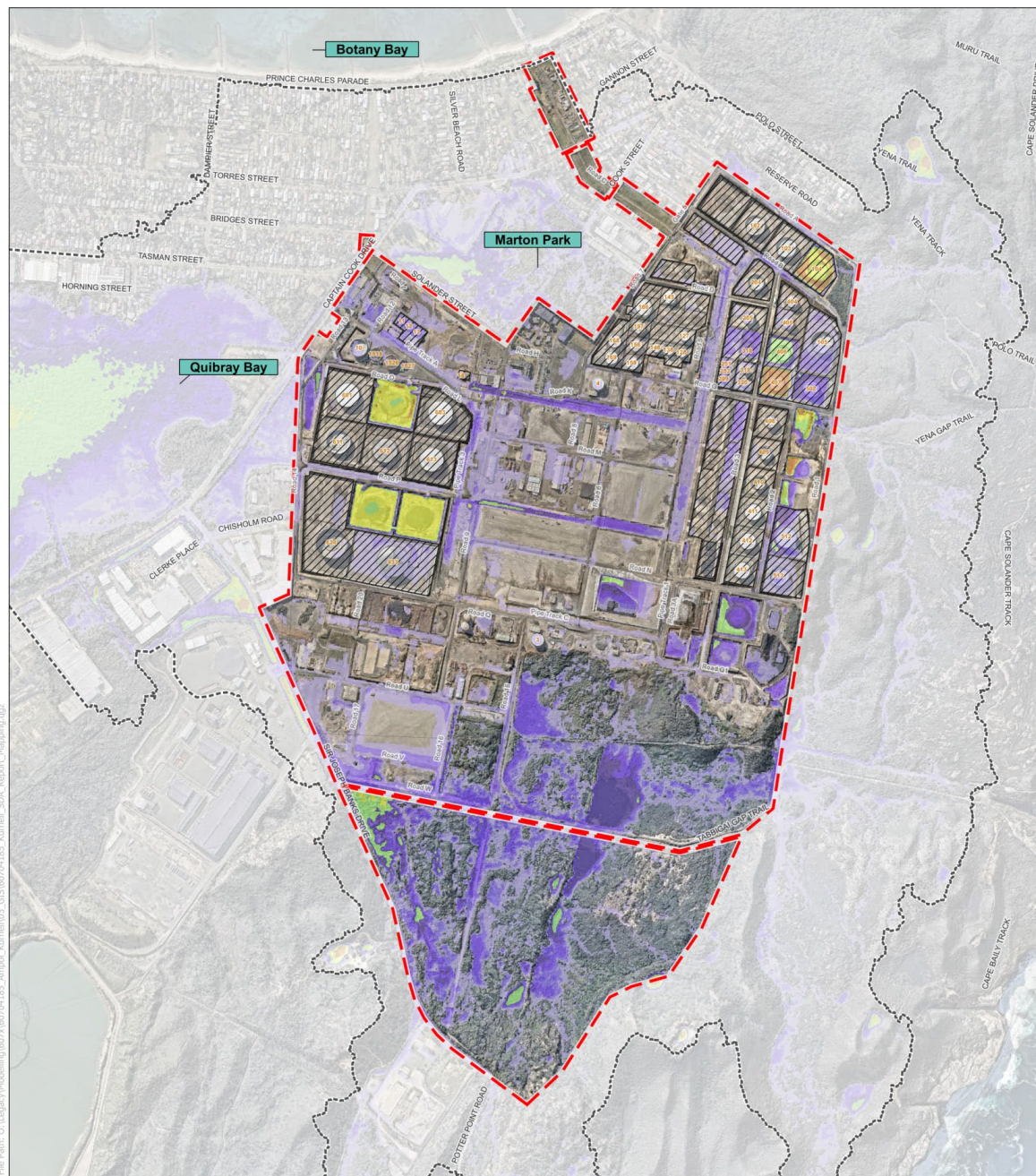
- Coastal flooding – From high tides or storm surges that causes water levels to rise in Botany Bay and Quibray Bay
- Catchment flooding – From intense rainfall over the catchment which causes large flows and a rise in water levels along drainage paths and within low-lying areas. The rise in water level may also be affected by flow constrictions (e.g., culverts, blockages, fences, and buildings).

¹ Water draws are a typical supervised operational activity used to drain water from storage tanks.

As outlined in Section 2.3, baseline flooding behaviour was assessed through modelling undertaken by AECOM in 2026. Peak flood depths for the 1% AEP event for present day (2030) conditions are presented in Figure 4-3. Peak flood depths for the 1% AEP event in the future climate (2100) scenario are presented in Figure 4-4. Additional flood maps for the 20% and 5% AEP events are presented in Appendix B.

It can be seen from the flood extents shown in Figure 4-3 and Figure 4-4 that most overland flows across the Site would be contained to the roads, pipeways, and bunded OWS areas in the combined 1% AEP catchment and 1% AEP coastal event. There is minimal floodwater moving through vacant or operational land across the Site.

Surface water accumulating within the bunded OWS areas is shown to be contained within these bunded areas. These bunded areas would drain separately towards the WWTP via the existing OWS network and would not contribute to floodwaters moving along the roads and pipeways.



Legend

	Cadastrate		Peak Flood Depth (m)		1.00 - 1.50
	Oily Water System Extent		≤ 0.30		1.50 - 2.00
	Ampol Site Boundary		0.30 - 0.50		2.00 - 3.00
	TUFLOW Extent		0.50 - 0.75	> 3.00 m flood depth symbol"/>	> 3.00
	Stormwater Receiving Environment		0.75 - 1.00		

AECOM

0 200 400 m

(1:9500 meters)

DATUM GDA 2020, PROJECTION MGA ZONE 56

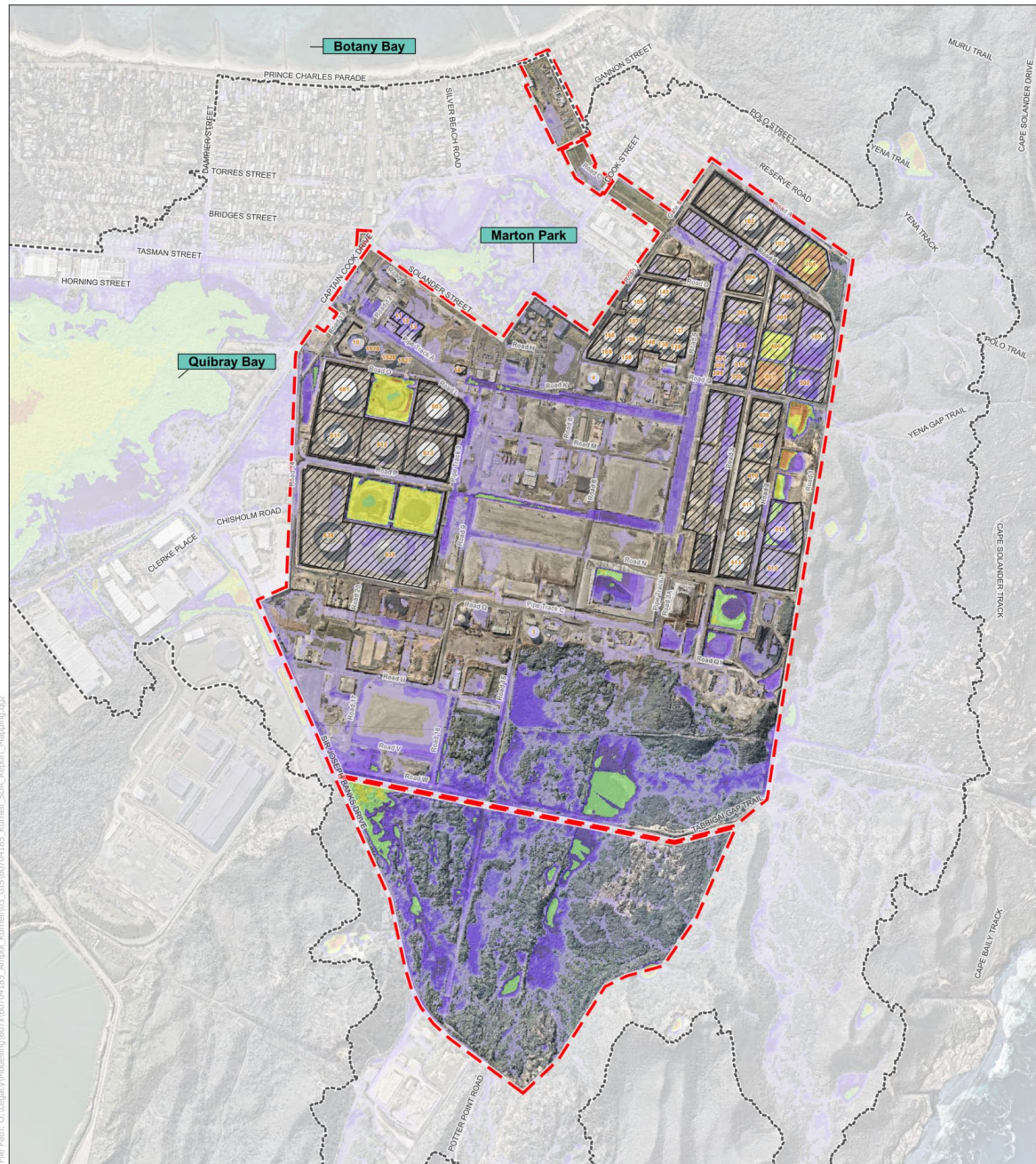
North Arrow

Data Sources:
 Base data - (C) AECOM, 2025
 LIDAR - ELVIS, 2020

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Figure 4-3 Peak Flood Depth for 1% AEP Event with 2030 Climate Change



Legend

Cadastrate	Peak Flood Depth (m)	1.00 - 1.50
Oily Water System Extent	≤ 0.30	1.50 - 2.00
Ampol Site Boundary	0.30 - 0.50	2.00 - 3.00
TUFLOW Extent	0.50 - 0.75	> 3.00
Stormwater Receiving Environment	0.75 - 1.00	

AECOM 0 200 400 m (1:9500 meters) DATUM GDA 2020, PROJECTION MGA ZONE 56

Data Sources:
 Base data - (C) AECOM, 2025
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 Print Date: 13/01/2025
 Author: KJMM

Figure 4-4 Peak Flood Depth for 1% AEP Event with 2100 Climate Change

4.5 Environmental management

4.5.1 Stormwater management

Stormwater at the Site is managed under the Kurnell Terminal Soil and Stormwater Management Plan (SWMP), which was prepared in accordance with Pollution Reduction Program (PRP) U24.1 of the EPL-837 (Stormwater Catchment and Management Plan) as a subplan to the Kurnell Terminal Operational Environmental Management Plan (OEMP).

The SWS collects runoff from areas of the Site that have been designated low risk with respect to potential interaction with petroleum products, as described in Section 4.1. As part of the SWMP, the following key controls and mitigation measures for the management of surface water are required in order to prevent contamination of stormwater during maintenance works:

- Where practicable, stormwater or groundwater ponded in excavations would be sent to the WWTP, unless it is tested and is of suitable quality to be directed to stormwater, in accordance with EPL-837
- Where practicable, stormwater that is captured in the bunds around contaminated soil stockpiles would be collected and sent to the WWTP
- Regular inspections would be undertaken of soils/ excavation areas, particularly after rain events to confirm pooled stormwater does not overflow
- Regular inspections would be undertaken of stormwater drains down hydraulic gradient of disturbed areas
- If stormwater quality is impacted in areas that have been disturbed by excavation work, water would be diverted to the oily water sewer system where practicable
- Leachate from the ACS Containment Cell would be directed to the OWS system, while surface water runoff would drain to the SWS
- During the regular inspections of the surface water management system, issues identified with the control measures, such as silt fencing or ponding of water, corrective actions would be implemented in accordance with this plan.

4.5.2 Oily water management

The Site has a separate OWS to manage water that is or may be impacted by petroleum products, including a proportion of stormwater runoff collected from areas where there may be interaction with petroleum products, such as tanks bunds. Oily water is treated in the WWTP, in accordance with strict EPL-837 requirements. Treated effluent must meet strict discharge limits with samples sent to a NATA accredited lab, independent of Ampol. Treated effluent is discharged to the Tasman Sea via the Yena Gap outfall under the conditions of the EPL.

5.0 Impact assessment

This section provides an assessment of the potential surface water, wastewater and flooding impacts that could result from the construction of the proposed modification and operation of the modified terminal (as defined in Section 1.2). It also considers the potential cumulative impacts that may result from other projects occurring concurrently and within the same surface water catchment.

The potential impacts resulting from the proposed modification have been assessed under the four key areas where surface water, wastewater, and flooding impacts are most likely to arise if not managed appropriately. These key areas include:

- Drainage – Whether the proposed modification would overload the existing SWS drainage networks and/ or alter the rate and volume of discharge to the receiving environment
- Wastewater – Whether the proposed modification would increase the amount of oily water entering the existing OWS and WWTP, exceeding the capacity of the system
- Water quality – Whether the proposed modification would affect the quality of water discharging offsite and entering downstream waters via the existing SWS
- Flooding – Whether the proposed modification would have an impact on existing flood behaviour at both onsite and offsite locations.

The identification of potentially adverse impacts provided in this section has guided the proposed modification amendments to the mitigation and management measures that were conditioned as part of the approved project (refer to Section 6.0).

5.1 Construction

The anticipated construction processes for the proposed modification are described in Section 1.2. If not managed appropriately, some of the proposed construction activities could have an impact on the quality and quantity of water leaving the Site. These risks are more likely to occur during the proposed excavations, stockpiling, and the introduction of large construction equipment.

The potential drainage, flooding, water quality and wastewater impacts resulting from anticipated construction works are summarised in the following sections.

5.1.1 Drainage impacts

The existing SWS would remain operational during all stages of the construction phase to continue servicing the Site during periods of rainfall.

If the construction works were to obstruct existing SWS infrastructure or the overland flow paths leading to existing drainage paths, surface water flows could be diverted elsewhere, thereby changing the quality and quantity of water leaving the Site.

To prevent this, management measures would be implemented to locate stockpiles and other potential flow obstructions away from key drainage paths (e.g. on the high side of construction areas). Temporary sediment controls would also be installed on the SWS to prevent sediment-laden runoff from blocking the pit and pipe network during construction.

The management of potential drainage impacts on surface water runoff during the construction works, including the installation and operation of temporary sediment and erosion control measures, would be designed and documented in the Construction Environment Management Plan (CEMP), which would be prepared in accordance with the *Managing Urban Stormwater – Soils and Construction Guidelines* (the Blue Book) (Landcom, 2004). The CEMP would include modification specific management plans including a SWMP and one or more Erosion and Sediment Control Plan(s) (ESCP). The Blue Book is considered an appropriate guide for erosion and sediment control even for potentially long construction periods such as for the proposed modification and contains several references to long-term pollution control measures. In the case of the proposed modification, construction works, such as excavations, would be staged to minimise the extent of exposed sediment at any one time.

The proposed modification, as shown in Figure 1-2 and Figure 1-3, would not alter existing drainage paths across the Site. Surface water flows would continue to drain towards the designated surface water treatment and discharge locations for each sub-catchment, as described in Section 4.1.

In order to maintain drainage at all times in areas currently serviced by redundant OWS infrastructure, permanent surface water management measures would also be installed where required prior to the disconnection of redundant OWS infrastructure. This would also prevent drainage to the surrounding SWS network without formal controls in place.

5.1.2 Oily water management

Most of the Project Area is already disconnected from the existing OWS system and therefore would not be impacted by the removal of redundant OWS networks. Areas that currently drain to the OWS network, as shown in Figure 5-1, would continue to do so until the proposed diversion line has been constructed (towards the end of Stage 2), or until the area has been remediated (in Stage 3) and can safely drain to the SWS. Retaining the existing OWS infrastructure for as long as necessary during the construction phase would prevent oily water from entering the SWS and bypassing treatment at the WWTP. This would prevent uncontrolled release of wastewater during the construction phase.

The WWTP would continue to operate during the construction phase, discharging treated effluent to the Tasman Sea via the Yena Gap under the conditions of the EPL-837.

The existing OWS network and WWTP would be protected during construction works, to avoid damaging or blocking this existing infrastructure.

5.1.3 Water quality impacts

Downstream waters and ecosystems may be impacted if surface water runoff carries nutrients, sediments, and organic and inorganic contaminants drains and watercourses. This may affect sensitive ecological receptors located immediately downstream of the Site, such as Towra Point Nature Reserve (Ramsar wetland), Marton Park Wetland, Quibray Bay, Botany Bay, and areas within Proximity Areas for Coastal Wetlands.

Build-up and wash-off are the key mechanisms for generating contaminated surface water runoff. Build-up is the process whereby dry deposition of pollutants accumulates on the surface, and wash-off is the process whereby this deposition is removed by rainfall and runoff and then transported into downstream water systems.

Construction activities are likely to disturb or expose existing surfaces and temporarily stored soils and other materials onsite. Loose and exposed materials, as well as accidental leaks or spills, are vulnerable to wash off during periods of rainfall, transporting an array of pollutants into downstream ecosystems. This can lead to turbid waters, alter acidity levels, and introduce toxicants like metals and hydrocarbons, all of which have the potential to harm the health of the downstream aquatic ecosystems.

A summary of proposed construction activities, related concerns, and their potential impacts on surface water features, if unmanaged, is provided in Table 5-1. Excavation areas are discussed in Section 1.2.

Table 5-1 Potential impacts to surface water quality during the construction phase

Stage(s)	Catchment/s and receiving environment	Proposed modification construction activity	Pollutants of concern	Potential surface water impacts on sensitive receptors (without mitigation)
All	All except Catchment G	Increased onsite traffic due to trucks and other machinery during construction, which have the potential to increase dust, transport sediments, and increase the presence of oils and greases on trafficked surfaces.	Sediments, oils and greases.	Increased influx of sediments to nearby waterbodies can impact aquatic ecosystems. Oils and greases are of concern due to their potential for acute toxicity and bioaccumulation ability.
2	<ul style="list-style-type: none"> A (Botany Bay) B (Quibray Bay) F (Southern natural retention basin and coastal wetland area to the south of the Site) 	<p>The removal of surface cover and soil exposure increases the potential for erosion and sediment-laden runoff.</p> <p>Excavation works and stockpiling of loose soils could lead to the dispersion of dust, soils, sediments and other sorbed pollutants by wind and interaction with surface water runoff.</p>	Sediments, nutrients, and contaminants.	<p>Increased influx of sediments to nearby waterbodies could result in high turbidity, lower dissolved oxygen levels, and increased toxicant concentrations which could impact aquatic ecosystems.</p> <p>Excess nutrients could lead to eutrophication and prioritise the growth of toxic/ invasive algal species over native flora.</p>
2	<ul style="list-style-type: none"> A (Botany Bay) B (Quibray Bay) F (Southern natural retention basin and coastal wetland area to the south of the Site) 	Construction works to augment the existing FWS in Zone 1 and relocate FWS (including firewater tank, pumphouse, and pipework), would occur in the Proximity Areas for Coastal Wetlands. These have the potential to increase the dispersion of dust, soils, and sediments, transport sediments, and increase the presence of oils and greases on surface runoff discharge to the Marton Park Wetland.	Sediments, nutrients, oils and greases, and contaminants.	<p>Increased influx of sediments to nearby waterbodies could result in high turbidity, lower dissolved oxygen levels, and increased toxicant concentrations which could impact aquatic ecosystems.</p> <p>Excess nutrients could lead to eutrophication and prioritise the growth of toxic/ invasive algal species over native flora.</p> <p>Oils and greases are of concern due to their potential for acute toxicity and bioaccumulation ability.</p>

Stage(s)	Catchment/s and receiving environment	Proposed modification construction activity	Pollutants of concern	Potential surface water impacts on sensitive receptors (without mitigation)
2	<ul style="list-style-type: none"> A (Botany Bay) B (Quibray Bay) F (Southern natural retention basin and coastal wetland area to the south of the Site) 	Dewatering of open excavations and construction basins with potentially contaminated, untreated water being discharged to the receiving environment.	Sediments, nutrients, contaminants, dissimilar pH, oils and greases.	<p>A change in pH levels and toxicant concentrations could lead to fish kills and other undesirable impacts on aquatic ecosystems, livestock, and aquatic foods.</p> <p>Increased influx of sediments to nearby waterbodies could result in high turbidity, lower dissolved oxygen levels, and increased toxicant concentrations which could impact aquatic ecosystems.</p>
2	<ul style="list-style-type: none"> A (Botany Bay) B (Quibray Bay) F (Southern natural retention basin and coastal wetland area to the south of the Site) 	Increased overland flows due to damaged or blocked pits and pipes, or the sudden release of stored fire water during removal/ relocation works. This would increase the risk of surface waters interacting with petroleum products, sediments and other pollutants on the surface.	Sediments, nutrients, oils and greases, and contaminants.	<p>Increased influx of sediments to nearby waterbodies could result in high turbidity, lower dissolved oxygen levels, and increased toxicant concentrations which could impact aquatic ecosystems.</p> <p>Excess nutrients could lead to eutrophication and prioritise the growth of toxic/ invasive algal species over native flora.</p> <p>Oils and greases are of concern due to their potential for acute toxicity and bioaccumulation ability.</p>

Stage(s)	Catchment/s and receiving environment	Proposed modification construction activity	Pollutants of concern	Potential surface water impacts on sensitive receptors (without mitigation)
2 & 3	<ul style="list-style-type: none"> A (Botany Bay) B (Quibray Bay) E (Towra Point Nature Reserve (Ramsar site) and Quibray Bay via Sir Joseph Banks Drive roadside drains) F (Southern natural retention basin and coastal wetland area to the south of the Site) 	<p>Runoff of concrete washout from structure relocation and/or construction of new OWS pits and pipes entering receiving waterbodies.</p> <p>Mobilisation of concrete dust through wind and interaction with surface water runoff.</p> <p>Spills of chemicals used in the treatment and curing of concrete.</p> <p>Spills of excess or waste concrete.</p>	High pH, chromium, contaminants, waste, sediments, and gross pollutants.	Increased alkalinity and toxicant concentrations could impact the health of aquatic ecosystems and lead to fish kills. Increased turbidity in receiving waters.
3 & 4	<ul style="list-style-type: none"> A (Botany Bay) B (Quibray Bay) F (Southern natural retention basin and coastal wetland area to the south of the Site) 	Construction of OWS pumps along the southern boundary of Zone 2, and remediation in southern and eastern area of Zones 2 and 3, respectively, would occur in the Proximity Areas for Coastal Wetlands, which have the potential to increase the dispersion of dust, soils, sediments dust, transport sediments, and increase the presence of oils and greases on surface runoff discharge to the downstream wetlands.	Sediments, nutrients, oils and greases, and contaminants.	<p>Increased influx of sediments to nearby waterbodies could result in high turbidity, lower dissolved oxygen levels, and increased toxicant concentrations which could impact aquatic ecosystems.</p> <p>Excess nutrients could lead to eutrophication and prioritise the growth of toxic/ invasive algal species over native flora.</p> <p>Oils and greases are of concern due to their potential for acute toxicity and bioaccumulation ability.</p>
2, 3, & 4	All except Catchment G	Accidental spills of petroleum products, lubricants, wastewater and leachate (from machinery/ equipment or augmented/ removed/ relocated infrastructure) entering downstream waterways.	Hydrocarbons, oils and greases, hydraulic fluids, contaminants, and hazardous chemicals.	Increased pollutant concentrations could impact aquatic flora and fauna, including fish kills in aquatic ecosystems.

Construction phase water quality mitigation measures

To prevent changes to contaminant loads in offsite stormwater discharges, the following measures would be implemented during the construction phase:

- The proposed modification works would be carried out in stages to effectively minimise ground disturbance, soil exposure, and stored waste
- Sediment and erosion controls would be installed and operated in accordance with *The Blue Book* (Landcom, 2004)
- Silt fences would be installed around stockpiles to reduce erosion and the movement of suspended solids, as necessary
- Soil stockpiles and contaminated materials would be stored separately in designated areas which are not in close proximity to any stormwater drainage systems
- Erosion control structures, bunded areas, containment areas, drainage lines, and interception measures would be subject to regular inspection
- Clean materials would be separated from contaminated materials
- Soil erosion and sedimentation devices would remain in place until the disturbed ground surface is restored. These devices would also capture any gross pollutants
- Traffic speed limits apply on internal roads to limit dust generation and loose soils
- Dust suppression measures will be applied in accordance with the Blue Book (Landcom, 2004).
- Chemicals and other hazardous materials to be stored onsite in accordance with the National Code of Practice for the Storage and Handling of Workplace Dangerous Goods (Commonwealth of Australia, 2001)
- The measures and processes currently in place at the Site to prevent any loss of contaminant would be maintained throughout the demolition, construction and operation phases of the terminal (as modified) and during the delivery of the proposed modification. This includes appropriate measures to be implemented in the event of a spill, including initial response and containment, notification of emergency services and relevant authorities.

5.1.4 Flooding impacts

Potential flooding impacts during the construction phase have been considered, including how floodwaters would impact the proposed modification, how the proposed modification would potentially impact existing flood behaviour within the Site, and whether potential impacts would have follow-on effects across downstream locations.

Flooding impacts on construction works

The proposed modification would maintain the existing landform and surface levels at the Site, with the exception of RPIP Mountain and Source Area Excavation 5. RPIP Mountain would be regraded to allow water to drain, prevent water pooling in the centre of the mound, and prevent slope instability, whilst the bund at Source Area Excavation 5 would be removed during remediation activities as this area does not currently retain large amounts of water. As such, the Site's resilience against external floodwaters would not change. As described in Section 4.4, previous flood modelling results have indicated that the Site would be protected from surrounding/ external floodwaters in all events up to, and including a 1% AEP flood. Existing surface levels along the Site boundaries would also remain unchanged, thereby maintaining the same level required to keep external floodwaters out of the Site.

Surface water flows into the Site from the National Park (refer to Figure 4-1). Existing SWS drainage infrastructure capturing and conveying these external flows through the Site would be retained during all stages of construction. The existing level of service provided for these external flows would therefore also be retained during construction.

It is unlikely that significant flow diversion works would be required, as the existing road network currently acts as an overland flow path for local and external floodwaters moving through the Site. The proposed modification would not impact the road network and would continue to provide an overland flow path during construction.

Flood protection would, however, be required around excavations or susceptible construction zones to minimise the risk of floodwater ingress and to divert large external surface flows entering the Site around these construction zones – particularly, for works within Zone 2 as external flows from the National Park move in a westerly direction through Zone 2 and towards the main pipeway. Temporary diversion systems, such as bunding around proposed excavation zones, would be installed to direct flows around construction works and towards the nearest existing SWS, thereby preventing localised flood issues.

Construction works, such as excavations, would be staged where practicable to minimise the extent of required diversion works at any one time.

Design, installation, and operation of any temporary flood diversion works required during construction would be captured as part of the CEMP.

Potential impacts of construction work on flooding

Figure 4-3 and Figure 4-4 provide an indication of existing flood prone areas across the Site based on flood modelling completed by AECOM (refer to Appendix B). The results indicate that certain areas proposed to undergo excavation as part of remediation works in Stage 3 (refer Figure 1-4) would be located in areas subject to localised flooding in a combined 1% AEP catchment and 1% AEP coastal event. These excavation areas relative to the post-modification flood modelling results have been presented in Section 5.2.4. A detailed description of the remediation works is provided in Appendix B (Updated description of the proposed modification) of the Submissions Report.

Most of these areas are subject to small amounts of flooding from local flows exceeding the hydraulic capacity of the road network. However, the petroleum hydrocarbon (PHC) hotspot excavation and remediation area at the eastern side of Zone 2 (i.e., Source Area Excavation 2 on Figure 1-4) would be spread across existing OWS bunded areas that can be subject to large flood depths during periods of rainfall. These bunded OWS areas are shown to be subject to significant (greater than 300 mm flood depths) during large flood events, such as the combined 1% AEP catchment and 1% AEP coastal event shown in Figure 4-4 as a result of retention of water during storm events.

To prevent alterations to existing flooding behaviour at these remediation locations, and to prevent an increase to floodwaters leaving the Site, the proposed modification has incorporated the following measures:

- With the exception of Source Area Excavation, existing OWS bunded areas across the Site would remain bunded throughout the proposed modification works to prevent water that accumulates within these bunded areas from being uncontrollably released to the SWS network. The bunding at Source Area Excavation 5 would be removed to allow remediation activities to occur; this area does not currently retain large amounts of water and its removal would result in a negligible change in surface flows (refer to Figure 5-8 and Figure 5-9).
- The proposed modification would be completed in a manner that does not alter existing surface levels – i.e., remediated/ excavated areas would be returned to existing surface levels following the completion of these works.
- Where practicable, major construction works would be scheduled during dry periods, where there is not expected to be heavy rainfall.

These measures would prevent significant changes to existing flood storage volumes across the Site, which would in turn minimise the likelihood of localised flood impacts resulting from the proposed modification at other onsite or offsite locations.

5.2 Operation

Following the completion of the proposed modification works, the Site would continue to operate as described in the approval documentation for the approved project. Operations would predominantly occur in Zones 1 and 1A, and remediated land across Zones 2 and 3 would remain largely vacant.

Potential operational impacts resulting from these changes on drainage, wastewater, water quality, and flooding are described in the following sections.

5.2.1 Drainage impacts

Currently, surface water in Zones 2 and 3 is collected and processed under either the SWS or OWS systems. Under future operational (or post-modification) conditions, following removal of the OWS from Zones 2 and 3 (refer to Figure 1-2), the existing SWS would collect additional surface water runoff that would have previously been collected by these redundant OWS lines.

Figure 5-1 and Figure 5-2 illustrate the total area that would drain to the SWS under pre- and post-modification conditions, respectively. Figure 5-3 and Figure 5-4 illustrate the impervious area percentages across SWS catchments under pre- and post-modification conditions, respectively.

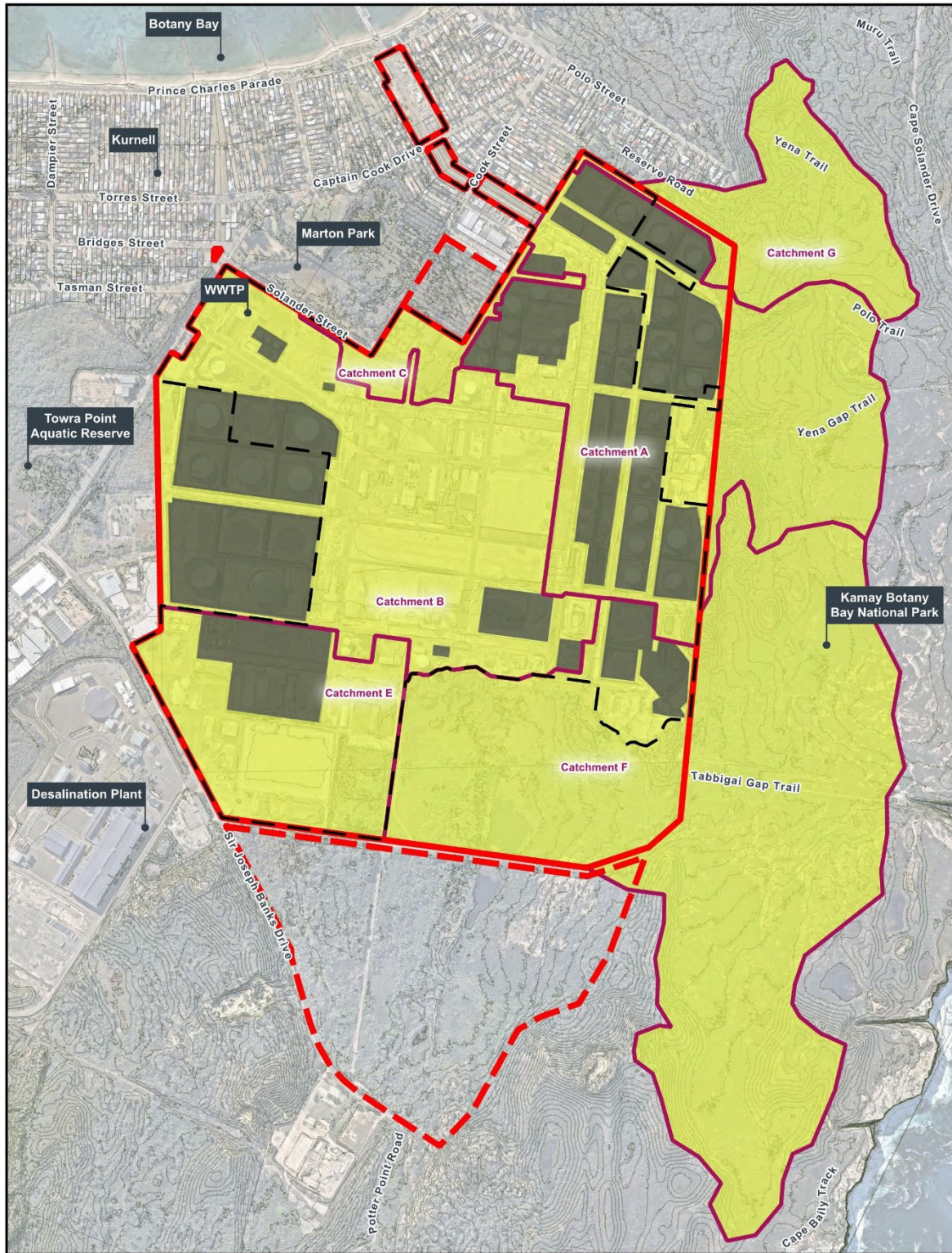
The total SWS catchment area across the Site would increase by approximately 12.2 ha as a result of redirecting sections of OWS to the SWS as part of the proposed modification. Table 5-2 summarises the changes in SWS catchment areas and associated impervious areas as a result of the proposed modification. Surface water catchment changes would only occur within Catchments B, E, and F.

Table 5-2 Surface water catchment changes

Catchment	Discharge point	Existing catchment area (ha)	Increase in:		
			Catchment area (ha)	Impervious area (ha)	Pervious area (ha)
A	Botany Bay	67	0.0	0.0	0.0
B	Quibray Bay	70	2.0 (2.9%)	1.4 (2.0%)	0.6 (0.9%)
C	Marton Park Wetland	6	0.0	0.0	0.0
E	Sir Joseph Banks Drive	26	6.0 (23.1%)	3.3 (12.7%)	2.7 (10.4%)
F	Natural retention basin	108	4.2 (3.9%)	2.9 (2.7%)	1.3 (1.2%)
G	Council-owned drains	19	0.0	0.0	0.0
Total		296	12.2 (4.1%)	7.6 (2.6%)	4.6 (1.6%)

The impervious and pervious area percentages have been identified based on the existing surface type shown in the latest (2025) aerial imagery. The proposed modification would not alter existing surface finishes. For instance, following excavation, the area colloquially known as Refining Process Improvement Project (RPIP) Mountain (Excavation 6 in Figure 1-4) would be hydromulched (or fixed using another appropriate method) to help prevent surface water flows from this land being impacted by sediment following the works; the LPG Area (Excavation 7 in Figure 1-4) would be covered in gravel or similar material to present.

All aboveground structures would be relocated to areas that were already impervious prior to the proposed modification, with the exception of the firewater tank and pumphouse within the FWS Relocation Area and new storage shed in Zone1A. These areas are currently covered in gravel and sand. Under post-proposed modification conditions, the relocated tank and pumphouse would be sit upon concrete foundations. Given that there will be minimal changes in impervious areas, significant increases to the volume of surface water runoff are not anticipated. As such, changes to perviousness are not expected.



Legend

- Site Boundary
- Ampol Ownership
- Project Area
- SWS catchment boundary
- SWS area
- OWS banded area



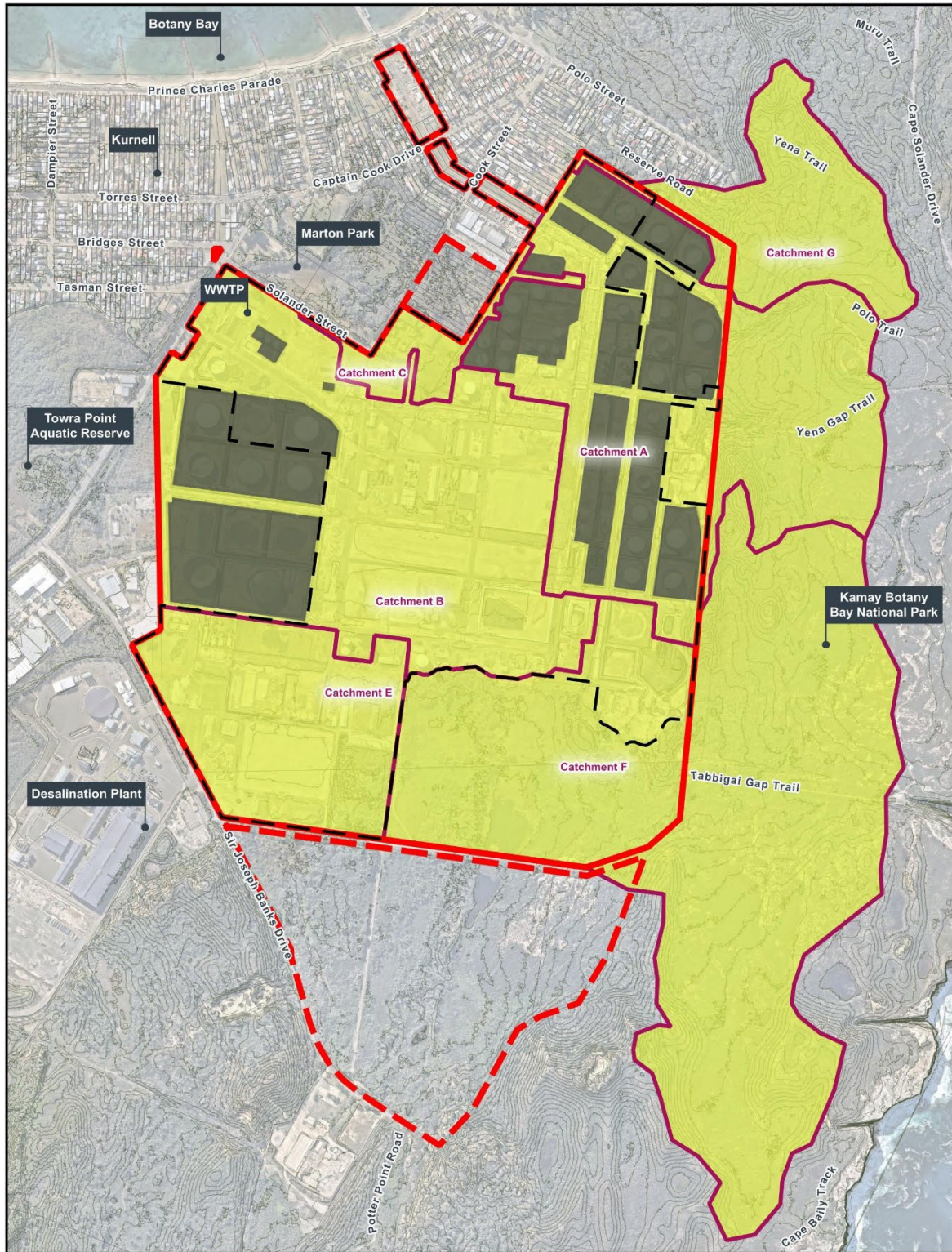
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Source: Neemap, 2024

Figure 5-1 Pre-modification SWS and OWS areas



Legend

- Site Boundary
- Ampol Ownership
- Project Area
- SWS catchment boundary
- SWS area
- OWS bunded area



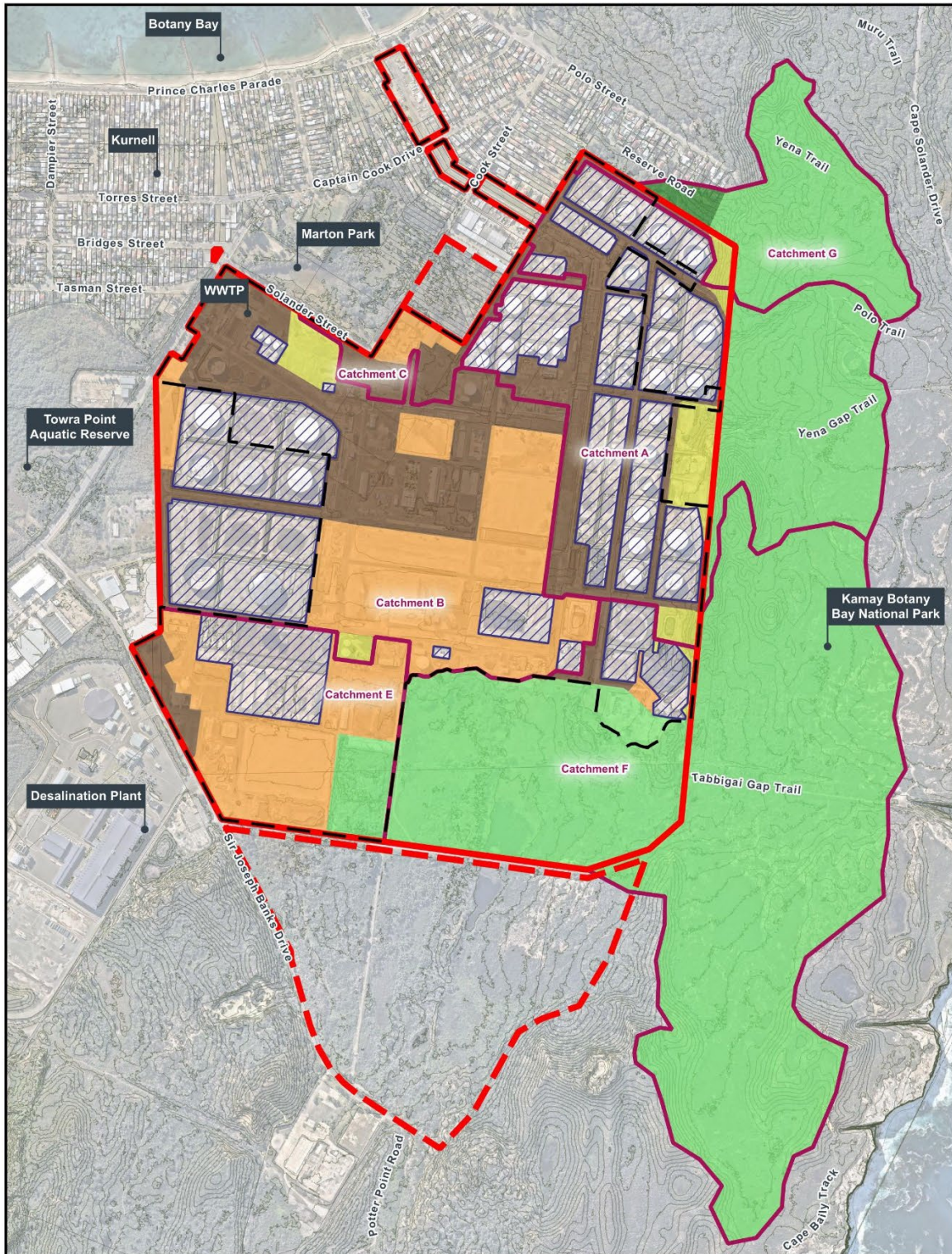
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Source: Neatmap, 2024

Figure 5-2 Post-modification SWS and OWS areas



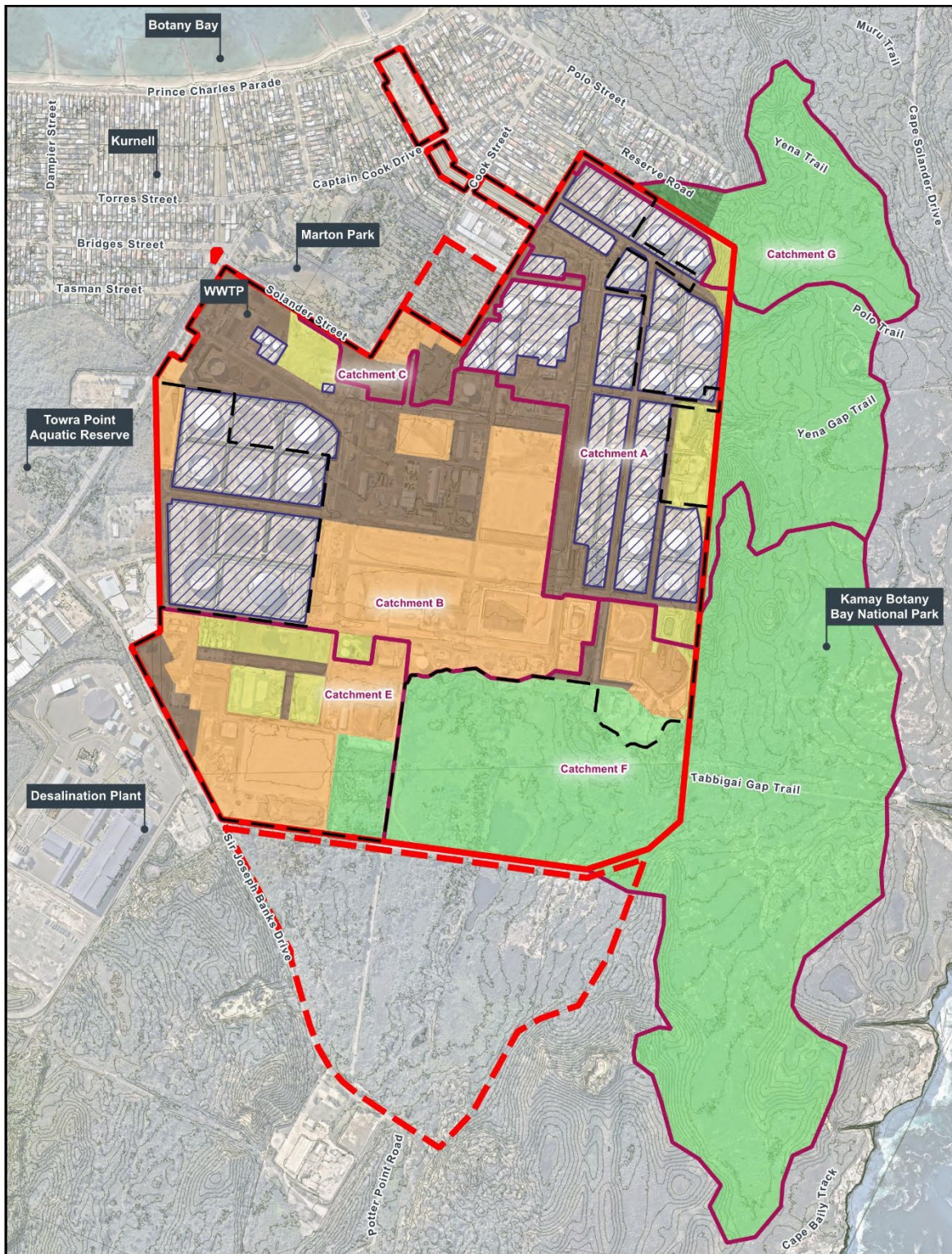
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Source: Nearemap, 2024

Figure 5-3 Pre-modification SWS catchment imperviousness



Legend

- Site Boundary
- Ampol Ownership
- Project Area
- SWS catchment boundary
- OWS banded area
- Imperviousness:**
- 50% impervious
- 70% impervious
- 90% impervious
- 0% impervious
- 10% impervious



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Source: Newmap, 2024

Figure 5-4 Post-modification SWS catchment imperviousness

As there would be no alterations to existing surface levels (with the exception of RPIP Mountain and Source Area Excavation 5), existing bunded areas would be retained under post-modification conditions. The majority of the OWS to be removed lies within bunded areas. Removal of the OWS network within these bunded areas would cause these bunded areas to act as surface water retention systems, where surface water runoff continues to pool and accumulate within these areas. Pooled water would only drain slowly via infiltration and evaporation and would continue to accumulate until eventually overflowing to the SWS under prolonged heavy rainfall conditions.

Due to a larger area draining to the SWS, surface water runoff within some of the sitewide catchments (refer to Table 4-1) would increase. The Site would also experience an increase peak discharge rates from these affected catchments, if no surface water management measures were implemented. Consistent with the River Flow Objectives for the Georges River catchment (refer to Section 3.7), the SWS area increase resulting from the proposed modification would be managed onsite to confirm that the peak post-modification discharge rates from the Site would not exceed pre-modification discharge rates at all discharge locations and in all storm events up to and including the 1% AEP event.

Detailed hydrologic and hydraulic modelling of the Site under both pre- and post-modification conditions was conducted as part of this impact assessment to quantify potential increases in peak discharge rates for the SWS and propose suitable surface water management strategies and mitigation measures. Refer to the surface water modelling methodology documented in Annexure A.

The following sections discuss the surface water management measures proposed in each of the affected SWS catchments and summarise the outcomes of the hydrologic and hydraulic modelling, to demonstrate how the proposed modification would be unlikely to increase peak discharge rates from the Site.

Catchments B and F

The SWS area increase in Catchment F would be redirected to Catchment B, as shown in Figure 5-5, so as to prevent changes to surface water inflows entering the natural retention basin and coastal wetland located south of the Site. As such, these catchments are discussed together in this section. Figure 5-5 shows the surface water management strategy that is proposed in Catchments B and F.

Retention of existing bunds would maintain existing storage volumes within these bunded areas and continue to provide attenuation and/or retention of surface water flows following removal of the OWS.

The existing storage volumes to be retained within each of the bunded areas in Catchments B and F are summarised in Table 5-3. The basin locations are labelled in Figure 5-5.

Table 5-3 Existing surface water storage volumes to be retained in Catchments B and F

Location	Existing storage volume to be retained (m ³)
Basin 94C	20,400
Basin 94D	1,100
Basin 33C	28,300
Basin 33D	14,000
Basin 31Da	8,100
Basin 31Db	2,600

Following removal of the OWS from the south eastern corner of the Site (spread across Catchments B and F), these bunded areas would not have any formal means of drainage. Surface water runoff collecting within these bunded areas would pool and continue to accumulate over time, only draining slowly through infiltration and evaporation. It is likely that these bunded areas would hold permanent water and potentially spill during large storm events.

To reduce the risk of such impacts, low-flow outlet pipes would be installed within each of these existing bunded areas (Figure 5-5). These outlet pipes would drain via a new SWS network that bypasses the southern natural retention basin and directs flow into the nearest existing SWS network within Catchment B.

Surface water flows would be directed towards Catchment B to prevent additional surface water from entering the southern natural retention basin and protected coastal wetland. The new SWS lines servicing these existing bunded areas would also remain separate to the existing SWS network within Catchment F such that areas currently draining south, towards the natural retention basin, would continue to do so under post-modification conditions. This approach would maintain the current inflow regime for the natural retention basin, as required per the RFOs listed in Section 3.7 for the Georges River catchment. The requirement for upgrades to the existing SWS would be investigated during detailed design.

The rate of flow release from these bunded areas would be controlled by low-flow outlet systems and operational procedures. By preventing an increase in surface water flow moving through the existing SWS network within Catchment B, the capacity of the existing SWS would not be overloaded.

It was assumed that, in the hydrologic and hydraulic modelling conducted as part of the Stormwater Assessment (Annexure A), these low-flow outlet systems would be as small as possible. This was to utilise the full storage capacity within these bunded areas without causing overtopping of the basins, and while maintaining a suitable amount of freeboard. A slow release could be achieved through the inclusion of small outlet pipes, orifice plates, control valves, custom outlet pits, pumped outlet systems, or other flow restriction methods.

Modelling results showed that utilising the available storage within these bunded areas and slowly releasing surface water flows into Catchment B would be capable of maintaining peak discharge rates from Catchment B, and to Quibray Bay, in all storm events up to and including the 1% AEP event. These measures would be capable of maintaining pre-modification discharge rates under both present-day and future climate conditions.

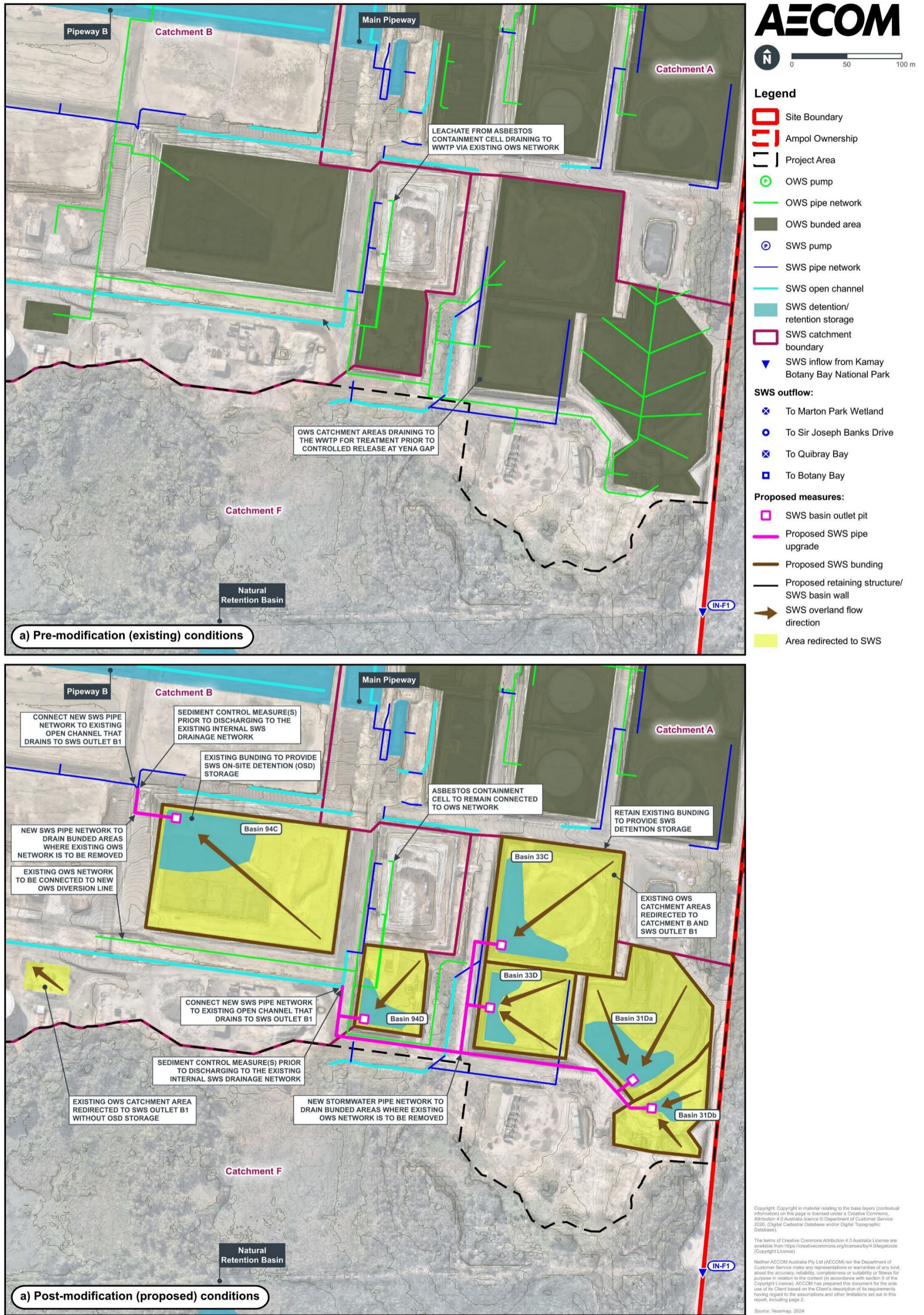


Figure 5-5 Proposed surface water management in Catchments B and F

Catchment E

Figure 5-6 shows the surface water management strategy that is proposed in Catchment E, in the south western corner of the Site.

Under existing (pre-modification) conditions, surface water runoff from Catchment E is collected by the SWS and conveyed towards four main drainage outlets, as illustrated in Figure 4-1. These outlets discharge to the roadside channel along the western side of Sir Joseph Banks Drive, which continues to convey flow in a northerly direction towards Towra Point Nature Reserve (Ramsar site) and Quibray Bay.

RPIP Mountain, located at the south eastern corner of Catchment E, is a former soil stockpiling area. Some of the soils were found to contain asbestos and this may present an asbestos mitigation risk to other parts of the Site due to the growth of vegetation across this area. The surface level lies 3 m above natural ground levels. Currently, surface water runoff from RPIP Mountain is conveyed by an open channel that runs along the western side of this area and discharges to an existing vegetated swale along the southern boundary of the Site. This southern swale directs flow in a westerly direction towards the roadside channel along Sir Joseph Banks Drive.

Vegetation would be removed, and ACS removed to a depth of 1 m below existing ground levels to target asbestos at the root zone of vegetation growing at the current ground surface. For larger tree roots, there is potential for excavation to a depth of 4 m bgl. Following excavation, RPIP Mountain would be graded to allow water to drain, prevent water pooling in the centre of the mound, and prevent slope instability. Where necessary, the excavation would be backfilled with clean material. The surface of RPIP Mountain would be hydromulched (or fixed using another appropriate method) to help prevent surface water flows from this land being impacted by sediment following the works. Once regraded, surface levels would not be below existing surrounding ground levels.

Consequently, RPIP Mountain would remain pervious. The peak discharge rate would be slightly increased as this change in surface roughness has the potential to reduce the time it takes for rainfall to convert to runoff and spread across the area. This would result in higher discharge rates entering the southern swale and draining to Sir Joseph Banks Drive.

It is therefore proposed that on-site detention (OSD) is provided within, or downstream of, RPIP Mountain to maintain the peak flow rates leaving this area and entering the southern swale at or below discharge rates under pre-modification conditions (Figure 5-6).

The northern side of Catchment E would also undergo changes as part of the proposed modification, where existing OWS areas would be redirected to the SWS following the removal of redundant OWS lines. The area draining to the SWS in Catchment E would increase by approximately 6.0 ha as a result of this change. This additional SWS area would increase the peak discharge rates leaving Catchment E and entering the roadside channel along Sir Joseph Banks Drive if no mitigation or management measures were to be implemented.

It is proposed that the former CLOR pipeway would be converted into an OSD system to capture, contain, and attenuate surface water runoff from the surrounding area that would be redirected to the existing SWS within Catchment E. This proposed OSD storage would help to minimise peak flow rates entering the existing SWS within Catchment E, so as not to overload the existing hydraulic conveyance capacity of this system, and to limit discharge rates entering the downstream channel along Sir Joseph Banks Drive.

Preliminary sizing of these two OSD systems within Catchment E was undertaken as part of the hydrologic and hydraulic modelling, documented in the Stormwater Assessment (Annexure A), to confirm that pre-modification peak discharge rates from Catchment E would be maintained in all storm events up to and including the 1% AEP event.

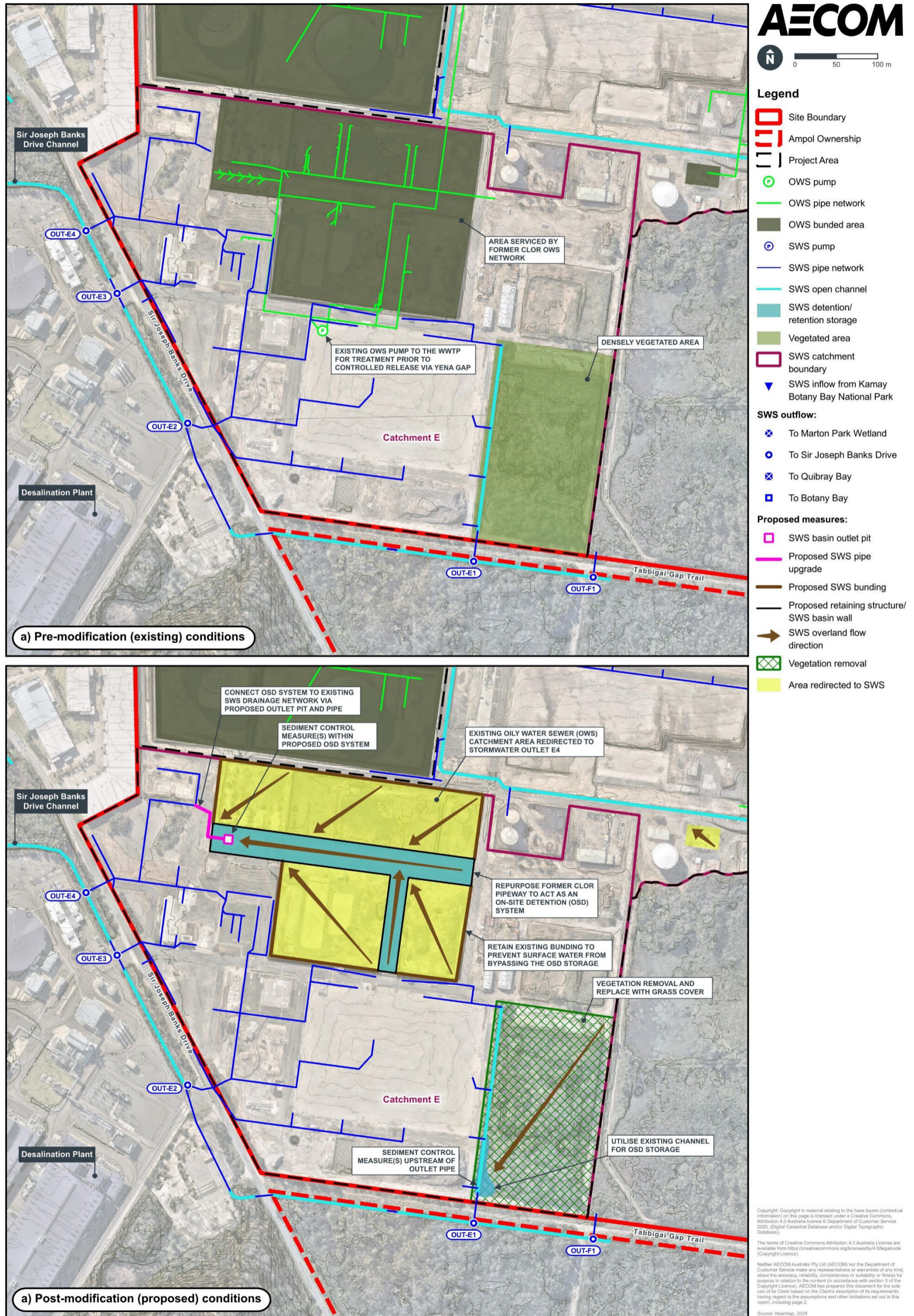


Figure 5-6 Proposed surface water management in Catchment E

The estimated OSD storage volumes at these two locations are summarised in Table 5-4 for both present and future climate conditions. More details on the adopted climate conditions are provided in the Stormwater Assessment (Annexure A).

Table 5-4 Proposed on-site detention volumes in Catchment E

Location	Minimum OSD volume required (m ³)	
	Present (2030)	Future climate (2100)
Former CLOR Pipeway	11,000	17,000
RPIP Mountain	400	700

The volumes quoted in Table 5-4 do not account for any freeboard and would therefore require additional storage volume to allow for an appropriate amount of freeboard. These quoted volumes should also be treated as indicative only and would require further refinement during subsequent design phases. It is possible that an alternative solution, such as providing detention storage further downstream of the former CLOR pipeway, could also be adopted to achieve the same objective of maintaining the peak pre-modification discharge rates from the Site.

The OSD volume required at RPIP Mountain would be achieved by widening the existing open channel that runs along the western side of this area. For example, widening the base width of this channel by 1.5 m would achieve the required 400 m³ of OSD storage under present-day climate conditions. Additional widening would be expected to achieve the larger 700 m³ required under future climate conditions.

Alternatively, an OSD basin would be provided at the downstream (south western) corner of RPIP Mountain in lieu of widening the existing channel. Upgrades to the existing 450 mm diameter outlet pipe at the southern end of this channel would likely not be required, as the existing pipe would be capable of maintaining pre-modification discharge rates without any adjustments in all storm events up to and including the 1% AEP event. The dimensions and final siting of the OSD would be determined during detailed design.

The required OSD storage within the former CLOR pipeway would require alterations to the existing pipeway in order to achieve the larger volume that has been estimated. Upgrades would likely require the following key modifications:

- Upgrades to the existing vertical wall around the pipeway, where necessary, to achieve a constant top of wall elevation, estimated to be up to 2 m in height, to contain surface water inflows and increase the maximum storage height within the pipeway
- Where possible, excavation of the pipeway by up to 1-1.5 m to increase the storage capacity and regrading the invert of the pipeway to direct low flows towards the western side of the pipeway, where the outlet is proposed
- Basin outlet structure to control discharge rates from the pipeway
- New SWS piped network connecting the basin outlet structure to the existing downstream SWS network
- A designated spillway system to safely direct any overflows towards the Site discharge point.

These modifications to the former CLOR pipeway would be reviewed and refined during the subsequent design phases.

It is likely that the areas surrounding this proposed OSD system would also require temporary flow diversion measures, such as swales, to direct surface water runoff into the OSD system. This would prevent surface water runoff from permanently pooling within natural low points across the surface of these areas.

The former CLOR pipeways A and B would be confirmed as clean (and remediated as required) prior to being converted to a detention system in order to prevent the contamination of surface waters inflows.

5.2.2 Oily water management

The existing OWS within Zones 2 and 3, as indicated in Figure 5-5 and Figure 5-6, would be decommissioned and removed at the end of Stage 2. The only remaining OWS network in these zones would be the new OWS diversion line that would collect leachate from the ACS Containment Cell and connect to the existing OWS network along the eastern side of Zone 1. The OWS network in Zone 1 would continue to direct oily water and leachate towards the WWTP for treatment.

The OWS diversion line from the ACS Containment Cell is proposed to be a pumped system and would be designed to, at the very least, maintain (or improve) the hydraulic capacity of the OWS network servicing the ACS Containment Cell. Maintaining the existing hydraulic capacity would prevent leachate/ contaminated water bypassing the proposed OWS network and discharge to the receiving environment without treatment. Additionally, the proposed pumping station would incorporate an emergency storage tank to contain leachate from the containment cell in the event of a power outage to minimise the risk of leachate discharging offsite without treatment.

Other bunded areas draining to the existing OWS network along the eastern side of Zone 1 (i.e., where the proposed diversion line would connect in) are equipped with valves on the outlet pipes to control the amount of oily water entering the OWS network. The process of only allowing a few bunded areas to drain to the OWS network at a time by using these valves would confirm that the network is not overloaded, even by introducing additional inflows from the ACS Containment Cell.

There would therefore be no increase in the total flow within the OWS line that runs along the northern boundary of Zone 2. There would be a marginal increase in the OWS area draining to existing OWS line that runs along the eastern side of Zone 1, before connecting into the line running east-west. This slight increase would be managed by the staged release from all bunded OWS areas, so as not to overload this section of the existing OWS line.

The remaining and remediated portions of Zones 2 and 3 would not produce oily water runoff after completion of the proposed modification works, and all surface water runoff from these zones would be of suitable quality for redirection to the existing SWS.

On this basis, the total oily water load from the Site and entering the OWS system and WWTP would be significantly reduced during periods of rainfall. The OWS and WWTP are therefore not likely to be impacted by the proposed modification and would continue to operate as per the approved project.

5.2.3 Water quality impacts

Potential water quality impacts during the operations phase are listed in Table 5-5. The main contaminants of potential concern in stormwater runoff from the Site during operations would be sediment and nutrients, generated mainly from pervious surfaces. Given that proposed modification works would not alter existing finished surface levels (with the exception of RPIP Mountain, which would be regraded) nor existing surface finishes, these key potential contaminants are similar to the existing condition. As discussed in Section 3.6, there are a number of sensitive receiving environments which could be impacted by stormwater discharges from the Site, particularly downstream of Catchment E (Towra Point Nature Reserve (Ramsar wetland area), Catchment C (Marton Park Wetland), Catchment B (coastal wetlands within Quibray Bay) and Catchment F (coastal wetlands to the south of the site, which overflow to Towra Point Nature Reserve (Ramsar wetland area)). Given the high value of these receiving environments, protection of aquatic ecosystems is a particularly important WQO.

Changes in pervious and impervious areas pre- and post-modification are presented in Table 5-2. This table shows that changes to impervious surfaces would occur as a result of the increased size of Catchments B and E, where sections of the OWS are removed and the surfaces are redirected to the SWS. Across the Project Area, the area of impervious surfaces would increase by 2.6%, whilst pervious surfaces would increase by 1.6%. On an individual catchment basis, the largest increases would occur in Catchment E (23.1% increase in impervious surfaces and 12.7% increase in pervious surfaces). As discussed below, additional permanent sediment treatment is proposed downstream of the two proposed OSD systems.

Proposed measures to mitigate against water quality impacts during the operational phase are presented in Table 5-6. Further detail regarding mitigation measures is provided following:

- Once the redundant sections of the OWS network in Zones 2 and 3 are decommissioned and removed in Stage 2 and the proposed modification works are complete, leachate from the ACS Containment Cell would continue to drain to the WWTP via the OWS diversion line connected to Zone 1.
- Disturbed surfaces across the Site would be stabilised to provide sufficient surface cover, such as hydromulching, hardstand compaction, or temporary vegetative cover. It is understood that existing flow controls or water quality treatment devices, such as oil skimmers and PFAS treatment, would remain and be maintained as part of the modified terminal. OSD requirements in the south eastern corner of Zone 3 would be constructed upstream of existing PFAS devices to maintain existing treatment measures.
- Remediation of RPIP Mountain would involve the removal of the existing vegetation and ACS up to a depth of 4 mbgl to remove roots but be mostly within 1 mbgl to allow clean backfill to be placed over this area. RPIP Mountain would be hydromulched (or fixed using another appropriate method) to help prevent surface water flows from this land being impacted by sediment following the works.
- Excavated areas would be reinstated to the existing grade and stabilised with adequate surface cover, maintaining current stormwater discharge rates.
- There is some potential for erosion and sedimentation on the excavated areas immediately after construction ceases, when surface/ vegetative cover is not yet fully established and the soils remain exposed. Erosion and sedimentation control measures would be implemented at the source until surfaces have been completely stabilised. This would include sediment traps upstream of pumps or outlet pits or installing a trash rack at the OSD discharge point to prevent gross pollutants from leaving the Site.
- Sediment loads in stormwater during the operational phase of the proposed modification are expected to be low given the final landform. However in order to further protect sensitive receiving environments, such as the coastal wetlands, permanent sediment control measures are proposed to be installed within or at the downstream end of the two proposed OSD systems (refer to Section 5.2.1). Surface water discharge from these bunded areas would undergo treatment via the series of measures that are already in place within Catchment B (refer to Table 4-2), prior to discharging offsite. The slow release of flow would prevent the overloading of the existing treatment measures.
- The proposed SWS network within Catchments B and F would also incorporate sediment control measures upstream of the connection point to the existing SWS network in Catchment B. These sediment control measures would be designed during subsequent design phases and would be designed to minimise the amount of sediment and other sediment-bound pollutants that leave this south eastern corner of the Site.

Once surface/ vegetative cover has been well established, the risk of pollution of surface water runoff would be negligible,

Table 5-5 Potential impacts to surface water quality during the operations phase

Catchment and receiving environment	Modified Terminal operational activity	Pollutants of concern	Potential surface water impacts on sensitive receptors (without mitigation)
A – Botany Bay	Stormwater runoff from final landform will be collected in SWS and discharged via existing outlet/s.	Minor generation of sediments and nutrients, predominantly from pervious areas during heavy rain (similar to pre-modification scenario).	Minor potential for temporary increased influx of sediments and nutrients to nearby waterbodies.
B ¹ – Quibray Bay	Stormwater runoff from final landform (including flows from the area formerly draining to OWS in Catchment F) will be collected in SWS and discharged via existing outlet/s.	Minor generation of sediments and nutrients, predominantly from pervious areas during heavy rain (slight increase compared to pre-modification scenario due to additional catchment area draining former OWS).	Minor potential for temporary increased influx of sediments and nutrients to nearby waterbodies.
C – Marton Park Wetland	Stormwater runoff from final landform will be collected in SWS and discharged via existing outlet/s.	Minor generation of sediments and nutrients, predominantly from pervious areas during heavy rain (similar to pre-modification scenario).	Minor potential for temporary increased influx of sediments and nutrients to nearby waterbodies.
E – Towra Point Aquatic Reserve (Ramsar site), Quibray Bay via Sir Joseph Banks Drive and Captain Cook Drive roadside drains	Stormwater runoff from final landform (including flows from area formerly draining to OWS) will be collected in SWS and discharged via existing outlet/s.	Minor generation of sediments and nutrients, predominantly from pervious areas during heavy rain (slight increase compared to pre-modification scenario due to additional catchment area draining former OWS).	Minor potential for temporary increased influx of sediments and nutrients to nearby waterbodies.
F – Southern retention basin and coastal wetland area to the south of the site. Overflows from this area would discharge to Sir Joseph Banks Drive and then to Towra Point Aquatic Reserve (Ramsar site) Quibray Bay	Stormwater runoff from unchanged landform will be collected in SWS and discharged via existing outlet/s.	Not applicable – no change to quality or quantity of SWS flows discharging to southern retention storage/ coastal wetland from Catchment F as part of the proposed modification	Not applicable – no change to quality or quantity of SWS flows discharging to southern retention storage/ coastal wetland from Catchment F as part of the proposed modification.

Catchment and receiving environment	Modified Terminal operational activity	Pollutants of concern	Potential surface water impacts on sensitive receptors (without mitigation)
G – Council-owned drains which discharge to Marton Park Wetland	Stormwater runoff from final landform will be collected in SWS and discharged via existing outlet/s.	Minor generation of sediments and nutrients, predominantly from pervious areas during heavy rain (similar to pre-modification scenario).	Minor potential for temporary increased influx of sediments and nutrients to nearby waterbodies.

Notes: 1 – Catchment D, as referenced in previous surface water reports, is no longer a separate catchment and is now part of Catchment B.

Table 5-6 Proposed operational phase stormwater quality mitigation measures

Catchment and receiving environment	Proposed stormwater quality mitigation measures
A – Botany Bay	<ul style="list-style-type: none"> • Disturbed surfaces would be stabilised to provide sufficient surface cover (of similar perviousness to pre-modification condition), such as hardstand compaction or vegetative cover. • At-source sediment control until remediated surfaces are stabilised • Existing stormwater treatment measures in this catchment would be retained (refer to Table 4-2).
B – Quibray Bay	<ul style="list-style-type: none"> • Disturbed surfaces would be stabilised to provide sufficient surface cover such as hardstand compaction or temporary vegetative cover • Additional permanent sediment control measures are proposed within or immediately downstream of the existing bunded OWS areas that would be connected to the existing SWS as part of the proposed modification. These measures would treat surface water flows from these existing bunded areas prior to discharging into the existing SWS within Catchment B. • At-source erosion and sediment control measures to be implemented until excavated / remediated surfaces are stabilised • Short-term post-construction water quality monitoring at Basin 1B (Location A, Figure 5-7) during three wet weather events during discharge. In the event of non-compliance, corrective and preventative actions would be identified.
C – Marton Park Wetland	<ul style="list-style-type: none"> • Disturbed surfaces would be stabilised to provide sufficient surface cover, such as hardstand compaction or temporary vegetative cover • At-source sediment control until remediated / excavated surfaces are stabilised
E – Towra Point Nature Reserve (Ramsar site) via Sir Joseph Banks Drive Channel	<ul style="list-style-type: none"> • Disturbed surfaces would be stabilised to provide sufficient surface cover such as hardstand compaction or temporary vegetative cover • At-source sediment control measures would be put in place until remediated surfaces are stabilised • Post-stabilisation of landforms – sediment control measures, such as sediment traps upstream of OSD discharge proposed at the Pipeway A & B (CLOR) and at the RPIP Mountain (see Figure 5-6) • Additional sediment control measures are proposed upstream of Outlet E1 and Outlet E3 (refer to Figure 5-6) • Proposed trash rack at OSD discharge to prevent gross pollutants leaving Site • The existing vegetated swale receiving discharges from RPIP Mountain would be retained and provide additional contaminant treatment, prior to discharge to the roadside drains alongside Sir Joseph Banks Drive • Short-term post-construction water quality monitoring at Locations B and C (Figure 5-7) during three wet weather events during discharge. In the event of non-compliance, corrective and preventative actions would be identified.

Catchment and receiving environment	Proposed stormwater quality mitigation measures
F – Coastal wetlands	<ul style="list-style-type: none"> No specific mitigation measures proposed for Catchment F. No change to surfaces or SWS flows discharging to southern retention storage/ coastal wetland from Catchment F and therefore no change to quality or quantity of runoff to this receiving environment. Refer to Catchment B for mitigation measures for flows redirected to SWS from area formerly draining to OWS. Short-term post-construction water quality monitoring at Location D (Figure 5-7) to monitor water discharged from the proposed orifice during three wet weather events. In the event of non-compliance, corrective and preventative actions would be identified.
G - Council-owned drains which discharge to Marton Park Wetland	<ul style="list-style-type: none"> Not applicable. No change to Catchment G as part of the proposed modification.

Short-term post-construction water quality monitoring at main outlets at affected catchments (Catchments B, F, and E) would be undertaken to confirm the discharged stormwater quality meets the WQOs for the wider catchment (refer to Section 3.7). Proposed stormwater quality monitoring locations are shown in Figure 5-7. Baseline water quality sampling would be conducted at the proposed monitoring locations prior to the construction to define the baseline water quality conditions. Only those contaminants potentially associated with activities undertaken as part of the proposed modification would be monitored.

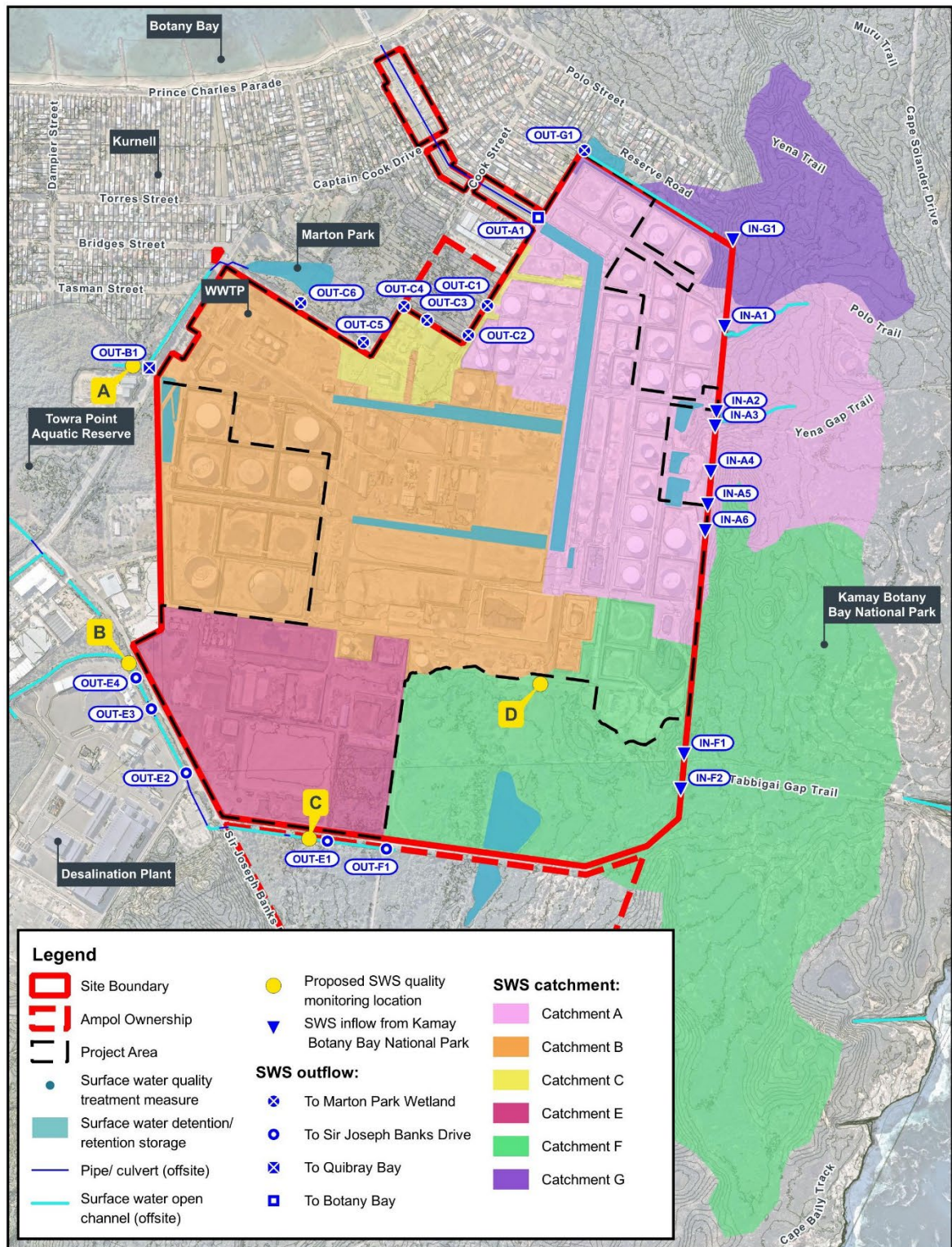
Table 5-7 lists the proposed stormwater quality monitoring parameters and default trigger values in accordance with the aquatic ecosystem WQO for the Georges River catchment (which are the most stringent trigger values for the relevant contaminants compared to other WQOs). Should results exceed trigger values, an investigation would be undertaken to determine the cause and assess whether additional mitigation measures are required.

Table 5-7 Proposed stormwater quality monitoring parameters

Objective	Proposed water quality monitoring parameters	Default trigger value ¹
Aquatic ecosystems: maintaining and improving the ecological condition of waterbodies and their riparian zones over the long term	Total Phosphorus (TP) (<i>ex situ</i>)	0.03 mg/L
	Total Nitrogen (TN) (<i>ex situ</i>)	0.30 mg/L
	Chlorophyll-a (<i>ex situ</i>)	0.04 mg/L
	Turbidity (<i>in situ</i>)	0.5-10 NTU
	Dissolved oxygen (DO) (<i>in situ</i>)	80-110% saturation
	pH (<i>in situ</i>)	7.0-8.5

Notes: 1 – Refer to Section 3.7.

By implementing the proposed mitigation measures and the post-construction water quality monitoring scheme, potential water quality impacts on downstream sensitive receptors would be effectively mitigated.



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Source: Nearamap, 2024

Figure 5-7 Proposed stormwater quality monitoring locations

5.2.4 Flooding impacts

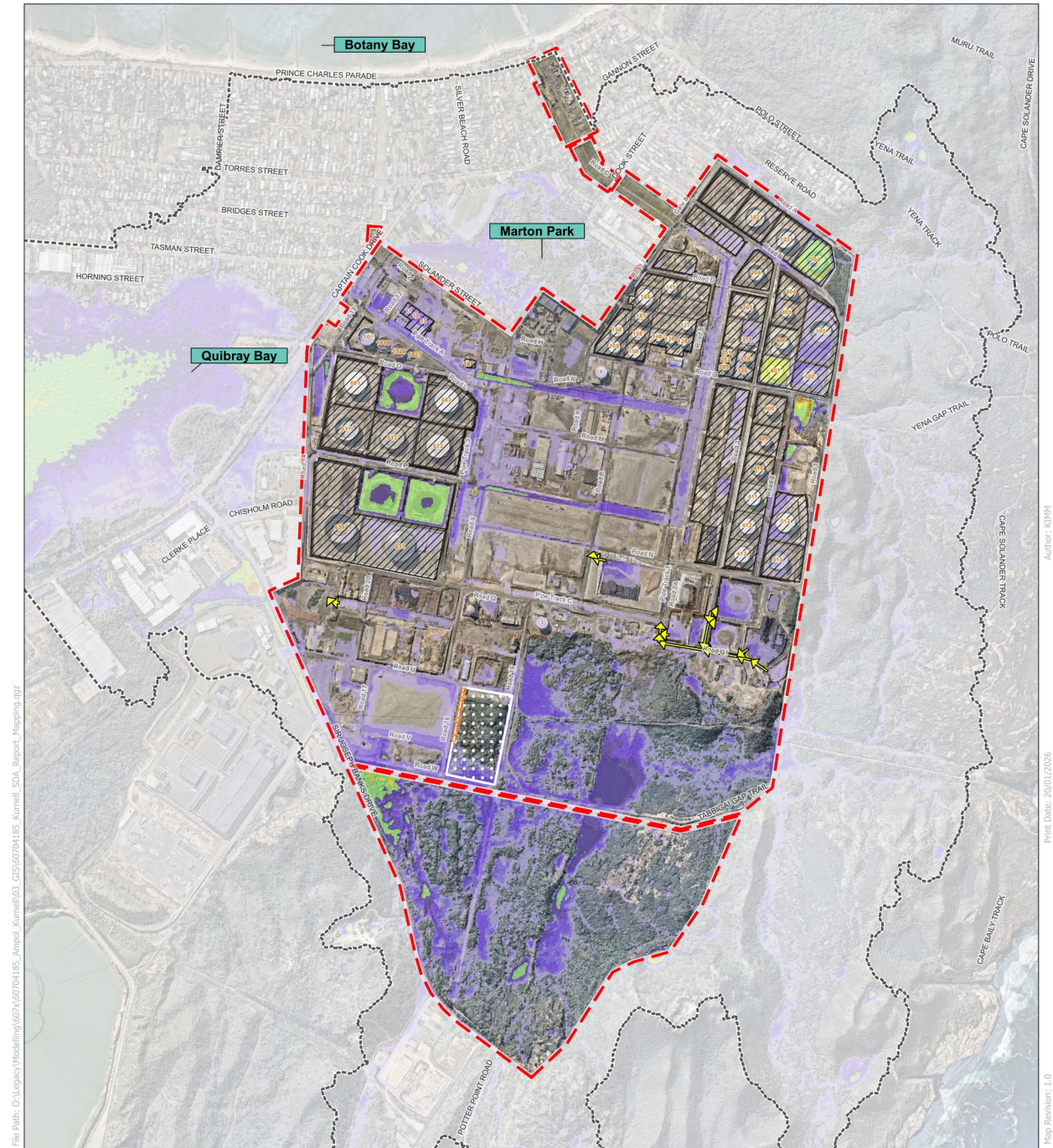
The operational phase of the proposed modification is not expected to alter existing flooding conditions on and offsite. The design controls implemented during the construction excavations, detailed in Section 5.1.4, would also be implemented under operational conditions to maintain existing finished surface levels across the Site under post-modification conditions. In turn, this would maintain existing flood storage volumes and flood flow paths across the Site.

Stormwater discharge from the Site would be regulated by the proposed surface water management measures, detailed in Section 5.2.1, such that the post-modification discharge rates would not be any larger than existing, pre-modification discharge rates at all discharge locations. This would prevent significant changes to downstream flooding extents.

The proposed modification would also not alter the paths for external flows coming from the Kamay Botany Bay National Park or overland flow paths across the Site, as these overland flow paths generally follow the existing road network, which would not be impacted by the proposed modification.

The post-modification peak flood depths for the 1% AEP event for present day (2030) conditions are presented in Figure 5-8. Peak flood depths for the 1% AEP event in the future climate (2100) scenario are presented in Figure 5-9.

Similar to the current site conditions, surface water accumulating within the bunded OWS areas is contained within the bunded areas. These bunded areas will continue to drain separately towards the WWTP via the existing OWS network and would not contribute to floodwaters moving along the roads and pipeways.



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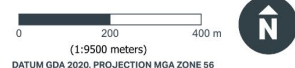
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Map Revision: 1.0

Targeted Remediation Activities
Peak Flood Depth in 1% AEP with 2030 Climate Change

Legend

- | | | | |
|----------------------------------|---------------------------------|------------------------------|-------------|
| Cadastre | Targeted Remediation Activities | Peak Flood Depth (m) <= 0.30 | 1.00 - 1.50 |
| Oily Water System Extent | Low Level Drainage | 0.30 - 0.50 | 1.50 - 2.00 |
| Ampol Site Boundary | On-site Detention | 0.50 - 0.75 | 2.00 - 3.00 |
| TUFLOW Extent | Reprofilling & Grass Cover | 0.75 - 1.00 | > 3.00 |
| Stormwater Receiving Environment | | | |

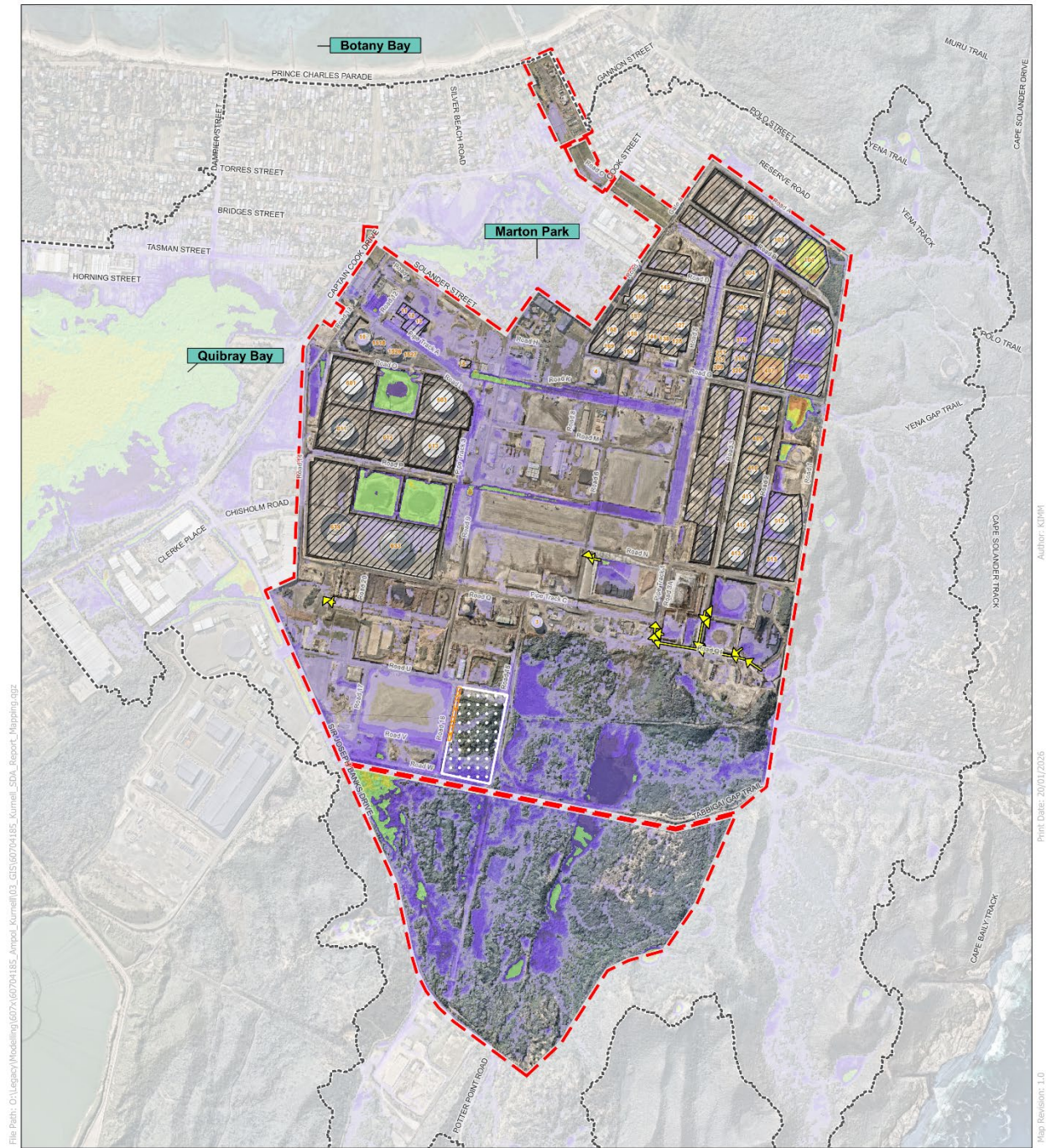


Data Sources:
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Figure 5-8 Post-modification peak flood depth for 1% AEP event with 2030 climate change



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Author: KIMM

Print Date: 20/01/2025

Map Revision: 1.0

Targeted Remediation Activities
Peak Flood Depth in 1% AEP with 2100 Climate Change

Legend

Cadastre	Targeted Remediation Activities	Peak Flood Depth (m)	1.00 - 1.50
Oily Water System Extent	Low Level Drainage	<= 0.30	1.50 - 2.00
Ampol Site Boundary	On-site Detention	0.30 - 0.50	2.00 - 3.00
TUFLOW Extent	Reprofilling & Grass Cover	0.50 - 0.75	> 3.00
Stormwater Receiving Environment		0.75 - 1.00	

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(1:9500 meters)
 DATUM GDA 2020, PROJECTION MGA ZONE 56

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Figure 5-9 Post-modification peak flood depth for 1% AEP event with 2100 climate change

5.2.5 Assessment against Georges River Catchment Flow Objectives

An assessment of potential impacts of the proposed modification to the Georges River catchment RFOs is presented in Table 5-8. In summary, there are not expected to be any impacts associated with the operation of the proposed modification to catchment flow objectives.

Table 5-8 Assessment of potential impacts to River Flow Objectives for estuaries within the Georges River Catchment (DECCW, 2006c).

Objective	Assessment of proposed modification related impacts
<p>Protect pools in dry times: Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flow.</p>	<p>The proposed modification would not alter the existing outlets from any nearby natural waterbodies, such as Marton Park Wetland and the natural retention basin located south of the Site. The existing permanent pools within these natural waterbodies would remain unchanged as a result of the proposed modification.</p>
<p>Protect natural low flows: Protect natural low flows.</p>	<p>The proposed surface water management strategies detailed herein would maintain pre-modification peak discharge rates from the Site following construction of the proposed modification during all storm events up to and including the 1% AEP event.</p> <p>The proposed modification would not alter the area that currently drains directly to natural retention basin located at the southern end of the Site, so as not to cut-off any frequent low flows.</p> <p>There would also be no proposed modification works that could potentially block any natural flows coming from the Kamay Botany Bay National Park, moving through and around the Site, towards downstream surface water receptors.</p> <p>Surface water flows entering downstream surface water receptors would therefore remain relatively unchanged under post-modification conditions.</p>
<p>Maintain wetland and floodplain inundation: Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems.</p>	<p>As discussed further in Section 5.2.4, the operational phase of the proposed modification is not expected to alter existing flooding conditions on and offsite.</p> <p>Maintaining existing surface levels across the Site would avoid any alteration to existing onsite flooding conditions, while maintaining pre-modification discharge rates from the Site would prevent any alteration to existing offsite flooding conditions.</p>
<p>Maintain natural flow variability: Maintain or mimic natural flow variability in all streams.</p>	<p>As per the measures to ‘protect natural low flows’, the proposed modification would:</p> <ul style="list-style-type: none"> • Include surface water measures, such as OSD systems, to maintain pre-modification peak discharge rates • Maintain the surface water catchment area draining directly to the southern natural retention basin • Avoid the inclusion of any works that could potentially block or obstruct natural flows moving through and around the Site. <p>These measures would help to maintain existing, pre-modification, flow patterns towards downstream surface water receptors.</p>
<p>Minimise effects of weirs and other structures: Minimise the impact of instream structures.</p>	<p>Not applicable – no new instream structures proposed as part of the Modification.</p>

5.3 Cumulative impacts

Cumulative impacts have the potential to occur when benefits or impacts from a project overlap or interact with those of other projects, potentially resulting in a larger overall effect (positive or negative) on the environment or local communities. Cumulative impacts may occur when projects are constructed or operated concurrently or consecutively.

Projects were reviewed against the following screening criteria for this cumulative impact assessment:

- Spatially relevant (i.e., the development or activity overlaps with, is adjacent to or within two kilometres of the proposed modification)
- Scale (i.e., large-scale major development or infrastructure projects that have the potential to result in cumulative impacts with the proposed modification, as listed on the NSW Government Major Projects website and on the relevant council websites)
- Timing (i.e., the expected timing of its construction and/or operation overlaps or occurs consecutively to construction and/or operation of the proposed modification)
- Status (i.e., projects in development with sufficient publicly available information to inform this environmental impact statement and with an adequate level of detail to assess the potential cumulative impacts).

The following offsite projects were considered to have met the above criteria, with the potential to have cumulative impacts with the proposed modification:

- Kamay Ferry Wharves (350 m north of the Project Area)
- Breen Resource Recovery Facility (2 km west of the Project Area)
- Woollooware to Kurnell Tower Replacement Project (120 m south west of the Project Area)
- Kurnell Planning Proposal (800 m south west of the Project Area).

The locations of the projects are shown on Figure 5-10.

Since lodgement of the Modification Report, one project, Kurnell Stormwater Separation Improvement Project, has finished construction and has been removed from the cumulative impact assessment. Cumulative noise impacts were identified for this project, and therefore the combined impacts have been addressed as part of the baseline assessment of this Updated Surface Water, Wastewater, and Flooding Report.

Kamay Ferry Wharves has also completed construction. However, as ferry services have not yet commenced, the project continues to be included in the operational cumulative impact assessment.



- Legend
- Site
 - Ampol Land Ownership
 - Project Area
 - Watercourse
 - Breen Resource Recovery Facility
 - Kamay Ferry Wharves
 - Kurnell Planning Proposal
 - Kurnell Tower Replacement Project



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Figure 5-10 Cumulative development projects

The potential for cumulative impacts has been described in Table 5-9.

Table 5-9 Cumulative development projects

Project	Location	Status/ timing compared to the proposed modification	Potential cumulative impact
Breen Resource Recovery Facility	2 km west	The project is currently under assessment. Construction overlaps with the proposed modification: The project construction is expected to continue until 2028.	Potential for increased sediment/ contaminant load and flows to common surface water receiving environment (Quibray Bay) during construction.
Kamay Ferry Wharves	350 m north, on the coastline of Botany Bay	Project completed in February 2025.	Potential for increased sediment/ contaminant load and flows to common surface water receiving environment (Botany Bay) during construction.
Kurnell Planning Proposal	800 m south west	The project is pending approval. Construction will commence immediately upon approval and would be progressively delivered over approximately 20 years.	Potential for increased sediment/ contaminant load and flows to common surface water receiving environment (Quibray Bay) during construction and operation.
Woolooware to Kurnell Tower Replacement Project	120 m south west	The project is approved. Construction due to be complete prior to commencement of proposed modification construction period.	Potential for increased sediment/ contaminant load and flows to common surface water receiving environment (Quibray Bay) during construction.

The projects listed in Table 5-9 and the proposed modification would wholly or partly discharge stormwater to Quibray Bay, with the exception of the Kamay Ferry Wharves which would discharge directly to Botany Bay. Without appropriate controls, the combined discharge from these projects entering Quibray Bay could potentially exacerbate poor surface water quality and increases in flow rates and volumes, which could continually degrade the natural integrity and health of these bays and surrounding environments, including the Towra Point Nature Reserve (Ramsar site) and Towra Point Aquatic Reserve.

The risk of poor-quality discharge and the uncontrolled release of polluted waters entering Quibray Bay would be highest during the construction phase of these projects, when soils are exposed/ disturbed, chemicals and other harmful substances are stored onsite, and permanent surface water measures are yet to be established. There is an even greater risk of this occurring and having a more harmful effect on the environment during the potential overlap of construction works across these projects.

The projects identified in Table 5-9 would be subject to stringent surface water management measures and monitoring throughout their construction periods in order to mitigate risks to receiving environments and maintain compliance with environmental protection standards. Given this, and the negligible changes to water quality and quantity associated with the proposed modification, cumulative impacts for surface water are not anticipated.

While the projects would discharge to Quibray Bay, their discharge flows would approach these bays via separate flow paths. It is therefore not likely that existing drainage paths would be overloaded due to a combined increase in flow from all of these projects because their discharge flows would not merge prior to reaching the Quibray Bay. Similarly, existing flooding conditions across the Site and nearby township are not likely to be adversely impacted by the other external projects as their discharge flows would have a separate and safe flow path towards Quibray Bay.

6.0 Management of impacts

Mitigation measures to manage potential surface water, wastewater and flooding impacts of the proposed modification are outlined in Table 6-1. Additional and/ or modified environmental safeguards and management measures to those presented in the approved SSD-5544 are shown in **bold**. Deleted measures, or parts of measures, have been ~~struck out~~. Where approved measures have been consolidated to reduce duplication, previously agreed text that has been brought into existing or new measures has been underlined.

Table 6-1 Management and mitigation measures for surface water, wastewater and flooding

ID	Issue	Mitigation/ management measure
F1	Soil and water management	<p>The Construction Environmental Management Plan (CEMP) for the Project proposed modification would include a Soil and Erosion and Water Soil and Water Management Plan (SaWMP). This plan would include the following measures:</p> <ul style="list-style-type: none"> • All materials would be stockpiled in accordance with 'The Blue Book' Managing Urban Stormwater – Soils and Construction Volume 1 and 2 (Landcom, 2004) • Sediment and erosion controls would be installed and operated in accordance with <i>The Blue Book' Managing Urban Stormwater – Soils and Construction Volume 1 and 2 (Landcom, 2004)</i> • Silt fences would be installed around stockpiles to reduce erosion and the movement of suspended solids as necessary • Soil stockpiles and any polluted materials would be stored in designated areas which are not in close proximity to any stormwater drainage systems • Erosion control structures, bunded areas, containment areas, drainage lines and interception measures would be subject to regular inspection • Clean materials would be separated from contaminated materials • Soil erosion and sedimentation devices would remain in place until the disturbed ground surface is restored. These devices would also capture any gross pollutants.
F2	Soil and water management	<p>A Soils and Water Management Plan (SaWMP) would include be developed as a sub-plan to the DEMP CEMP. M measures to be included in the plan and implemented during the demolition construction works to protect stormwater quality would including e:</p> <ul style="list-style-type: none"> • Stormwater or groundwater ponded in excavations would be sent to the WWTP, unless it is tested and is of suitable quality to be directed to stormwater • Stormwater that is captured in the bunds around the contaminated soil stockpiles would be collected and sent to the WWTP • Silt fencing and/or alternate sediment control measures would be installed around soil stockpiles and disturbed areas or areas where dust suppression is being undertaken • Regular inspection would be undertaken of soil stockpiles/ and excavation areas, including following rainfall events • Regular inspection of excavation areas and containment cell area, including following rainfall events • Regular inspections would be undertaken of stormwater drains down hydraulic gradient of disturbed areas • Stormwater management measures incorporated into the design of the containment cell would be regularly inspected during operation in line

ID	Issue	Mitigation/ management measure
		<p>with the Site's existing Inspection Checklist and following heavy rain events;</p> <ul style="list-style-type: none"> • If stormwater quality is impacted during the demolition works and ACS Modification works in areas that have been disturbed, water would be diverted to the intermediate sewer system; and • During the demolition works and ACS Modification works, following notable but prolonged rainfall events (over three days) or following heavy rainfall events over a shorter timescale, water sampling would be completed at the stormwater retention basin to ensure that the quality of the water is of an appropriate standard to be discharged from the Site. Water that is not of an appropriate quality would be either treated in situ or directed to the WWTP.
F4	Discharge	Discharges from the Wastewater Treatment Plant would be within existing EPL limits during demolition, construction and operation. Any required change to this Oily Water Management System would be discussed and agreed with NSW EPA.
F5	Spills	The measures and processes currently in place at the Site to prevent any loss of contaminant would be maintained throughout the demolition, construction and operation phases of the terminal (as modified) and during the delivery of the Project proposed modification . <u>This includes appropriate measures to be implemented in the event of a spill, including initial response and containment, notification of emergency services and relevant authorities (as relevant)</u> . All bunds on tanks which are retained in service would meet the capacity requirements of <i>Australian Standard AS1940</i> during the operation of the Project terminal (as modified) .
F8	Surface water management	<p>The following measures would be employed during and following the demolition remediation of the refinery process units and associated infrastructure land within Zones 2 and 3 (see Figure 1-1 of the MOD-7 Modification Report):</p> <ul style="list-style-type: none"> • Appropriate bunding and controls would be put in place to prevent stormwater runoff from the demolition works area contaminated soils entering the stormwater system. • Activities associated with the proposed modification would not significantly alter existing landform or finished surface levels across the Site, with the exception of RPIP Mountain and Source Area 5, nor would these alter the existing surface finishes (in terms of imperviousness). Following the completion of the demolition works and removal of redundant infrastructure, the former refinery process area would be regraded. The regrading would aim to ensure that water does not pool in this area. construction, the landform would be returned to grade (except RPIP Mountain and Source Excavation Area 5), thereby retaining surface levels across the Site. Reinstated surface finishes would be no less impervious than the current scenario. • RPIP Mountain would be graded to allow water to drain, prevent water pooling in the centre of the mound, and prevent slope instability. • As part of the regrading works, the Surface material in this area would meet the commercial/ industrial use criteria as defined by Schedule B4 Guidelines, <i>Investigation Levels for Soil and Groundwater, National Environment Protection Measure (Assessment of Site Contamination) Amendment Measure 2013</i>. A crushed aggregate made from clean concrete and asphalt from the demolition works would also be spread across the surface to help reduce soil erosion. Surface treatments,

ID	Issue	Mitigation/ management measure
		<p>such as grassing hydromulch, would be provided to help mitigate soil erosion.</p> <p>Stormwater runoff collected in the stormwater system would be subject to the controls within this system (such as the oily water separators) prior to being discharged.</p>
F9	Soil erosion and sedimentation	<p>All excavations of the pipeways would be staged, effectively minimising the area of disturbance at one time. The ACS Modification MOD-7 works would be undertaken in a manner to minimise the potential for soil erosion and sedimentation.</p>
F10	Surface water management	<p>Local weather patterns would be monitored to confirm ensure confirm ensure that workers completing the ACS Modification construction works at the Site were aware of predicted heavy rainfalls so that work could be stopped in the pipeways and other flood-prone areas prior to them containing surface water flows.</p>
F12	Offsite flood risk	<p>Works required for the proposed modification would not remove existing bunding currently used in the OWS (with the exception of Source Area Excavation 5) and would not result in an increased offsite flood risk.</p>
F13	Discharge rates	<p>Post-MOD-7 peak discharge rates from the Site would not exceed pre-modification discharge rates in all events up to and including the 1% AEP design storm event.</p>
F14	Stormwater quality monitoring	<p>Stormwater quality monitoring would be carried out pre-construction to establish a baseline, as well as short-term post-construction to confirm the efficacy of stormwater treatment measures.</p> <p>This water quality monitoring would be undertaken in accordance with the Blue Book (Landcom, 2004) and ANZG (2018) guidelines.</p> <p>The stormwater quality monitoring regime would be detailed in the SaWMP and would include a reactive management approach whereby actions are taken to avoid impacts prior to significant impacts occurring.</p> <p>In the event of non-compliance, corrective and preventative actions would be identified.</p>
F15	Protection of existing infrastructure	<p>The existing OWS network would be protected and inspected during construction works, to avoid damaging or blocking this existing infrastructure and the WWTP.</p>

7.0 Conclusion

This Updated Surface Water, Wastewater and Flooding Report has reviewed the proposed modification and identified the potential surface water, wastewater, and flooding impacts. Specifically, this report has been prepared to mitigate the potential impacts of the construction and operation of the proposed modification on the receiving environment, and to identify appropriate safeguards and management measures to address the impacts identified.

The following design measures would be implemented for the proposed modification:

- With the exception of the area colloquially known as Refining Process Improvement Project (RPIP) Mountain and Source Area Excavation 5, activities associated with the proposed modification would not alter existing landform or finished surface levels across the Site, nor would these alter the existing surface finishes. With the exception of Source Excavation Area 5, existing bunding around former bunded OWS areas would remain, thereby retaining surface water storage across the Site. The bunding at Source Area Excavation 5 would be removed to allow remediation activities to occur; this area does not currently retain large amounts of water and its removal would result in a negligible change in surface flows. Excavations required as part of the proposed modification would be reinstated to existing finished surface levels, with the exception of RPIP Mountain, which would be regraded.
- Existing surface finishes (in terms of imperviousness) would also not be altered. Excavations would be reinstated surface finish would be no less impervious than the current scenario. The surface of RPIP Mountain would be hydromulched (or fixed using another appropriate method) to help prevent surface water flows from this land being impacted by sediment following the works.
- Surface water runoff from the existing bunded OWS areas in Catchments B and F, where removal of OWS lines is proposed, would be redirected to the existing SWS in Catchment B via low-flow outlet pipes. These outlet pipes would slowly release surface water runoff that accumulates within these bunded areas, utilising existing SWS in Catchment B. The slow release of flows would utilise existing storage within these bunded areas to minimise peak flows to the existing drainage infrastructure within Catchment B. The diversion of flows to Catchment B would also prevent any alteration in flows entering the southern natural retention basin and protected coastal wetland. If required, operational controls would be used to manage flow volumes from the bunded areas.
- The increase in surface water flow coming from Catchment B, as a result of the proposed low-flow outlet pipes from existing bunded OWS areas, would be managed by existing surface water detention and retention systems across Catchment B. These existing detention/ retention systems would have sufficient capacity to contain this additional inflow, whilst still maintaining pre-modification discharge rates to Quibray Bay in all storm events up to and including the 1% AEP event.
- Two separate OSD systems are proposed in Catchment E to maintain existing, pre-modification discharge rates entering the existing roadside channel along Sir Joseph Banks Drive in all storm events up to and including the 1% AEP event. This would also maintain existing peak discharge rates entering the downstream Towra Point Nature Reserve (Ramsar site) and Quibray Bay. The former CLOR pipeways would be utilised for stormwater detention at the north western corner of Catchment E and additional OSD storage would be included within the existing open channel that runs along the western side of RPIP Mountain, at the south eastern corner of Catchment E.
- Sediment loads in stormwater during the operational phase of the proposed modification are expected to be low given there would be minor changes to the landform (at RPIP Mountain only), surface levels (at Source Area Excavation 5 only), and surface finishes. However in order to further protect sensitive receiving environments permanent sediment control measures are proposed to be installed within or at the downstream end of the two proposed OSD systems. This is in addition to the existing water quality treatment measures in place, which would be retained through both the construction and operational phase. The combination of water quality treatment measures would mitigate potential water quality impacts on downstream sensitive receptors.

Recommended safeguards and management measures for the construction phase, such as temporary sediment and erosion controls, flow diversion measures, and stockpile locations, would be captured in the CEMP and its supporting SaWMP. These plans would detail the design, installation, and operation of temporary controls required during the construction phase. Area specific ESCPs would be developed for specific work packages as needed.

Several measures have been recommended to mitigate and/or eliminate potential impacts related to surface water, wastewater, water quality and flooding; alternative approaches may also be considered during the detailed design phase. Any such alternative measure would align with applicable legislation, policies, and guidelines, while maintaining the water quality and river flow objectives for the Georges River catchment (as presented in Section 3.7).

To verify the effectiveness of these mitigation measures, short-term monitoring would be conducted following site stabilisation. This monitoring would confirm that expected environmental outcomes are achieved, while also allowing for adaptive management strategies where necessary.

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Glossary and abbreviations

Term	Description
ACS	Asbestos Contaminated Soil
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guidelines
API	American Petroleum Institute
ARI	Average Recurrence Interval
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ARR	Australian Rainfall and Runoff
ASS	Acid Sulfate Soils
BBWQIP	Botany Bay Water Quality Improvement Program
(the) Blue Book	Managing Urban Stormwater: Soils and Construction (Landcom, 2004)
BOD	Biochemical Oxygen Demand
BoM	Bureau of Meteorology
CBD	Central Business District
CEMP	Construction Environmental Management Plan
CLM Act	<i>Contaminated Land Management Act 1997</i>
CLOR	Caltex Lubricating Oil Refinery
Council	Sutherland Shire Council
CM Act	<i>Coastal Management Act 2016</i>
COB	Central Operations Buildings
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DECCW	Department of Environment, Climate Change and Water (now DCCEEW)
DCP	Development Control Plan
DEM	Digital Elevation Model
DPI	Department of Primary Industries
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EPA&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EPL	Environment Protection Licence
ESCP	Erosion and Sediment Control Plan
GDE	Groundwater dependent ecosystem

Term	Description
HAT	Highest Astronomical Tide
IAF	Induced Air Flotation
IPCC	International Panel of Climate Change
LEP	Local Environmental Plan
LGA	Local Government Area
MNES	Matter of National Environmental Significance
MPN	Most Probable Number
NHL	National Heritage List
NWQMS	National Water Quality Management Strategy
OWS	Oily Water Sewer
PMF	Probable Maximum Flood
POEO Act	<i>Protection of the Environment Operations Act 1997</i>
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSD	State Significant Development
SSIP	Stormwater Separation Improvement Project
SWaMP	Strategic Water Monitoring Plan
SWMP	Soil and Water Management Plan
SWS	Surface Water System
TSS	Total Suspended Solids
WM Act	<i>Water Management Act 2000</i>
WQO	Water Quality Objective
WSUD	Water Sensitive Urban Design
WWTP	Wastewater treatment plant

Annexure A

Stormwater Modelling Report

Kurnell Terminal SSD-5544 MOD-7

Annexure A - Stormwater Modelling Report

30 Jan 2026

Kurnell Terminal SSD-5544 MOD-7

Annexure A - Stormwater Modelling Report

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Abbreviations

Abbreviation	Expansion
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARR	Australian Rainfall and Runoff
BoM	Bureau of Meteorology
CLOR	Caltex Lubricating Oil Refinery
Council	Sutherland Shire Council
DCP	Development Control Plan
DEM	Digital Elevation Model
EWL	Environment Protection Licence
FWS	Firewater System
ICSM	Intergovernmental Committee on Surveying and Mapping
IPCC	Intergovernmental Panel on Climate Change
MHL	Manly Hydraulics Laboratory
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
OWS	Oily Water Sewer
RPIP Mountain	Refining Process Improvement Project Mountain
SLR	Sea Level Rise
SSD	State Significant Development
SSIP	Stormwater Separation Improvement Project
SSP	Shared Socio-economic Pathway
SWS	Stormwater System
WWTP	Wastewater Treatment Plant

1.0 Introduction

1.1 Background

The Kurnell Terminal (the Site) is located on the southern side of Botany Bay, in Kurnell, New South Wales (NSW). In 2012, Ampol Refineries (NSW) Pty Ltd (Ampol) decided that the oil refinery and fuel terminal would be converted to a finished product terminal (the approved project), ceasing refinery operations in 2014.

Development consent was received to complete the approved project under State Significant Development (SSD) application reference 5544 (SSD-5544). Ampol has modified SSD-5544 six times to facilitate the conversion and demolition works.

Ampol intends to consolidate operational infrastructure, remove redundant assets, and undertake remediation. Completion of these works (the proposed modification, MOD-7) would continue the viable, safe, reliable, and sustainable operation of the Kurnell Terminal. The location within the Site that these works would occur is referred to as the 'Project Area'.

This Stormwater Modelling Report has been prepared in support of the Updated Stormwater, Wastewater and Flooding Report (Appendix G of the Submissions Report). Hydrologic and hydraulic modelling has been undertaken as part of this assessment to analyse the stormwater changes resulting from the proposed modification and to develop an appropriate stormwater management strategy for the modified areas.

The assessment only focuses on the requirements for stormwater flows moving through and discharging from the Site. It does not assess all stormwater requirements stipulated in the applicable legislation, policies and guidelines – all other stormwater requirements have been addressed in the overarching technical review (Appendix G of the Submissions Report).

1.2 Stormwater requirements

The Site is located near and discharges to several stormwater receptors that support a range of environmental values and sensitivities, including areas of ecological value. These stormwater receptors are shown on Figure 1-1 and include:

- Botany Bay
- Quibray Bay
- Towra Point Nature Reserve (including the Ramsar-listed wetland)
- Towra Point Aquatic Reserve
- Coastal wetlands
- Coastal zone
- Marton Park Wetland
- Kamay Botany Bay National Park.

Site discharge would also be conveyed towards these receptors via a series of stormwater drainage systems that pass through and/or service other residential, commercial and industrial properties, including those within the suburb of Kurnell and the Sydney Desalination Plant located on the western side of Sir Joseph Banks Drive.

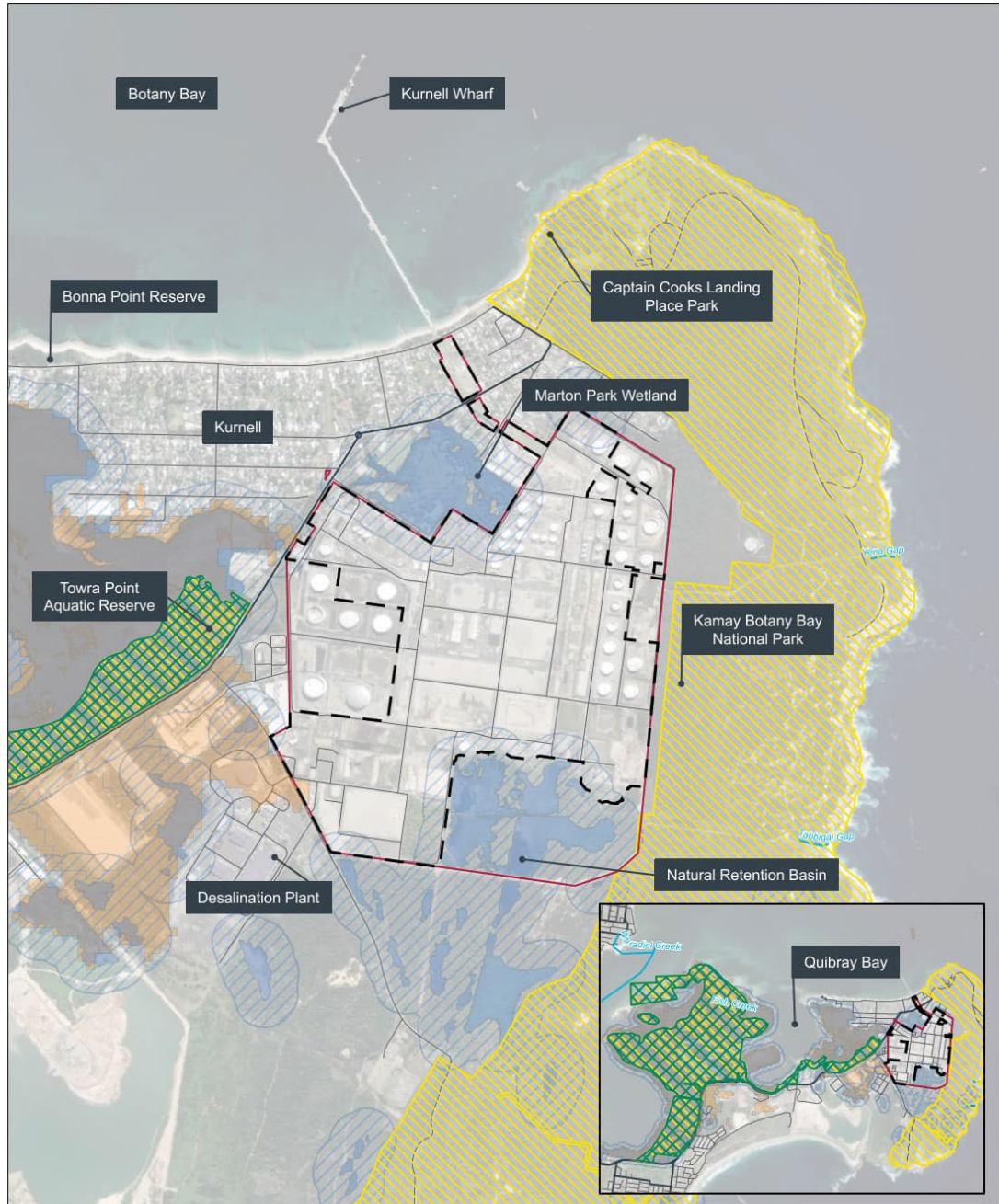
The primary objective for stormwater management at the Site is to ensure that the proposed modification does not have adverse stormwater impacts at any off-site locations – i.e., to not adversely impact these existing downstream, sensitive stormwater receptors and to not adversely impact existing stormwater conditions for properties draining to the same downstream stormwater systems.

In order to achieve this objective, it is required that the proposed modification ensures that peak stormwater discharge rates leaving the Site under post-modification conditions do not exceed existing (pre-modification) peak discharge rates in all storm events up to and including the 1% annual exceedance probability (AEP) event. This requirement is consistent with Clause 1.3 of the Sutherland Shire Council Development Control Plan (DCP) for Stormwater and Groundwater Management (Sutherland Shire Council, 2015).

This requirement and hence the objective of this assessment only addresses stormwater flows moving through and discharging from the Site. It does not assess all stormwater requirements stipulated in the applicable legislation, policies and guidelines – all other stormwater requirements have been addressed in the overarching Updated Stormwater, Wastewater and Flooding Report.

1.3 Purpose of this report

The purpose of this report is to assess the proposed modification against the stormwater requirements outlined in Section 1.2. This assessment summarises how the proposed modification will alter existing stormwater management across the Site, identifies any potential impacts on stormwater flows, and develops a proposed stormwater management strategy to minimise any off-site impacts.



Legend

- | | | |
|--------------|--------------|-------------------------------------|
| Site | Primary Road | Coastal Wetlands |
| Project Area | Local Road | Proximity Area for Coastal Wetlands |
| | Watercourse | Ramsar Wetlands |
| | | Protected Areas |
| | | Wetlands NSW |

Sources:

- Coastal Wetlands: Department of Planning, Housing and Infrastructure
- Ramsar wetlands: Department of Climate Change, Energy the Environment and Water
- Protected Areas: Department of Climate Change, Energy the Environment and Water
- NSW Wetlands: NSW Government Central Resource for Sharing and Enabling Environmental Data in NSW (SEED)



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Source: Neatmap, 2022, and State Government of NSW and NSW Department of Planning, Housing and Infrastructure 2022.

Figure 1-1 Stormwater receptors

2.0 Stormwater alterations

2.1 Pre-modification conditions

Existing stormwater management across the Site is split into two separate systems: a stormwater system (SWS) and an oily water sewer (OWS).

The SWS collects stormwater runoff from areas that have a designated low risk potential for interaction with petroleum products, such as from roadways, hardstand areas, roof areas, and undeveloped/vacant land. Some external flows from the Kamay Botany Bay National Park also enter the Site and the SWS via the eastern boundary. Stormwater runoff conveyed by the SWS is considered relatively 'clean' in comparison to oily waters at the Site. The SWS directs flow towards on-site stormwater treatment systems before discharging off-site and to the stormwater receptors listed in Section 1.2.

The OWS collects and contains wastewater from previous refinery process areas and any stormwater runoff that may be impacted by petroleum products. This includes stormwater runoff from many of the bunded storage areas across the Site. The OWS directs water to the on-site wastewater treatment plant (WWTP) for treatment before discharging to the Tasman Sea via the Yena Gap under the conditions of an existing Environment Protection Licence (EPL-837).

This assessment primarily focuses on the SWS and how the proposed modification works would potentially impact discharge from the SWS and to the receiving environment. For the purposes of this assessment, it has been assumed that the SWS and OWS operate independently and that there is no interaction between the two systems – i.e., water within the OWS does not transfer or overflow to the SWS and vice versa.

2.1.1 Catchments

The SWS drains to six main discharge points and is therefore split into six catchments. These catchments and their discharge points are shown on Figure 2-1 and are summarised in Table 2-1.

Table 2-1 Sitewide stormwater catchments

Catchment	Area (ha)	Discharge point	Description
A	67	Botany Bay	Eastern and northern area of the Site which discharges directly to Botany Bay via a single piped outlet (A1).
B ¹	70	Quibray Bay	Central portion of the Site which drains to an on-site stormwater retention basin prior to discharging to an open channel on the northern side of Captain Cook Drive at outlet B1. This open channel then directly connects to Quibray Bay.
C	6	Marton Park Wetland	Northern corner of the Site which discharges directly to the Marton Park Wetland via six separate drainage outlets (C1-C6). The Marton Park Wetland eventually discharges further downstream, towards Quibray Bay.
E	26	Sir Joseph Banks Drive	South-western corner of the Site that discharges to an existing open channel along the western side of Sir Joseph Banks Drive via four separate drainage outlets (E1-E4). This open channel drains in a northerly direction, towards Quibray Bay.
F	108	Natural Retention Basin	South-eastern corner of the Site, which predominately comprises relatively undeveloped land including a large portion of the Kamay Botany Bay National Park. This catchment drains to a natural retention basin located at the southern end of the Site. When this retention basin spills, it overflows to an existing open channel along the southern boundary of the Site at outlet F1, which then connects to Sir Joseph Banks Drive.

Catchment	Area (ha)	Discharge point	Description
G	19	Council-owned drains	North-eastern undeveloped area mostly outside of the Site boundary, which is part of the Kamay Botany Bay National Park. This area drains along the northern side of the Site via the Catchment G drain, towards a natural depression storage area at the north-eastern corner of the Site. This storage eventually spills to a Council-owned drainage system that connects to the Marton Park Wetland.

Notes: 1 – The formerly designated Catchment D is no longer a separate catchment and is now part of Catchment B.

Stormwater flows at all of these discharge locations eventually travel downstream and towards Quibray Bay via a series of pipes, open channels and stormwater basins/ wetlands. The only discharge point that bypasses Quibray Bay is the direct outlet to Botany Bay.

Figure 2-1 also shows the locations where stormwater inflows from the upstream Kamay Botany Bay National Park enter the Site along the eastern boundary. These external flows contribute to the total amount of flow moving through the Site and discharging to the six main discharge points.

2.1.2 Drainage system

The existing SWS drainage network within each catchment is shown in more detail on Figure 2-2. The bunded areas serviced by the existing OWS network and therefore not contributing to flow within the SWS are shown as hatched areas.

The sitewide SWS drainage system comprises a network of pits and pipes, open channels, pumps, stormwater detention and/or retention storage systems.

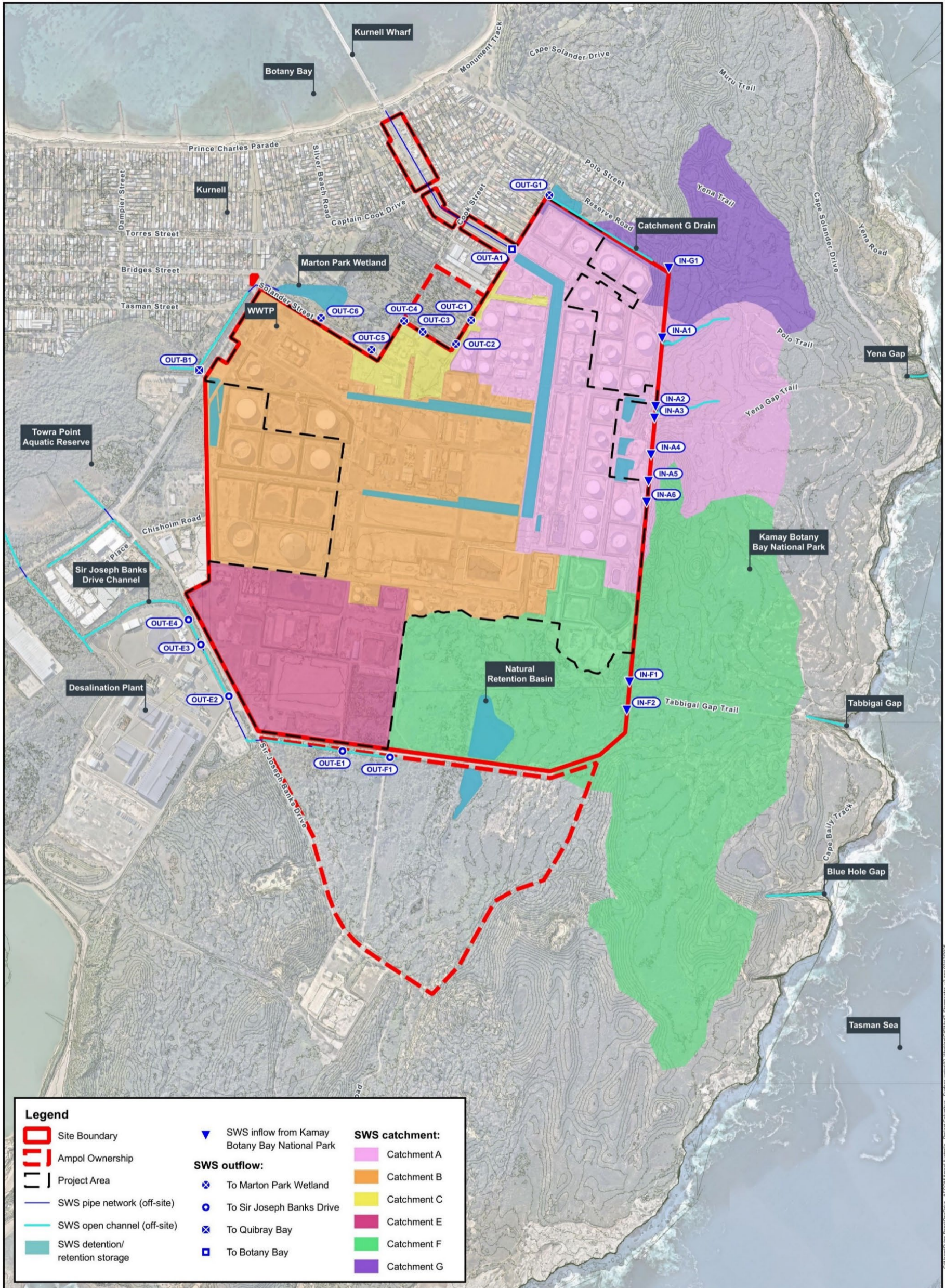
The two largest catchments (A and B) both have stormwater detention and/or retention systems in place to control the rate of discharge leaving the Site. There are three former services pipeways – the Main Pipeway, Pipeway A, and Pipeway B – that function as stormwater detention systems. Pipeways A and B are located within Catchment B, while the Main Pipeway is within Catchment A. These pipeways each discharge via stormwater pumps that direct discharge flows towards the nearest gravity draining stormwater network.

Catchment A includes another large stormwater retention basin at the western boundary of the Site prior to discharging to Quibray Bay. This basin consists of three connected storages: B1A, B1B and B1C.

Catchment B has some additional stormwater detention systems along the eastern boundary of the Site to capture and attenuate external flows coming from the Kamay Botany Bay National Park. These basins help to slow down external flows before allowing them to drain via the internal SWS.

There is a large natural retention basin at the southern end of the Site that captures flows coming from a large portion of the Kamay Botany Bay National Park, in addition to a small south-eastern section of the Site within Catchment F. This large retention system would eventually spill west, towards an existing southern open channel that drains to Sir Joseph Banks Drive.

To help manage stormwater flows during extreme weather events, the existing SWS also includes three recently installed pump stations at Pit A, Pit B and another connecting to the existing retention basin B1A. These three pump stations were installed as part of the Kurnell Stormwater Separation Improvement Project (SSIP) to divert large floodwaters away from the SWS and stormwater discharge points (AECOM, 2023). These diverted flows are directed towards existing and vacant bunded areas that are able to contain a large volume of stormwater and slowly release this water to the OWS network that undergoes treatment at the on-site WWTP prior to discharging off-site via the Yena Gap. The purpose of this diversion is to prevent extreme floodwaters from overloading the existing SWS and spilling to the OWS network.

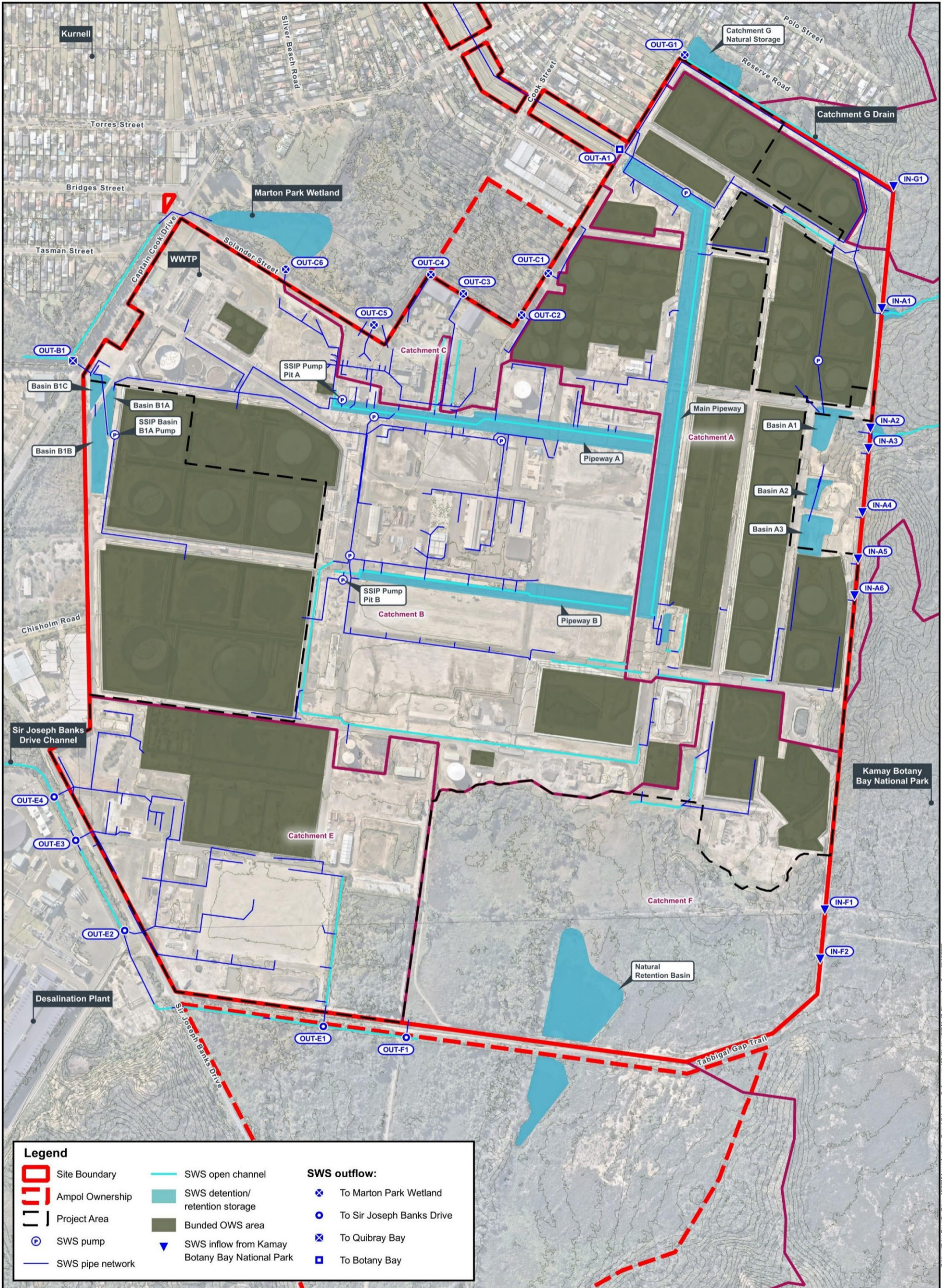


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FIGURE 2-1
STORMWATER CATCHMENT PLAN



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 Source: AECOM, 2024.

Figure 2-1 Stormwater catchment plan



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FIGURE 2-2
EXISTING STORMWATER DRAINAGE SYSTEM



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 Source: Neemap, 2024.

Figure 2-2 Existing stormwater drainage system

2.2 Post-modification conditions

Proposed modification works detailed in the Updated Stormwater, Wastewater and Flooding Report would be spread across all catchments except for Catchment G. However, the only proposed works that are likely to have a noticeable difference on stormwater management across the Site are located within Catchments B, E and F.

Removal of existing OWS networks within Catchments B, E and F would cut-off drainage for the areas that are currently connected to these existing OWS networks. It is proposed that these existing OWS areas would drain to the existing SWS under post-modification conditions. This would increase the total area contributing to stormwater runoff that enters the SWS and discharges off-site via the SWS.

The existing OWS areas being redirected to the SWS are shown on Figure 2-3 and Figure 2-4. The changes in impervious area percentages within each stormwater catchment are shown on Figure 2-5 and Figure 2-6. These changes are also presented in Table 2-2.

Table 2-2 Catchment and impervious area alterations

Catchment	Discharge point	Existing catchment area (ha)	Increase in:		
			Catchment area (ha)	Impervious area (ha)	Pervious area (ha)
A	Botany Bay	67	0.0	0.0	0.0
B	Quibray Bay	70	2.0	1.4	0.6
C	Marton Park Wetland	6	0.0	0.0	0.0
E	Sir Joseph Banks Drive	26	6.0	3.3	2.7
F	Natural Retention Basin	108	4.2	2.9	1.3
G	Council-owned drains	19	0.0	0.0	0.0
Total	-	296	12.2	7.6	4.6

The proposed modification would increase the SWS catchment area by 12.2 ha. Of this 12.2 ha increase, the largest changes occur within Catchments E and F, which drain to Sir Joseph Banks Drive and the Natural Retention Basin, respectively.

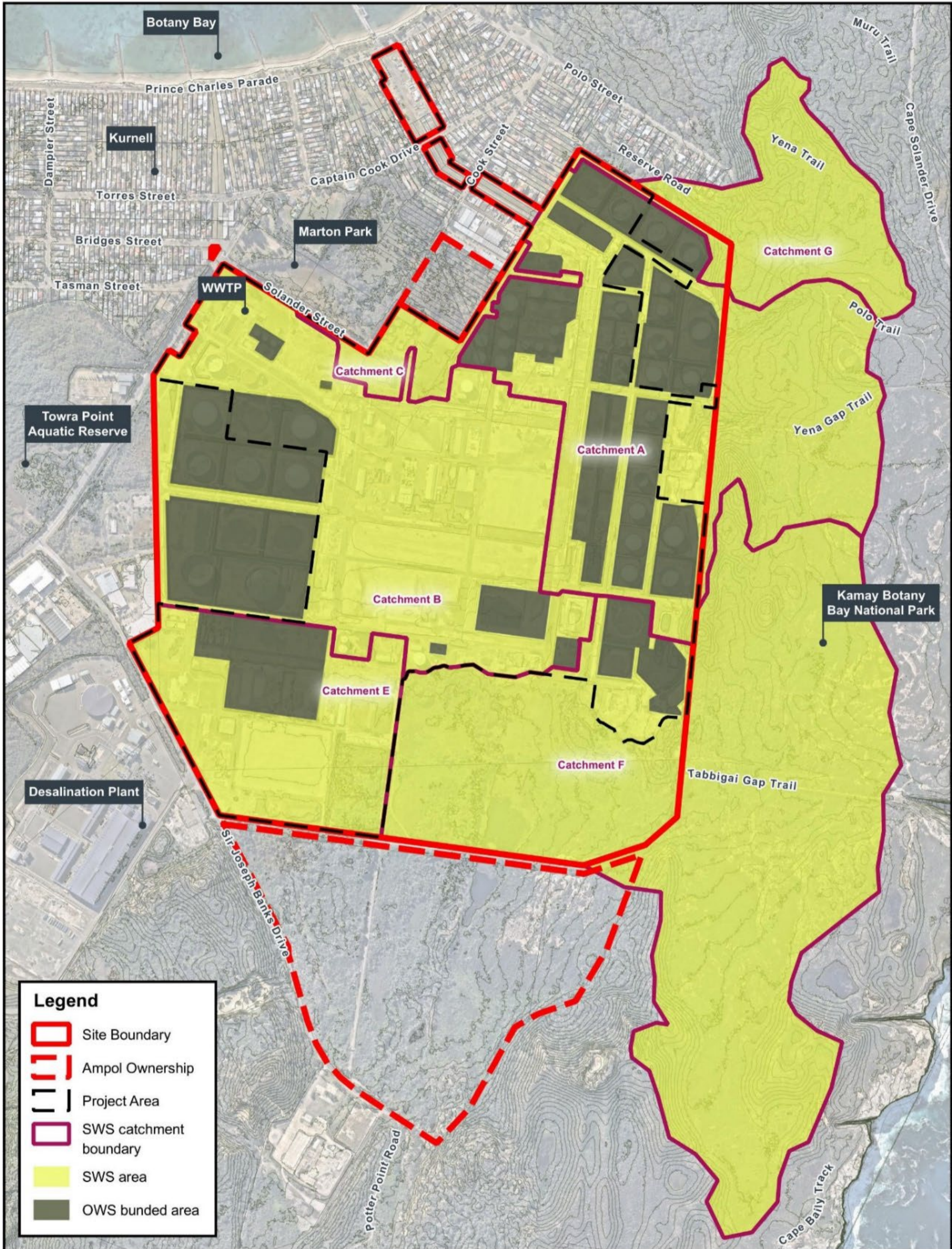
The proposed modification would maintain the existing landform and surface levels at the Site, with the exception of RPIP Mountain and Source Area Excavation 5. Existing bunds would be retained under post-modification conditions, with the exception of the Source Area Excavation 5. Some of the areas that currently drain to redundant (or proposed to be removed) OWS networks are bunded areas – i.e., bunded areas located at the south-eastern corner of the Site, within Catchments B and F. Removal of the OWS network within these bunded areas would cause stormwater runoff to accumulate and pool within the confines of these existing bunds. Stormwater runoff from these bunded areas would only contribute to flows within the sitewide SWS if these bunded areas were to spill and overflow to the surrounding SWS network.

The bunding at Source Area Excavation 5 would be removed to allow remediation activities to occur; this area does not currently retain large amounts of water and its removal would result in a negligible change in surface flows (refer to Annexure B of the Surface Water, Wastewater, and Flooding Report).

At RPIP Mountain, vegetation would be removed and asbestos contaminated soil (ACS) removed to a depth of 1 m below existing ground levels to target asbestos at the root zone of vegetation growing at the current ground surface. For larger tree roots, there is potential for excavation to a depth of 4 mbgl. Following excavation, RPIP Mountain would be graded to allow water to drain, prevent water pooling in the centre of the mound, and prevent slope instability. Once regraded, surface levels would not be below existing surrounding ground levels.

Activities would not alter the existing surface finishes (in terms of imperviousness). It has therefore been assumed that the impervious area currently present in each of these catchments would be maintained. Estimation of these impervious areas was based on the latest (2025) aerial imagery from Nearmap.

While RPIP Mountain would remain entirely pervious following removal of vegetation and application of hydromulch, the change in surface roughness would reduce the time it takes for rainfall to convert to runoff and spread across the area. This could potentially lead to an increase in peak discharge rates from this area, and higher discharge rates entering the downstream drainage system along Sir Joseph Banks Drive.



KURNELL TERMINAL SSD-5544 MOD-7
FIGURE 2-3
PRE-MODIFICATION STORMWATER AREAS



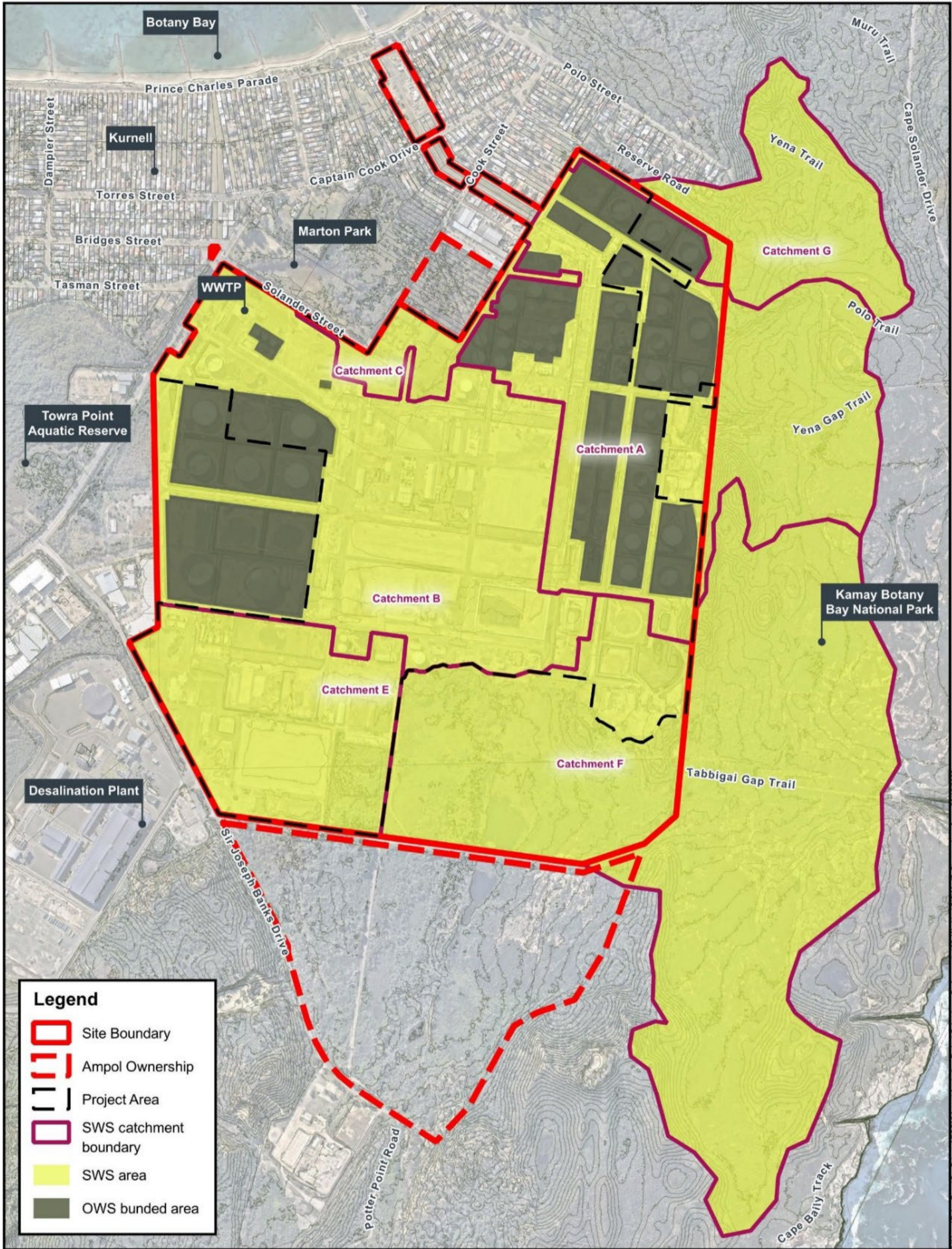
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Source: Nearmap, 2024.

Figure 2-3 Pre-modification stormwater areas



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FIGURE 2-4
POST-MODIFICATION STORMWATER AREAS



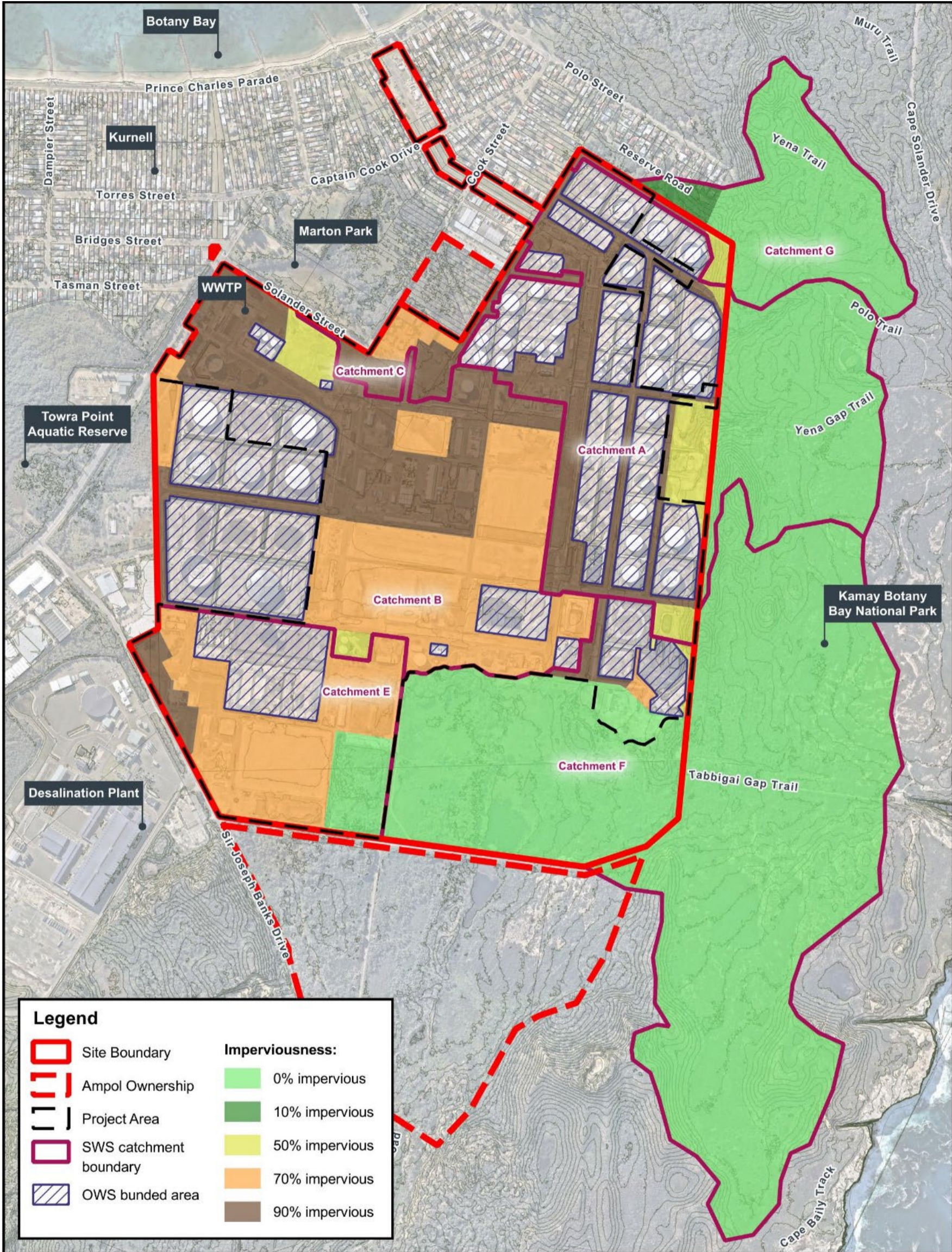
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Source: Nearmap, 2024

Figure 2-4 Post-modification stormwater areas



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FIGURE 2-5
PRE-MODIFICATION CATCHMENT IMPERVIOUSNESS



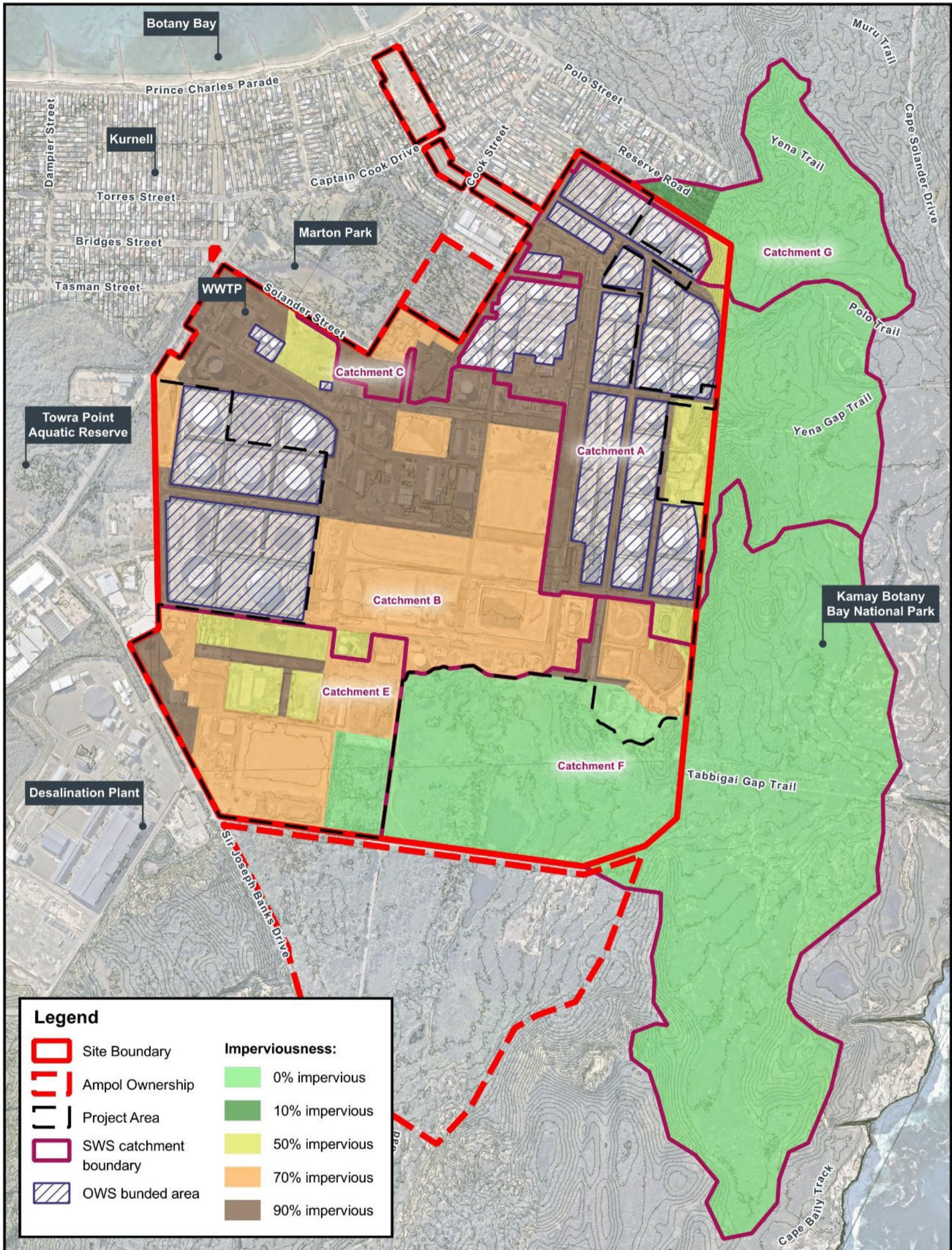
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Source: Nearmap, 2024

Figure 2-5 Pre-modification catchment imperviousness



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FIGURE 2-6
POST-MODIFICATION CATCHMENT IMPERVIOUSNESS



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Source: Nearnmap, 2024

Figure 2-6 Post-modification catchment imperviousness

3.0 Modelling approach

3.1 General

Hydrologic and hydraulic modelling of the sitewide SWS under both pre and post-modification conditions was completed in DRAINS – an industry standard urban stormwater modelling package. The modelling results were used to compare pre- and post-modification stormwater discharge rates at all of the discharge points listed in Table 2-1.

Comparison of the pre- and post-modification discharge rates were then used to develop a stormwater management strategy that would ensure the proposed modification would not increase stormwater discharge rates from the Site, as per the requirements outlined in Section 1.2.

The DRAINS modelling for this assessment was based on a previous model that was developed by Manly Hydraulics Laboratory (MHL) as part of their Caltex Kurnell – Stormwater Management Options Report (MHL, 2016). This previous DRAINS model was supplied by Ampol in August 2024.

The following sections provide a brief description of the previous DRAINS model, summarises the model updates carried out for this assessment, documents key model parameters, lists the modelled scenarios and design storm events, and presents any key modelling assumptions and limitations.

3.2 Previous model

The supplied DRAINS model was originally developed by MHL as part of an options assessment for stormwater management at the Site (MHL, 2016). The MHL (2016) options assessment looked at similar modifications to the Site, where several former OWS areas within the central Catchment B were being redirected to the SWS. The options assessment estimated the stormwater runoff increases caused by this change and confirmed that any increases in stormwater runoff on-site were not going to increase discharge rates off-site in all events up to and including the 1% AEP design storm event. The study also included several mitigation options to improve stormwater drainage across the Site.

The MHL (2016) study developed two separate stormwater DRAINS models for the options assessment: one pre- and one post-transformation model. The post-transformation model was adopted for use in this assessment as it best represented present-day conditions. The proposed changes included in the post-transformation model have already been implemented on-site as at the commencement of the stormwater assessment documented herein.

The previous DRAINS model was prepared in accordance with the latest Australian Rainfall and Runoff (ARR) guidelines at the time of model development – i.e., the 1987 version of ARR guidelines (Institution of Engineers, Australia, 1987). This 1987 version of ARR has since been superseded by Version 4.2 of the ARR guidelines that were first released in 2019 (Ball et al., 2019).

Key details of the previous MHL (2016) DRAINS model have been summarised in Table 3-1.

Table 3-1 Previous DRAINS model details

Component	Adopted value
Rainfall data	One best-representative design rainfall hyetograph for each design storm magnitude and duration, based on the 1987 version of ARR guidelines (Institution of Engineers, Australia, 1987).
Hydrological losses	An ILSAX-type hydrological loss model was adopted with the following parameter values: <ul style="list-style-type: none"> • Depression storage: <ul style="list-style-type: none"> – Impervious area: 1 mm – Pervious area: 5 mm • Soil type for adopted for continuing losses: Soil Type 2

Component	Adopted value
Catchment properties	<ul style="list-style-type: none"> Developed areas within the Site were modelled as 90% impervious and 10% pervious. Large external and heavily vegetated catchments, as well as any existing OWS areas converted to SWS areas, were modelled as 90% pervious and 10% impervious. The following times of concentrations were adopted for developed subcatchments within the Site: <ul style="list-style-type: none"> 5 minutes for impervious surfaces 5 minutes for pervious surfaces The time of concentration for larger, external and densely vegetated subcatchments was based on the Kinematic Wave Equation, using the flow path length, slope and a retardance coefficient (n^*) of 0.1 for grassed areas and 0.03 for paved areas. An additional time of concentration of 5 minutes was included for both impervious and pervious areas.
Overland flow	Flow conveyed by overland flow routes were modelled using the Kinematic Wave Equation.
Drainage network	<ul style="list-style-type: none"> The drainage network of pits, pipes, pumps, channels and basins were modelled based on the drawings provided by Caltex (AS-40818) and preliminary assessment of LiDAR survey levels. Stormwater basin height-storage volumes were modelled large enough to prevent instabilities in the model. Flow travelling through the stormwater drainage network was based on the following Manning's roughness (n) coefficients: <ul style="list-style-type: none"> Concrete pipes: 0.013 Box culverts: 0.012 Concrete-lined open channels: 0.013 Grassed open channels: 0.03
Tailwater levels	<p>Most drainage outlets were set to 'freely discharge'. Constant tailwater levels were only adopted at the following two discharge locations:</p> <ul style="list-style-type: none"> Direct outlet to Quibray Bay (outlet B1, from basin B1C): 2.5 mAHD (Australian Height Datum) for all storm events Direct outlet to Botany Bay (outlet A1): 0.6 mAHD for all storm events
Climate change	No consideration of climate change.

More details on the previous DRAINS model development are included in the MHL (2016) report which has been provided in Appendix A.

3.3 Model updates

The previous MHL (2016) DRAINS model was initially updated to represent present-day conditions, and to capture any Site changes that have occurred since the model was first developed. It was also updated in line with the most recent version (4.2) of the ARR guidelines (Ball et al., 2019).

The key modelling updates to the previous MHL (2016) DRAINS model included:

- Adoption of the latest ARR guidelines (Ball et al., 2019), which required updates to:
 - rainfall depths and hyetographs,
 - climate change factors, and
 - downstream tailwater levels.
- Adjustments to subcatchment properties, including the impervious area percentages and times of concentration.

- Resolution of any modelling errors that were introduced as a result of updating to the latest version of DRAINS (Version 2025.01.9147.24925 – 16 Jan 2025). This included some adjustments to the existing drainage network details, where adjustments made in DRAINS were compared against the latest site-wide SWS and OWS schematic plan drawings (Ampol, 2020; Ampol, 2022).
- The height-storage relationships for stormwater basins were updated and extracted from the latest available LiDAR digital elevation model (DEM) obtained from ICSM (2024).
- Inclusion of recent stormwater upgrades across the Site – namely, the inclusion of three stormwater pump stations that were designed and constructed as part of the SSIP. The details of these SSIP pump stations were obtained from the development application drawings (Ampol, 2023) and associated flood modelling report (BPM Projects, 2024).

3.4 Modelled events

DRAINS modelling was undertaken for a suite of design storm events to ensure that the proposed modification would not increase on existing discharge rates under all events up to and including the 1% AEP design storm event. Each design storm event required model runs for several storm durations ranging from 5-minutes to 36-hours in order to capture the critical storm duration for each discharge point.

The proposed modification and associated stormwater management strategy was analysed under the following two climate condition scenarios in order to assess how the SWS would perform under both present and future climate conditions:

- ‘Present-day’ climate conditions – for the year 2030
- ‘Future climate’ conditions – for the year 2100.

The full suite of modelled scenarios, design storm events and durations are shown Table 3-2.

Table 3-2 List of modelled events

Development scenario	Climate scenario	Storm magnitudes	Storm durations
<ul style="list-style-type: none"> • Pre-modification • Post-modification 	<ul style="list-style-type: none"> • Present-day (year 2030) • Future climate (year 2100) 	<ul style="list-style-type: none"> • 20% AEP • 5% AEP • 1% AEP 	<ul style="list-style-type: none"> • 5-minutes to 36-hours

3.5 Model parameters

The key model parameters adopted for DRAINS modelling in this stormwater assessment are summarised in Table 3-3.

Table 3-3 DRAINS model parameters

Component	Adopted values	Basis
Rainfall	<ul style="list-style-type: none"> The full ensemble of ten temporal patterns for each storm duration under each storm magnitude were modelled. The design rainfall depths were obtained from BoM (2025) and temporal patterns were obtained from the ARR Data Hub (Ball et al., 2019). The probability-neutral burst initial loss values were adopted to capture 'wetting' of the soils prior to the main design storm burst. 	<p>This adopted ensemble approach is in line with the latest version 4.2 of the ARR guidelines (Ball et al., 2019).</p> <p>Adopting the probability-neutral burst initial loss values is in line with NSW-specific guidance issued by the NSW Office of Environment and Heritage (OEH, 2019).</p>
Hydrological losses	<p>An ILSAX-type hydrological loss model was adopted with the following parameter values:</p> <ul style="list-style-type: none"> Depression storage: <ul style="list-style-type: none"> – Impervious area: 1 mm – Pervious area: 5 mm Soil type for adopted for continuing losses: Soil Type 2 	<p>These values are consistent with the hydrological model adopted for the previous MHL (2016) study and are also consistent with NSW guidance.</p> <p>NSW Hydrologic Soil Groups shows the Site catchment is located on soils of 'Type A – high infiltration' properties, which would correlate to a Soil Type 1. However, the infiltration rates for Soil Type 1 is considered too high for a developed site with compacted surfaces, and therefore the Soil Type 2 has been adopted.</p>
Catchment properties	<ul style="list-style-type: none"> Impervious area percentages were based on a review of the latest (2025) aerial imagery available on Nearmap. The following times of concentrations were adopted for developed subcatchments within the Site: <ul style="list-style-type: none"> – 5 minutes for impervious surfaces – 10 minutes for pervious surfaces The time of concentration for larger, external and densely vegetated subcatchments was based on the Kinematic Wave Equation, using the flow path length, slope and a retardance coefficient (n^*) of 0.3 for these densely vegetated areas. 	<p>These adopted catchment properties are consistent with best-practice guidance in NSW. The times of concentration were compared against values included in the Austroads guidelines for urban stormwater drainage.</p>
Overland flow	<p>Flow conveyed by overland flow routes were modelled using the Kinematic Wave Equation.</p>	<p>The Kinematic Wave Equation is the default and most commonly adopted approach included in DRAINS.</p>
Drainage network	<ul style="list-style-type: none"> The drainage network of pits, pipes, pumps, channels and basins were modelled based on the latest SWS drainage plans available (Ampol, 2020; Ampol, 2022; Ampol, 2023; and BPM Projects 2022). Stormwater basin height-storage volumes were based on the latest available topographic information (ICSM, 2024). 	<p>These values and the adopted DRAINS modelling approach for urban stormwater drainage networks is consistent with best-practice guidance in NSW.</p>

Component	Adopted values	Basis
	<ul style="list-style-type: none"> • Flow travelling through the stormwater drainage network was based on the following Manning's roughness (n) coefficients: <ul style="list-style-type: none"> – Concrete pipes and box culverts: 0.013 – Concrete-lined open channels: 0.013 – Grassed open channels: 0.03 	
Tailwater levels	<p>At every downstream pipe outlet, a constant tailwater level was adopted and was equal to the greater value of the:</p> <ul style="list-style-type: none"> • Pipe obvert level, or • 1.40 mAHD (5% AEP tide level) 	<p>The greater of the pipe obvert and 5% AEP tide level was based on the latest (2015) version of NSW's <i>Floodplain Risk Management Guide – Modelling the Interaction of Catchment Flooding and Oceanic Inundation in Coastal Waterway</i> (OEH, 2015), where it is stated that a 1% AEP catchment flood should be modelled in conjunction with a 5% AEP tide level. For a 'Type A Waterway Entrance Type' (Group 1 Oceanic Embayment for Botany Bay), the estimated 5% AEP tide level was 1.40 mAHD.</p>
Climate change	<p>The following climate change factors were applied to the above rainfall depths for both climate scenarios, based on the high-range emission scenario (SSP3-7.0):</p> <ul style="list-style-type: none"> • Present-day (year 2030): 1.18 • Future climate (year 2100): 1.66 <p>Climate change effects on sea level rise (SLR) for present-day and future climate conditions were incorporated into the above constant tailwater levels by adjusting the 5% AEP tide level to be:</p> <ul style="list-style-type: none"> • Present-day (year 2030): 1.50 mAHD • Future climate (year 2100): 2.08 mAHD 	<p>The adopted climate change adjustments are in accordance with the latest version 4.2 of the ARR guidelines (Ball et al., 2019) which aligns with the most recent guidance from the Intergovernmental Panel on Climate Change (IPCC).</p> <p>The high-range emission scenario (SSP3-7.0) was adopted as it represents the median value between commonly adopted medium (SSP2-4.5) emission scenario and very high (SSP5-8.5) emission scenario.</p> <p>A single short duration (less than 1-hour duration) rainfall multiplier has been used since all subcatchment runoff times are less than 1.5 hours and the majority (more than 90%) of subcatchment runoff times are less than 1.0 hour.</p> <p>The 5% AEP tide level of 1.40 mAHD was adjusted to allow for SLR as a result of climate change. The SLR adopted for both of the modelled climate scenarios were obtained from the NASA Sea Level Projection Tool. The median SLR values that were adopted for the high-range (SSP3-7.0) emission scenario are:</p> <ul style="list-style-type: none"> • Present-day (year 2030): 0.10 m • Future climate scenario (year 2100): 0.68 m

3.6 Assumptions and limitations

The following key assumptions and limitations were adopted for DRAINS modelling carried out as part of this stormwater assessment:

- It was assumed that all stormwater basins with a low-level drainage outlet or pumped outlet would have an initial water level equal to the invert of this low-level drainage outlet – i.e., often set to the basin invert level, where the low-level outlet matches the invert. This assumes that the basins would completely drain prior to the next storm event occurring and is consistent with aerial imagery showing that the majority of stormwater basins remain dry all-year-round.
- Existing stormwater pumps that were included in the DRAINS model were slightly adjusted to remove modelling instabilities and to more accurately represent the gradual ramp-up that would occur with these pumps. The existing peak pump rates that were included in the previous model were maintained, and it was assumed that the pump rates would increase at a linear rate up to this peak pump rate in relation to the rising water level within the pump sump/ basin.
- It was assumed that any stormwater retention basins, without a low-level drainage outlet, would be half full at the beginning of the design storm event.
- The subcatchment boundaries included in the supplied MHL (2016) DRAINS model were maintained under this assessment. Catchment imperviousness values were updated for these subcatchments to best represent current development conditions across the Site. These imperviousness values were based on a desktop review of the latest (2025) aerial imagery available on Nearmap.
- Updates to the supplied MHL (2016) DRAINS model were undertaken to best represent current Site drainage conditions, based on the information available as at the time of this study. No on-site inspections were undertaken to confirm the modelled SWS drainage network matches what is on-site.
- For the purposes of this assessment, it was assumed that the OWS and SWS are entirely separate. It is assumed that stormwater runoff moving through the OWS would not spill to the SWS and vice versa.

4.0 Stormwater management measures

Several stormwater management measures are proposed as a means to prevent the proposed modification from increasing peak discharge rates leaving the Site and entering the downstream stormwater (and some sensitive) receptors.

There are two main locations where stormwater management measures are proposed:

- South-eastern corner of the Site, spread across Catchments B and F
- South-western corner of the Site, within Catchment E.

The proposed stormwater management measures at both of these locations are discussed in the following sections. These measures have undergone preliminary sizing based on the increases in stormwater flows that are likely to occur without any management measures in place. These sizes are only intended to ensure that the proposed modification is capable of maintaining (or reducing) pre-modification peak discharge rates from the Site. The sizes and proposed measures would need to be refined during subsequent design phases.

4.1 South-eastern corner (Catchments B and F)

The proposed stormwater management measures proposed at the south-eastern corner of the Site, across both Catchments B and F, are shown on Figure 4-1.

The proposed modification would remove existing OWS lines that currently service the bunded areas located at the south-eastern corner of the Site. Removing these existing OWS lines would also remove any form of drainage from these bunded areas and would cause stormwater runoff to permanently pool within the confines of these bunds. Stormwater accumulating within these bunded areas would continue to rise, storm after storm, and would only drain slowly via infiltration, evaporation, and/or by spilling to the surrounding area when water levels rise above bund levels.

To reduce the risks associated with these bunds holding permanent water and not having a safe spillway or overflow route, it is proposed that low-flow stormwater outlet systems are installed within each of these bunded areas. It is proposed that these stormwater outlets are part of a new stormwater pipe network that would connect to the nearest existing SWS within Catchment B. These low-flow outlet systems would allow for existing bunds in the south-eastern corner of the Site to provide detention of stormwater runoff before slowly releasing these stormwater flows to the existing SWS within Catchment B.

Utilising the existing bunded areas within Catchments B and F would ensure that no additional/ new detention storage would be required within these catchments as part of the proposed modification.

Redirecting stormwater discharge from all of these bunded areas to Catchment B, as opposed to splitting discharge across Catchments B and F, also helps to avoid any alterations to existing inflow patterns for the southern Natural Retention Basin within Catchment F. This natural storage area is listed as a Coastal Wetland under the relevant environmental protections, and alteration of existing hydrological flow patterns into this system is not allowed.

The proposed stormwater drainage network that would service these existing bunded areas would remain separate to any existing stormwater drainage infrastructure within Catchment F. Although some proposed pipes may cross existing drainage infrastructure within Catchment F, these pipes would not connect to this existing infrastructure. This would ensure that the existing catchment area contributing to the Natural Retention Basin remains unchanged so as to maintain the existing hydrological regime for this basin.

Stormwater discharge from the bunded areas would be released at a slow rate so as to not overload existing drainage infrastructure within Catchment B. The slow release of flows would be controlled by the low-flow outlet structures, which could be achieved through the inclusion of small outlet pipes, orifice plates, control valves, custom outlet pits, pumped outlet systems, or other flow restriction methods.

For the purposes of this stormwater assessment, discharge from the bunded areas was modelled using orifice plates to limit the discharge rates as much as possible – i.e., to utilise the full storage capacity within these bunded areas without causing overtopping of the basins and while maintaining a suitable amount of freeboard in all modelled storm events, up to and including the 1% AEP

The estimated storage volume that is currently present and needs to be retained within each of these existing bunded areas is presented in Table 4-1.

Table 4-1 Existing storage volumes in Catchments B and F to be retained

Location	Existing storage volume to be retained (m ³)
Basin 94C	20,400
Basin 94D	1,100
Basin 33C	28,300
Basin 33D	14,000
Basin 31Da	8,100
Basin 31Db	2,600

In addition to the small release of flow from these bunded areas, Catchment B would also accept stormwater runoff from a small (0.1 ha) former OWS area shown on the left side of Figure 4-1. Due to the small size of this area, detention storage is not required.

DRAINS modelling confirmed that the adopted orifice plates and discharge rates from these bunded areas, in combination with flows coming from the small 0.1 ha area, would result in a marginal increase in peak discharge rates entering the existing SWS within Catchment B. Existing stormwater drainage infrastructure within Catchment B, including pipes, channels, pumps, detention and retention systems were shown to have sufficient capacity to accommodate this minor increase in flow without affecting the hydraulic performance of this existing downstream infrastructure.

Modelling results showed that the bunded areas/ basins would only fill up halfway (50% of the total storage capacity, not allowing for any freeboard) in the 1% AEP design storm event, under present-day climate conditions.

It may also be possible to increase discharge rates from these bunded areas, if the existing SWS within Catchment B can accommodate an increase in flow without causing an increase in discharge rates from the Site. This scenario, or any other potential options, have not been investigated as part of this assessment.

Sediment control measures are also proposed for installation on the new stormwater drainage network leading out of these bunded areas. The sediment controls could be installed within the bunded areas or along the proposed drainage network, prior to discharging into the existing SWS within Catchment B. These measures aim to minimise the amount of sediment and sediment-bound pollutants transferring to Catchment B and potentially discharging off-site.

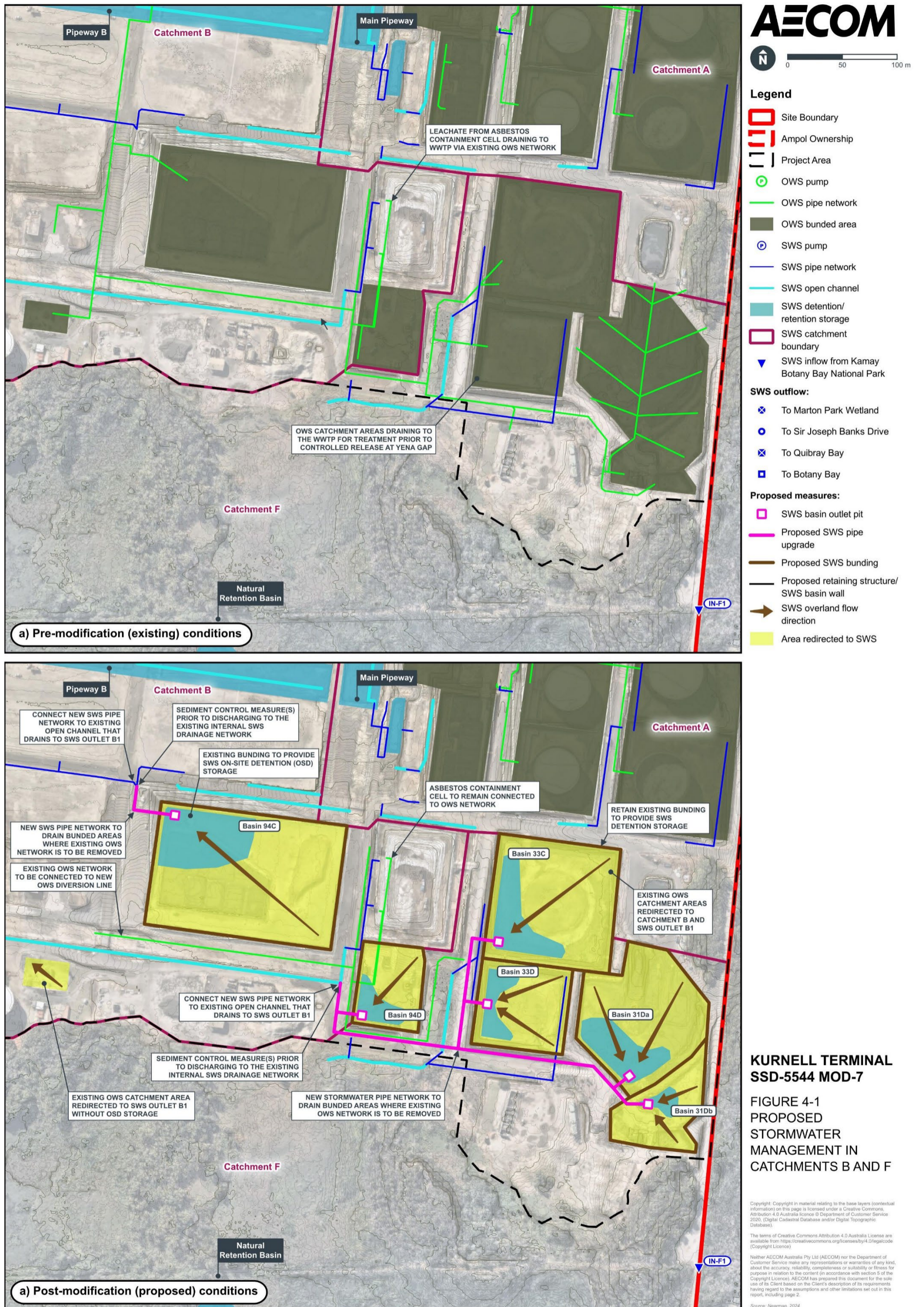


Figure 4-1 Proposed stormwater management in Catchments B and F

4.2 South-western corner (Catchment E)

The proposed stormwater management measures proposed at the south-western corner of the Site, within Catchment E, are shown on Figure 4-2.

The SWS in Catchment E discharges to four outlets (E1-E4) as shown in Figure 4-2. Three of these outlets (E2-E4) discharge directly to the open channel along the western side of Sir Joseph Banks Drive. The remaining stormwater outlet pipe from RPIP Mountain (E1), located at the south-eastern corner of Catchment E, discharges to an existing vegetated swale along the southern boundary of the Site. This southern swale conveys flow in a westerly direction towards the channel along Sir Joseph Banks Drive.

The proposed modification would remove the existing OWS lines that service the former Caltex Lubricating Oil Refinery (CLOR) area along the northern side of Catchment E. Removing these existing OWS lines would cause stormwater runoff from this area to drain to the surrounding SWS that discharges directly to Sir Joseph Banks Drive via the north-most outlet (E4). This change would increase the total catchment area draining towards outlet E4 by approximately 6.0 ha. It would also increase the peak discharge rate at outlet E4, should no stormwater management measures be implemented.

It is estimated, from DRAINS modelling, that the total increase in peak discharge rates at outlet E4 would be in the order of 0.4 m³/s in the 1% AEP design storm event under present-day climate conditions, without any stormwater management measures in place. This is an increase of 0.4 m³/s above the existing peak discharge rate of 2.0 m³/s in the same 1% AEP design storm event.

Additionally, removal of the dense vegetative canopy cover within RPIP Mountain has the potential to increase peak discharge rates at outlet E1 and travelling downstream towards Sir Joseph Banks Drive. It is estimated, from DRAINS modelling, that peak runoff rates from RPIP Mountain would increase from 0.54 m³/s to 0.67 m³/s in the 1% AEP design storm event under present-day conditions.

It is proposed that two on-site detention (OSD) systems are included as part of the proposed modification works in order to manage the increase in peak discharge rates from both of these areas. One OSD system would be located at the downstream end of the former CLOR area, within the former CLOR pipeway, and the other would be located within RPIP Mountain.

Table 4-2 summarises the estimated OSD volumes that would be required to limit post-modification discharge rates from Catchment E back to pre-modification discharge rates in all storm events up to and including the 1% AEP design storm event for both present-day and future climate conditions.

Table 4-2 Proposed on-site detention volumes in Catchment E

Location	Minimum OSD volume required (m ³)	
	Present day	Future climate
Former CLOR Pipeway	11,000	17,000
RPIP Mountain	400	1,100

The volumes quoted in Table 4-2 do not account for any freeboard and would therefore require additional storage volume to allow for an appropriate amount of freeboard. These volumes should also be treated as indicative only and would require further refinement and more detailed analyses during subsequent design phases.

DRAINS modelling showed that a detention storage volume in the order of 11,000 m³ would be required within the former CLOR pipeway to ensure peak post-modification discharge rates do not exceed the pre-modification discharge rates at outlet E4 in all storm events up to and including the 1% AEP event under present-day climate conditions. Modelling results also showed that this required volume would need to be increased to approximately 17,000 m³ under future climate conditions.

It is anticipated that the former CLOR pipeway would require alterations in order to accommodate the required detention storage volume. The required alterations are likely to involve:

- Upgrades to the existing vertical wall around the pipeway where necessary to achieve a constant top of wall elevation, estimated to be up to 2 m in height, to contain surface water inflows and increase the maximum storage height within the pipeway.
- Where possible, excavation of the pipeway by up to 1-1.5 m to increase the storage capacity and regrading the invert of the pipeway to direct low flows towards the western side of the pipeway, where the outlet is proposed.
- Basin outlet structure to control discharge rates from the pipeway/ OSD storage. This outlet structure be in the form of orifice plates, control valves, staged discharge outlet structures, or other flow control structures.
- New piped network connecting the basin outlet structure to the existing downstream SWS discharging to outlet E4.
- A designated spillway system to safely direct any overflows towards the Site discharge point during storm events larger than the 1% AEP design storm event, or in the event of outlet blockage issues.

These alterations to the former CLOR pipeway would be reviewed and refined during the subsequent design phases.

The existing bunding around the area draining to the OSD storage within the former CLOR pipeway should be retained as part of the proposed modification to prevent any stormwater runoff from bypassing the OSD storage and draining towards the surrounding road network. It is likely that the areas surrounding this proposed OSD system would also require temporary flow diversion measures, such as swales, to direct surface water runoff into the OSD system. This would prevent surface water runoff from permanently pooling within natural low points across the surface of these areas.

The proposed OSD storage within RPIP Mountain could be achieved by widening the existing open channel that runs along the western side of this area. For example, widening the base width of this channel by 1.5 m would achieve the required 400 m³ of OSD storage under present-day climate conditions. Additional widening would be expected to achieve the larger 1,100 m³ required under future climate conditions.

It is also possible for an OSD basin to be provided at the downstream (south-western) corner of RPIP Mountain in lieu of widening the existing channel. Upgrades to the existing 450 mm diameter outlet pipe at the southern end of this channel are likely not required, as the existing pipe would be capable of maintaining pre-modification discharge rates without any adjustments in all storm events up to and including the 1% AEP event.

Sediment control measures are also proposed for installation at the downstream end of the two new OSD systems. These sediment control measures aim to minimise the amount of sediment and sediment-bound pollutants discharging off-site via the Catchment E outlets.

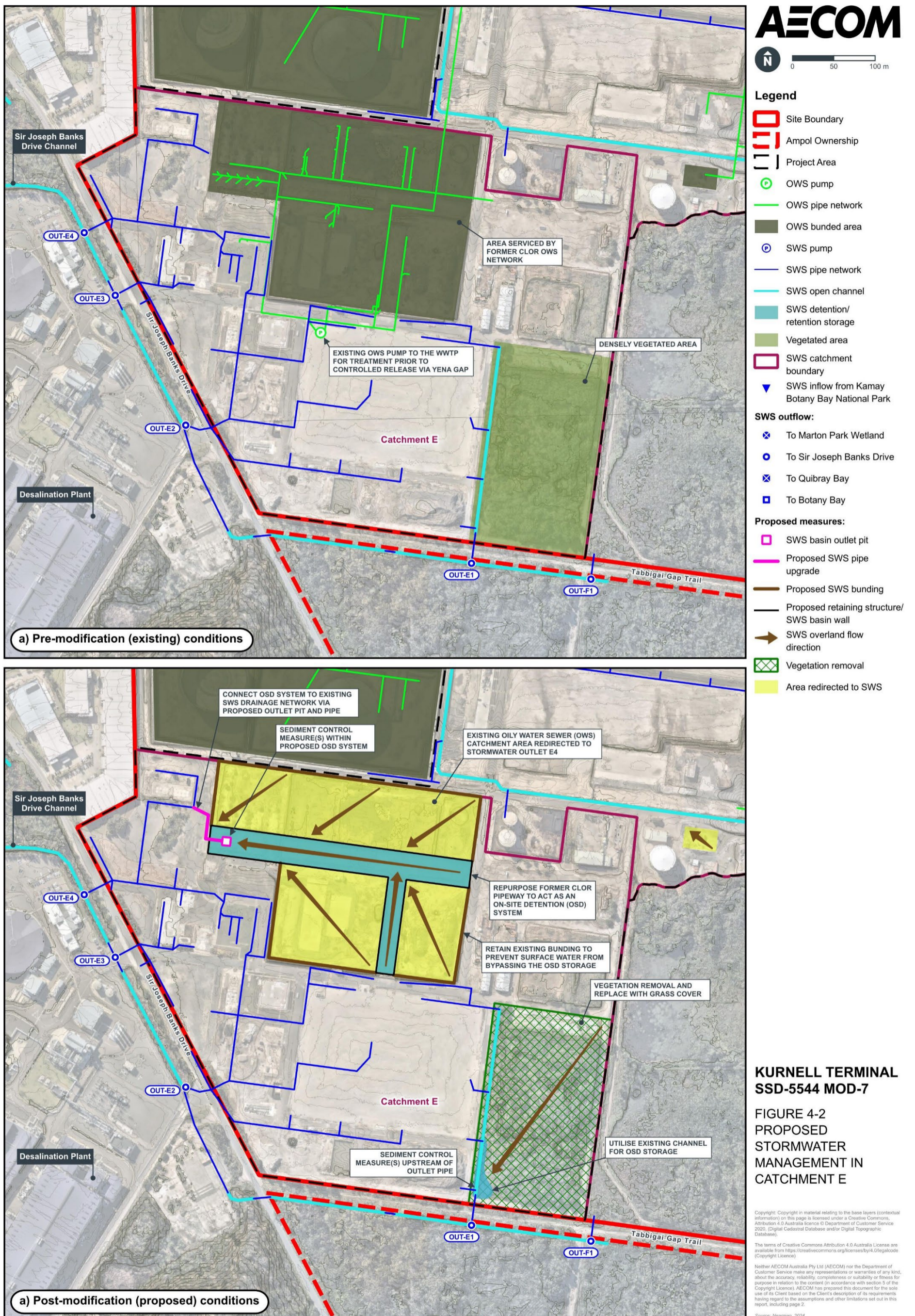


Figure 4-2 Proposed stormwater management in Catchment E

5.0 Modelling results

5.1 Overview

The pre- and post-modification DRAINS model layouts that were developed and used for this assessment are presented in Appendix B.

The peak discharge rates under both pre- and post-modification conditions were recorded and compared at all of the discharge points listed in Table 2-1 and for all of the modelled scenarios and design storm events listed in Table 3-2. The locations where discharge rates were recorded in the DRAINS model are shown on Figure 5-1 and are described in Table 5-1.

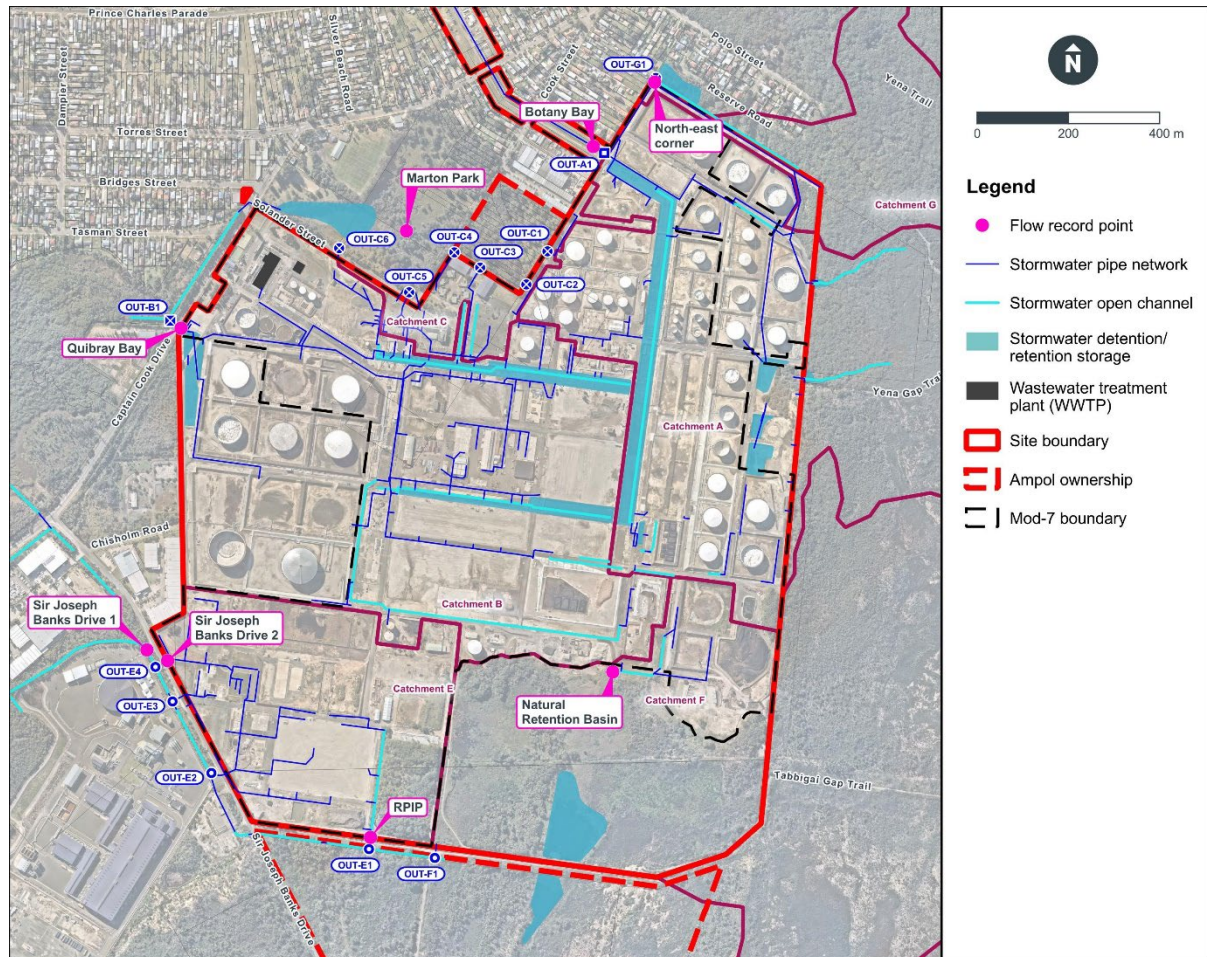


Figure 5-1 Flow record locations

Table 5-1 Flow record locations

Discharge point	DRAINS label	Drainage outlet(s)	Objective
North-east corner	OF40972	G1	To record the total flow rate discharging to the north-eastern corner of the Site, directly from Catchment G in addition to overflows coming from Catchment A.
Botany Bay	Pipe O1D	A1	To record the peak flow rates discharging directly to Botany Bay via the drainage easement leading out of Catchment A.
Marton Park	OF19761	C1-C6	To capture the total combined flow rate discharging directly to the Marton Park Wetland from Catchment C, in addition to some overflows coming from Catchment A.
Quibray Bay	QF QB	B1	To record peak discharge rates from the western stormwater retention basin B1 and discharging directly to Quibray Bay.
Sir Joseph Banks Drive 1	OF40951	E1-E4 and F1	To capture the total combined peak flow rate moving along the Sir Joseph Banks Drive channel, including the total combined peak discharge rates from Catchment E and overflows from the Natural Retention basin in Catchment F.
Sir Joseph Banks Drive 2	OF40945	E4	To record the peak discharge rates coming from the portion of Catchment E that is affected by the redirection of existing OWS areas to the SWS network, before it combines with the total flow heading along the Sir Joseph Banks Drive channel.
RPIP Mountain	Ch152F	E1	To record the peak discharge rates coming from the open channel that heads along the western side of RPIP Mountain, as it discharges to the open channel along the southern side of the Site before connecting to Sir Joseph Banks Drive.
Natural Retention Basin	OF2562194	F1 (upstream)	To capture the total combined flow coming from the south-eastern corner of the Site, within Catchment F, and entering the Natural Retention Basin.

The pre- and post-modification discharge rates are presented and discussed in the following sections under both present-day and future climate conditions.

5.2 Present-day conditions

The peak discharge rates under present-day conditions for both pre- and post-modification conditions are summarised in Table 5-2.

Table 5-2 Peak discharge rates for present-day conditions

Discharge point	Result	20% AEP		5% AEP		1% AEP	
		Pre	Post	Pre	Post	Pre	Post
North-east corner	Peak flow rate (m ³ /s):	0.2	0.2	1.0	1.0	1.9	1.9
	<i>Critical duration:</i>	<i>10-min</i>	<i>10-min</i>	<i>20-min</i>	<i>20-min</i>	<i>25-min</i>	<i>20-min</i>
Botany Bay	Peak flow rate (m ³ /s):	1.4	1.4	1.9	1.9	1.6	1.6
	<i>Critical duration:</i>	<i>2-hr</i>	<i>2-hr</i>	<i>15-min</i>	<i>15-min</i>	<i>2-hr</i>	<i>2-hr</i>
Marton Park	Peak flow rate (m ³ /s):	2.0	2.0	4.3	4.3	6.5	6.5
	<i>Critical duration:</i>	<i>45-min</i>	<i>45-min</i>	<i>1-hr</i>	<i>1-hr</i>	<i>45-min</i>	<i>45-min</i>
Quibray Bay	Peak flow rate (m ³ /s):	0.1	0.1	0.1	0.1	0.4	0.4
	<i>Critical duration:</i>	<i>45-min</i>	<i>25-min</i>	<i>5-min</i>	<i>45-min</i>	<i>10-min</i>	<i>10-min</i>
Sir Joseph Banks Drive 1	Peak flow rate (m ³ /s):	2.8	2.8	3.7	3.7	4.6	4.6
	<i>Critical duration:</i>	<i>20-min</i>	<i>20-min</i>	<i>15-min</i>	<i>15-min</i>	<i>9-hr</i>	<i>9-hr</i>
Sir Joseph Banks Drive 2	Peak flow rate (m ³ /s):	1.1	1.1	1.5	1.5	2.0	2.0
	<i>Critical duration:</i>	<i>10-min</i>	<i>10-min</i>	<i>15-min</i>	<i>15-min</i>	<i>10-min</i>	<i>10-min</i>
RPIP Mountain	Peak flow rate (m ³ /s):	0.6	0.6	2.1	2.1	4.0	4.0
	<i>Critical duration:</i>	<i>2-hr</i>	<i>2-hr</i>	<i>6-hr</i>	<i>6-hr</i>	<i>6-hr</i>	<i>6-hr</i>
Natural Retention Basin	Peak flow rate (m ³ /s):	0.5	0.5	0.6	0.6	0.9	0.9
	<i>Critical duration:</i>	<i>10-min</i>	<i>10-min</i>	<i>5-min</i>	<i>5-min</i>	<i>5-min</i>	<i>5-min</i>

It can be seen that the proposed stormwater management measures outlined in Section 4.1 and Section 4.2 are capable of limiting post-modification discharge rates to pre-modification rates at all Site discharge points in all storm events up to and including the 1% AEP event under present-day climate conditions.

There is also no significant change in the critical storm duration generating these peak discharge rates. There is only a slight difference between the critical duration recorded at the Quibray Bay discharge point for the 20% and 5% AEP design storm events. This change in critical duration is due to there only being minor differences between peak discharge rates to Quibray Bay in all of the shorter storm durations (from 5 minutes to 2 hours).

5.3 Future climate conditions

The peak discharge rates under future climate conditions for both pre- and post-modification conditions are summarised in Table 5-3. The only slight increase in peak discharge rates has been highlighted in red.

Table 5-3 Peak discharge rates for future climate conditions

Discharge point	Result	20% AEP		5% AEP		1% AEP	
		Pre	Post	Pre	Post	Pre	Post
North-east corner	Peak flow rate (m ³ /s):	1.1	1.1	2.1	2.1	3.5	3.5
	Critical duration:	20-min	20-min	20-min	20-min	20-min	20-min
Botany Bay	Peak flow rate (m ³ /s):	1.4	1.4	1.4	1.4	1.4	1.4
	Critical duration:	1-hr	1-hr	45-min	45-min	25-min	25-min
Marton Park	Peak flow rate (m ³ /s):	5.1	5.1	7.7	7.6	11.1	11.1
	Critical duration:	45-min	45-min	1-hr	1-hr	45min	45min
Quibray Bay	Peak flow rate (m ³ /s):	0.3	0.3	0.7	0.7	1.0	1.0
	Critical duration:	10-min	10-min	10-min	10-min	15-min	15-min
Sir Joseph Banks Drive 1	Peak flow rate (m ³ /s):	3.8	3.8	5.0	5.0	8.9	8.9
	Critical duration:	10-min	10-min	15-min	15-min	9-hr	9-hr
Sir Joseph Banks Drive 2	Peak flow rate (m ³ /s):	1.7	1.7	2.3	2.3	2.9	2.9
	Critical duration:	10-min	10-min	15-min	15-min	10-min	10-min
RPIP Mountain	Peak flow rate (m ³ /s):	1.9	1.9	4.7	4.7	8.1	8.2
	Critical duration:	4.5-hr	4.5-hr	6-hr	6-hr	6-hr	6-hr
Natural Retention Basin	Peak flow rate (m ³ /s):	0.7	0.7	1.0	1.0	1.3	1.3
	Critical duration:	10-min	10-min	5-min	5-min	5-min	5-min

Similar to the present-day conditions presented in Section 5.2, the proposed stormwater management measures outlined in Section 4.1 and Section 4.2 are capable of limiting post-modification discharge rates to pre-modification discharge rates at all Site discharge points in all storm events up to and including the 1% AEP event under future climate conditions except RPIP Mountain in the 1% AEP storm event.

The larger OSD storage volumes quoted in Table 4-2 would be required in Catchment E under future climate conditions in order to manage the larger stormwater runoff rates that would be expected with increased rainfall and higher tailwater levels as a result of SLR.

The only increase in peak discharge rates occurs within the existing southern swale located immediately downstream of RPIP Mountain. The modelling results showed an increase in the order of 0.1 m³/s in the 1% AEP design storm event.

This increase in peak flow rates along the southern channel is caused by the attenuation of flow that occurs within the proposed OSD system in RPIP Mountain. The attenuation of flow helps to release flow at a controlled rate, no greater than pre-modification discharge rates. However, the timing of this attenuated/ prolonged peak flow rate under post-modification conditions is shown to align with the timing of the peak flow rate overflowing from the Natural Retention Basin in the 1% AEP design storm event – i.e., a synchronisation of peaks.

Despite this slight increase in peak flow rates along the southern swale, downstream of the RPIP area, there is shown to be no change in peak flow rates further downstream, along Sir Joseph Banks Drive.

Therefore, it is unlikely that this localised increase in peak flow rates along the southern swale would have any significant impact on downstream stormwater receptors.

If required, the synchronisation of these two peak flow rates under future climate conditions could be resolved during subsequent design phases by implementing a staged discharge control structure at the downstream end of RPIP Mountain – to further control the timing of peak discharge rates from this area.

6.0 Summary

The proposed modification at the Kurnell Terminal (the Site) intends to consolidate operational infrastructure, remove redundant assets, and undertake remediation. Without mitigation measures, these proposed works would alter existing stormwater management at two main locations across the Site:

- **South-eastern corner** of the Site, spread across Catchments B and F – The removal of existing and redundant OWS lines at this location would cause former bunded OWS areas to have no formal means of drainage. Any stormwater runoff collecting within these bunded areas would pool and continue to accumulate, storm after storm, until eventually spilling to the surrounding SWS network if no stormwater management measures were implemented. Any uncontrolled overflows would add to existing stormwater flows moving through the SWS in Catchment B and F and could potentially overload existing drainage infrastructure within these catchments.
- **South-western corner** of the Site, within Catchment E – Removal of existing and redundant OWS lines across the former CLOR area would cause stormwater runoff from this area to drain towards the surrounding SWS in Catchment E. This would increase the total catchment area draining to the existing SWS in Catchment E and would also increase peak discharge rates from this catchment and entering the Sir Joseph Banks Drive channel. Removal of dense vegetation across RPIP Mountain also has the potential to increase peak stormwater runoff rates from this area, and increase peak discharge rates flowing into the Sir Joseph Banks Drive.

This Stormwater Modelling Report has been prepared in support of the overarching Updated Stormwater, Wastewater and Flooding Assessment (Appendix G of the Submissions Report). Hydrologic and hydraulic modelling has been undertaken as part of this assessment to analyse the stormwater changes resulting from the proposed modification and to develop an appropriate stormwater management strategy for the modified areas.

The proposed stormwater management strategies aim to ensure that peak stormwater discharge rates leaving the Site under post-modification conditions do not exceed pre-modification discharge rates in all storm events up to and including the 1% AEP event. This requirement is consistent with Clause 1.3 of the Sutherland Shire Council DCP for Stormwater and Groundwater Management (Sutherland Shire Council, 2015).

The assessment only focuses on the requirements for stormwater flows moving through and discharging from the Site. It does not assess all stormwater requirements stipulated in the applicable legislation, policies and guidelines – all other stormwater requirements have been addressed in the overarching technical report.

Hydrologic and hydraulic modelling conducted as part of this assessment was carried out using DRAINS, where DRAINS modelling was based on a previous model that was developed by Manly Hydraulics Laboratory (MHL) as part of their *Caltex Kurnell – Stormwater Management Options Report* (MHL, 2016). The previous MHL (2016) DRAINS model was initially updated to represent present-day conditions, and to capture any Site changes that have occurred since the model was first developed. It was also updated in line with the most recent version (4.2) of the ARR guidelines (Ball et al., 2019).

DRAINS modelling was used to identify stormwater management measures capable of maintaining pre-modification discharge rates from the Site in all storm events up to and including the 1% AEP event. These stormwater management measures were also assessed under both present-day (year 2030) and future climate (year 2100) conditions under the high-range (SSP3-7.0) emission scenario detailed in the latest ARR guidelines (Ball et al., 2019).

The stormwater management measures identified as feasible solutions to maintaining pre-modification discharge rates from the Site are as follows:

- **South-eastern corner:**
 - Inclusion of new low-flow outlet systems within the existing bunded OWS areas to prevent stormwater from permanently pooling within these bunded areas and utilising the existing storage volumes within these bunded areas for stormwater detention storage.

- New stormwater pipe network connecting the low-flow outlet systems from bunded areas to the existing SWS within Catchment B. Directing these flows into Catchment B would prevent any changes to the inflows entering the southern Natural Retention Basin in Catchment F, as this is a protected Coastal Wetland.
- Sediment control measures, either within the bunded areas or at the downstream end of the new stormwater pipe networks to minimise the amount of sediment and sediment-bound pollutants transferring to Catchment B and potentially discharging off-site.
- **South-western corner:**
 - New OSD system within the former CLOR pipeway with a basin outlet structure to control discharge rates, estimated to require a storage volume in the order of 11,000 m³ under present-day climate conditions and 17,000 m³ under future climate conditions. The basin outlet structure would connect to the existing downstream SWS in Catchment E via a new stormwater pipe network.
 - New OSD storage within RPIP Mountain, estimated to be in the order of 400 m³ under present-day conditions and 1,100 m³ under future climate conditions. This OSD storage could be achieved by widening the existing channel along the western side of RPIP Mountain or by implementing a new OSD basin within RPIP Mountain.
 - Sediment control measures at the downstream end of the two new OSD systems to minimise the amount of sediment and sediment-bound pollutants discharging off-site via the Catchment E outlets.

The DRAINS modelling results indicated that the proposed stormwater management measures would be capable of ensuring that the peak post-modification discharge rates would not exceed pre-modification discharge rates at all Site discharge points and in all storm events up to and including the 1% AEP event under both present-day and future climate conditions. It was also shown that the storm durations generating the peak discharge rates at all discharge points would not be significantly altered as a result of the proposed modification.

On this basis, existing (pre-modification) discharge conditions would remain relatively unchanged under post-modification conditions with the proposed stormwater management measures in place.

7.0 References

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Appendix A

Previous DRAINS
Modelling Report



Public Works
Manly Hydraulics Laboratory

DRAFT - Caltex Kurnell Stormwater Management Options Report

Report MHL2506
December 2016

Caltex Refineries NSW Pty Ltd

DRAFT

DRAFT - Caltex Kurnell

Stormwater Management Options Report

Report MHL2506
December 2016

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Report No. MHL2506
First published (2016)



NSW Public Works Manly Hydraulics Laboratory is Quality System Certified to AS/NZS ISO 9001:2008.

Executive Summary

This options assessment follows on from the Caltex Refinery Kurnell Stormwater Modelling project (MHL, 2016) and forms a new scope of works which aims to identify and assess various options for managing the sites stormwater for the proposed site transformation. The key objectives were to:

- Address council stormwater requirements
- Improve stormwater management within the site

The DRAINS Stormwater model was updated to account for interactions between the Oily Water Drainage System and the Stormwater Drainage System. This involved determining surcharging flows utilising the Oily Water Drainage System model and accounting for these flows in the peak flow comparison analysis.

With regards to stormwater management, council requires that for changes to the site that impact stormwater discharge, the peak flow must not exceed existing for a full range of storm events up to and including the 100 year ARI event. However, this does not apply where discharge does not pass through Council stormwater drainage infrastructure. This report only deals with water quantity, not quality.

A Pre v Post - Transformation Peak Flows analysis was undertaken to compare peak flows discharging from the site and to understand the increased load on the system resulting from the demolition of the refinery process areas. Details of the Pre and Post-Transformation Scenarios were provided and confirmed by Caltex. The comparison found that peak flow did not increase at any of the discharge locations as a result of the site transformation. Therefore, the Council requirement is maintained.

It was noted that flooding occurs regularly on Road 9. Reducing the frequency/magnitude of flooding in this area would improve stormwater management within the site. Site stormwater management options were assessed with regards to the 2 year ARI event.

- Option 1 – Divert Flow to Quibray Bay via the Existing Cooling Water Pipes
 - Within Site: Road 9 at Road O peak flow was decreased slightly.
 - From Site: Quibray Bay peak discharge increased but did not overtop Captain Cook Drive. Marton Park peak discharge decreased slightly.
 - Cost estimate - \$230k
- Option 2 - Divert Flow to Quibray Bay via Overland Flow
 - Within Site: Road 9 at Road O peak flow decreased.
 - From Site: Quibray Bay peak discharge increased but did not overtop Captain Cook Drive. Marton Park peak discharge decreased slightly.
 - Cost estimate - \$110k
- Option 3 – Detain Flow in Pipeways A and B
 - Within Site: Peak flow on Road 9 was unchanged.

- From Site: Marton Park peak discharge increased slightly for the 100 year ARI event.
 - Cost estimate - \$30k
- Option 4 – Divert Flow to Botany Bay via the Main Pipeway
 - Within Site: Peak flow on Road 9 was unchanged.
 - From Site: Marton Park peak discharge increased slightly for the 100 year ARI event.
 - Cost estimate - \$120k
- Option 5 - Divert Flow off Road 9 to Pipe Track 3
 - Within Site: Road 9 at Road P and Road O peak flow decreased.
 - From Site: Peak site discharge remained the same.
 - Cost estimate - \$110k

Following the options assessment it is recommended to:

- Progress Option 5 - Divert Flow off Road 9 to Pipe Track 3 including undertaking survey to confirm levels for detailed design.
- Adopt sediment and erosion control measures in accordance with “The Blue Book” (Landcom) as part of the site transformation

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1. Introduction

This report documents the stormwater management options assessment undertaken by NSW Public Works Manly Hydraulics Laboratory (MHL) for the Caltex Kurnell proposed site transformation for Caltex Refineries NSW Pty Ltd.

This options assessment follows on from the Caltex Refinery Kurnell Stormwater Modelling project (MHL, 2016) and forms a new scope of works which aims to identify and assess various options for managing the sites stormwater for the proposed site transformation. The stormwater modelling project involved the development of a DRAINS hydrologic/hydraulic model of the site stormwater network with the aim to assess various options for managing the site's stormwater following completion of the site transformation which is currently taking place.

1.1 Objectives and Scope of Work

The objectives are to develop and assess various options for managing the site's stormwater in order to:

- Address council requirements of not increasing the peak stormwater flows off site through council infrastructure
- Improve stormwater management within the site (secondary objective following the primary objective of addressing council requirements)

To achieve the objectives the proposed scope of works is as follows:

- Familiarise with Caltex's existing oily water system model
- Update the hydraulic model base case to include the interaction with the oily water system. This would involve extracting overflow hydrographs from the oily water system model at key locations to then input to existing scenario stormwater model "*Caltex_Stormwater_2015-07-02.drn*".
- Complete a peak flow comparison (gap analysis) to understand the increased load on the system resulting from the demolition of the refinery process areas
- Define potential stormwater management options including:
 - Do nothing
 - On Site Detention (OSD)
 - Divert flow to Quibray Bay
 - Combination of the above
- Site visit and meeting at Caltex to confirm options to be assessed
- Model and assess stormwater management options
- Provide preliminary cost estimates of each of the options for comparative purposes
- Provide a summary of the advantages/disadvantages of each option

2. Background

2.1 Study Area

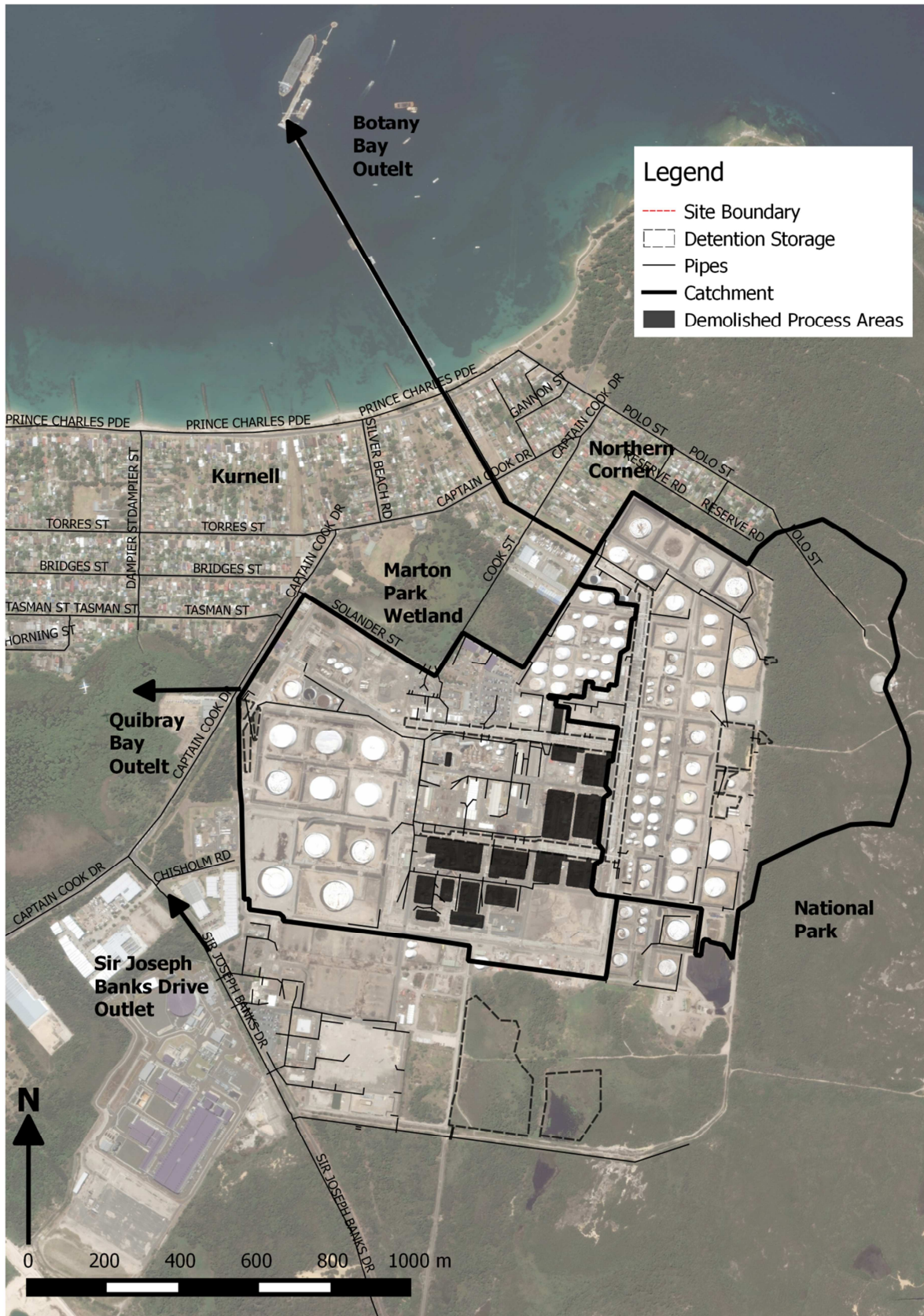
The site (and its land use) is subject to significant change as it transitions from predominately petroleum products refining to a storage and transport terminal. Stormwater flows can originate from the neighbouring national park lands, as well as on-site. Groundwater and surface flows are thought to be linked. Stormwater flooding issues exist in nearby areas. Stormwater flows within the site can pick-up pollutants and licenced stormwater discharge points exist. There are opportunities to better manage stormwater, particularly as choices are being made for land use changes, through systems operation, as well as detention and flow treatment.

The catchment area is provided in **Figure 2-1** and includes the Caltex Refinery site and surrounding Botany Bay National Park which lies upstream, east and south of the site. The upper reaches of the catchment are predominantly steep, particularly within Botany Bay National Park where slopes of up to 25% can be found. The Caltex site is highly industrialised land containing plant and equipment for refining oil and once had 56 storage tanks, of which some have now been decommissioned and removed. The refinery was built in 1956 by Caltex. On 26 July 2012, Caltex announced its decision to close the refinery in the second half of 2014, and convert it into a "major import terminal" to supply imported fuel for Australian customers.

The swamp system in the vicinity of Solander Street and Cook Street plays an important role in the drainage of the area, collecting runoff from the National Park to the east and south as well as the surrounding residential areas to the north and west. Prior to construction of the refinery, this swamp system covered a much larger area, and the Cook Street and Solander Street swamps were directly connected to each other. The northern corner of the refinery was constructed on reclaimed swamp, restricting the connectivity between the two swamps and pushing the main body of the Cook Street swamp closer to the residential properties in Cook Street. (WMA water, 2009)

The Caltex Oil Refinery site captures runoff from part of the Botany Bay National Park. The Caltex Oil Refinery's drainage system is designed to provide a level of treatment for runoff entering or generated within the site, prior to discharge into downstream areas. Runoff entering the site is therefore collected and treated along with non-oil water runoff generated within the site. Oily water runoff is contained within bunded areas, and undergoes additional treatment prior to discharge.

Figure 2-1 Study Area



2.2 Site Drainage Overview

Stormwater is managed on the site via two separate stormwater drainage networks. Each have been modelled using DRAINS hydrologic/hydraulic modelling software and are discussed in the following sections.

Stormwater System (SWS)

This system drains non-oily water runoff and includes runoff from within the site and external flow entering the site.

The Stormwater System DRAINS model was developed as part of the Caltex Refinery Kurnell Stormwater Modelling project (MHL, 2016) to assist with the sites stormwater management requirements, discuss further in **Section 2.3**.

Stormwater is discharged from the site at three main locations. The first of these is via a 1050 mm diameter pipe which runs along a drainage easement and discharges into Botany Bay near the Caltex Wharf. Flows also discharge through a 1050 mm diameter pipe under Captain Cook Drive and into Quibray Bay. Runoff from the Australian Lubricating Oil Refinery (ALOR) site to the west of site drains into an open channel, which runs along Sir Joseph Banks Drive and into Quibray Bay (WMA water, 2009). Refer to **Figure 2-1**.

- Botany Bay (note: excess flow spills to the northern corner of the site)
- Quibray Bay (note: excess flow spills to Marton Park Wetland)
- Sir Joseph Banks Drive

Oily Water System (OWS)

This system drains oily water runoff from catchment areas within the site considered to contain oily water. The oily water system drains an area of 3.45 ha, comprising the concrete and asphalt surfaces in the vicinity of the refinery's units.

The Oily Water System discharges at one location, i.e. the oily water separators in the north-western corner of the site. There are three pumps which pump flow from the oily water separators. These include; (1x) Sykes Pump @ 0.455 m³/s and (2x) G14 Pumps @ 0.164 m³/s which gives a total maximum pumped flow of 0.619 m³/s.

2.3 Recommendations from Previous Report

A DRAINS hydrologic/hydraulic model was developed as part of the Caltex Refinery Kurnell Stormwater Modelling project (MHL, 2016) to assist with the sites stormwater management requirements. This options assessment aims to follow on from the conclusions and recommendations identified in the previous report, which included:

- *With regards to stormwater management, council requires that for changes to the site that impact stormwater discharge, the peak flow must not exceed existing for a full range of storm events up to and including the 1% AEP (100 year ARI) event. However, this does*

not apply where discharge does not pass through Council stormwater drainage infrastructure.

- *Stormwater from the demolished process areas will be directed to Quibray Bay and Marton Park discharge locations. Model results demonstrate an increase in peak flow to Marton Park.*
- *Detaining flow in Pipeways A and B could help to reduce peak flows but not enough to prevent flow exceeding existing scenario flows. These pipeways also detain flow which backs up from the downstream network. Introducing a detention wall may also delay this flow entering the pipeway which could lead to negative flood impacts on site.*
- *The Stormwater Drainage model developed in the study did not account for runoff surcharging from the Oily Water Drainage System.*
- *It was recommended to undertake further investigation of the interactions between the Oily Water Drainage System and the Stormwater Drainage System. This would involve determining surcharging flows utilising the Oily Water Drainage System model and accounting for these flows in the peak flow comparison analysis.*
- *It was also recommended to confirm with council if discharge direct to Quibray Bay is exempt from the DCP requirements.*
 - *If exempt from the DCP requirements then;*
 - *Investigate discharging greater flow from the Quibray Bay outlet*
 - *Investigate increasing the capacity of the Marton Park outlet culvert*
 - *If not exempt from the DCP requirements then;*
 - *Investigate other ways to detain flow on site such as implementing bunds or utilising existing storage areas/structures*

2.4 Height Datums

The majority of drawings provided by Caltex are relative to the Kurnell Height Datum (KHD). However, the Stormwater System DRAINS model has been developed relative to the Australian Height Datum (AHD) which is 30.525m above KRD, as noted by Caltex (email from Rod Peile 19/11/2014).

2.5 Council Requirements

A review of council stormwater management requirements was undertaken to assist with defining the objectives of the proposed stormwater management options. Sutherland Shire Draft Development Control Plan (DCP) 2015 - CHAPTER 37 Stormwater and Groundwater Management (Sutherland Shire Council, 2015), was reviewed to identify requirements relevant to stormwater management on the site. Key requirements applicable to the site are provided as follows:

“1.3 Controls for All Other Built Development, Subdivision and Works

1. *The post development rate of stormwater runoff (both piped and overland) from the site shall not exceed the rate of flow of runoff from the site than would exist*

prior to the subject development occurring.

2. *The peak rate of flow for any site shall be calculated on the basis of catering for all storm events up to and including the 1% AEP (100 year ARI) event.*
3. *Where a site has a greater impervious area than the required landscaped area under SSLEP2015, the rate of stormwater runoff will be based upon a rate of flow of runoff that would occur from a site developed to its minimum required landscaped area. Where the LEP does not prescribe a minimum landscaped area, the rate of flow of stormwater runoff for any site shall be no greater than would be generated by a site having a maximum impervious area of 75%.*
4. *Where the post development rate of flow would exceed the predevelopment rate, or the rate established in accordance with subclause 2, the stormwater must be managed on site by a strategy utilising one or a combination of on-site retention and reuse, infiltration systems and on-site detention techniques. Where rainwater tanks are relied upon for stormwater management, rainwater tanks shall be assumed to be two-thirds full for the purposes of calculating peak flow and discharge.*
5. *Despite subclause 4 properties may be permitted to exceed the permissible site discharge, where it can be shown that the discharge from a property:*
 - a. *does not pass through Council stormwater drainage infrastructure e.g. natural systems such as mangroves, creeks, a pipe, culvert, bridge, overland flow path or other control source or,*
 - b. *the peak rate of flow is equal to or less than the PSD in all storm events up to and including the 1% AEP (100 year ARI) event.”*

This implies that for changes to the site that impact stormwater discharge, the peak flow must not exceed existing for a full range of storm events up to and including the 1% AEP (100 year ARI) event. However, this does not apply where discharge does not pass through Council stormwater drainage infrastructure. Discharge locations include:

- Botany Bay (note: excess flow spills to the northern corner of the site)
- Quibray Bay (note: excess flow spills to Marton Park Wetland)
- Sir Joseph Banks Drive

2.6 Other Considerations

Stormwater Quality

This report only deals with water quantity but it should be noted that water quality may also be an issue due to the change of land use as a result of the transformation. This is not to be confused with the oily water, discussed in **Section 2.2**, but are pollutants found in stormwater runoff from all types of developments. Generally the main pollutants of concern are Total

Phosphorus, Total Nitrogen, Total Suspended Solids and Gross Pollutants. Water Sensitive Urban Design (WSUD) is usually adopted to mitigate the impacts on water quality.

Erosion and Sediment Control

Erosion and sediment control should be considered. As pavements are broken up (refer to **Section 4.2**) and runoff from the demolished process areas discharges to the stormwater system, sediment needs to be captured prior discharging to the system. Failure to do so could lead to blocked pipes and similar maintenance issues. Typically design is undertaken in accordance with The Blue Book (Landcom).

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3. Stormwater Modelling

As previously discussed, a DRAINS hydrologic/hydraulic model was developed as part of the Caltex Refinery Kurnell Stormwater Modelling project (MHL, 2016) to assist with the sites stormwater management requirements.

3.1 Development of the Stormwater System DRAINS model

- A model was validated and approved by Caltex for the 2 June 2013 event for sites 4 and 7 and for also 24 March 2014 event for site 4 only.
- The configuration site at the time of the calibration event was accounted for in the models. This was the only available event data considered reliable.
- Following this the changes to the site were modelled and the model was approved by Caltex. This was the Stormwater Modelling project.
- For this stormwater management options assessment a new and improved version of DRAINS was available and has been used to undertake modelling.
- The latest version of DRAINS 2016.14 has a number of improvements as noted from communications with Bob Stack (DRAINS software developer) which make the latest version more accurate.
- In light of these updates the Caltex model has been converted to the 2016 version and a few minor adjustments made to be more functional with the latest drains version.
- It is noted that the aim of the assessment process is to compare the peak flows for pre and post construction scenarios.
- OWS & SWS DRAINS models to be run with DRAINS v2016.14
- Changes to the Stormwater Model
 - Storage in the basins must be large enough to prevent instabilities in the model. This can be achieved by reducing the channel length and adding the area to the basin. Due to instabilities in the model as a result of the additional Oily Water System flow, a number of the basins representing storages had to be increased. To balance this out, adjacent channels were decreased.
 - Changed to 20m wide flow path
 - OF3293
 - OF696
 - OF19760
 - OF19761
 - Basin B1-A Siphon from a pipe to a pump operating through to the break level
 - Included infiltration in Basin B1-B and B1-C
 - OF20 from Pit04A to Pit011
 - OF3293 weir level from 3.61 mAHD to 3.8 mAHD
 - Int Sep from 2.4 mAHD to 2.9 mAHD
 - Amendments to pipeway A to match levels provided in drawing AC-40818

- Additional sub-catchments were added to the model which do not discharge to the Stormwater System but do discharge directly to Marton Park and Quibray Bay. These areas were on the downstream boundary of the site. This was carried out to ensure all stormwater from the site is accounted for.

3.2 Interaction with the Oily Water System

The Kurnell Refinery Oily Water Sewer Model Design Report (WorleyParsons, 2011) states that:

“The above results assume that all run-off from rainfall falling on plant areas drains directly to the oily water sewer. However, Caltex’s experience to date has been that high intensity rainfall doesn’t necessarily equate to unit flooding, due to gradient variances within individual plant areas which could result in preferential run-off to pipeways.”

Similarly, the report for the Kurnell Oil Refinery Oily Water Drainage System Study (GHD, 1995) states that:

“The results of the modelling indicate that limited surcharging occurs in a 1 year ARI event, with more substantial surcharging occurring during a 2 year ARI event. The ultimate capacity of the system is approximately 1200 L/s (100 ML/d).”

This suggests that substantial surcharging of the Oily Water Drainage System occurs for around the 2 year ARI event and even greater surcharging would be expected for larger events. It is likely that most of this surcharging flow ends up in the Stormwater Drainage System or flows overland into Marton Park Wetlands.

To provide a comparison of existing and proposed site peak flows, surcharge from the Oily Water Drainage System needs to be taken into consideration. The adopted methodology is discussed in **Section 4.2**.

4. Peak Discharge Analysis

As discussed in **Section 2.5**, for changes to the site that impact stormwater discharge, the peak flow must not exceed existing for a full range of storm events up to and including the 1% AEP (100 year ARI) event. However, this does not apply where discharge does not pass through Council stormwater drainage infrastructure.

A Pre v Post - Transformation Peak Flows analysis was undertaken to compare peak flows discharging from the site and to understand the increased load on the system resulting from the demolition of the refinery process areas. Details of the Pre and Post-Transformation Scenarios were provided and confirmed by Caltex. Catchment plans of each scenario are provided in **Figure 4-1** and **Figure 4-2**, and indicate the areas to be transformed. These areas are all located within the catchment discharging to Quibray Bay. Due to interactions with and the options discussed in **Section 5**, the catchment discharging to Botany Bay was also assessed. Other areas of the site were not assessed as their peak flows will not be affected by the transformation.

The analysis was undertaken using the DRAINS stormwater model, discussed in **Section 2**. The 1, 2, 5, 10, 20, 50 and 100 year ARI (Average Recurrence Interval) storm events were analysed for 15, 25, 45 minute, 1, 1.5, 2, 3, 4.5, 6, 9, 12, 18 hour durations to determine the peak flow and critical duration.

4.1 Pre-Transformation Scenario

As discussed in **Section 3.2**, the Oily Water System surcharges in events greater than the 1 year ARI. These surcharging flows contribute to the stormwater discharge from the site and have been accounted for in the Pre-Transformation Peak Flow analysis as follows:

- The Oily Water System DRAINS model showed the system surcharges at the Oily Water System outlet, Plant 4, Plant 45.9 and Plant 11.
- Plant 11 was noted in the mark-up provided by Caltex to MHL on 24 October 2014, to drain to the Stormwater System. Hence this area was accounted for in the Stormwater System DRAINS model.
- There are three pumps which pump flow from the Oily Water System outlet. These include; (1x) Sykes Pump @ 0.455 m³/s and (2x) G14 Pumps @ 0.164 m³/s which gives a total maximum pumped flow of **0.619 m³/s**.
- The Oily Water System outlet surcharge was assumed to be the outlet discharge in excess of the pump capacity. The outlet surcharge hydrographs were derived by subtracting the pump capacity from the outlet hydrographs.
- Surcharge hydrographs from the Oily Water System outlet, Plant 4 and Plant 45.9 were extracted from the Oily Water System DRAINS model, identified in **Appendix A**.
- Oily Water System surcharge hydrographs were applied to the Stormwater System DRAINS model, as shown in **Appendix A**.

4.2 Post-Transformation Scenario

As part of the sites transition the process plants will be demolished and their oily water drainage will be decommissioned. As a result, it is expected runoff from these areas will be absorbed by the surrounding stormwater drainage network. Demolished process areas will have their pavements broken up resulting in a partially permeable surface.

Post-Transformation peak flows include flows from the proposed demolished process areas, which previously drained to the Oily Water System. The peak flows were determined as follows:

- Caltex's map of proposed Demolished Process Areas was superseded by the mark-up provided by Caltex to MHL on 24 October 2014. These areas were added to the Stormwater System DRAINS model to represent the Post-Transformation scenario. Refer to **Figure 4-2**.
- The demolished process areas will have their pavements broken up resulting in a partially permeable surface. These areas were modelled as 10% impervious as they will be highly permeable with an underlying sand base.
- Oily Water System surcharge is not applicable as the Demolished Process Areas account for the majority of sub-catchments which previously drained to the Oily Water System.

A comparison of Pre and Post-Transformation pervious/impervious catchment areas is provided in **Table 4-1**. The total pervious and impervious areas are greater for the Post-Transformation scenario. However, it must be noted that the Pre-Transformation scenario also includes surcharging flows from the Oily Water System which are not applicable to the Post-Transformation scenario.

Table 4-1 Pervious/Impervious Areas

		Pre-Transformation (ha)	Post-Transformation (ha)
To Botany Bay	Total SWS Catchment Area	47.8	47.8
	Pervious Area	28.6	28.6
	Impervious Area	19.2	19.2
To Quibray Bay	Total SWS Catchment Area	46.3	52.9
	Pervious Area	4.6	10.5
	Impervious Area	41.7	42.4

NOTE: The Total SWS (Stormwater System) Catchment Area excludes OWS (Oily Water System) areas and banded tank areas.

Caltex Kurnell

Pre-Transformation
Catchment Plan

Figure 4-1

Legend

- Site Boundary
- Stormwater Pipes
- - - Detention Storage
- Catchment
- 10% Impervious
- 90% Impervious
- Oily Water System
- Bunded Tank Areas



0 100 200 300 m



Botany Bay

PRINCE CHARLES PDE

PRINCE CHARLES PDE

GANNON ST

CAPTAIN COOK DR

POLO ST

POLO ST

SHARN ST

RESERVE RD

RESERVE RD

OWS outlet surcharge

TORRES ST

CAPTAIN COOK DR

To Botany Bay

Northern Corner

BRIDGES ST

Marton Park Wetland

To Quibray Bay

TASMAN ST

SOLANDER ST

POLO ST

National Park

OWS Plant 4 surcharge

OWS Plant 45.9 surcharge

CHISHOLM RD

SIR JOSEPH BANKS DR

Caltex Kurnell

Post-Transformation
Catchment Plan

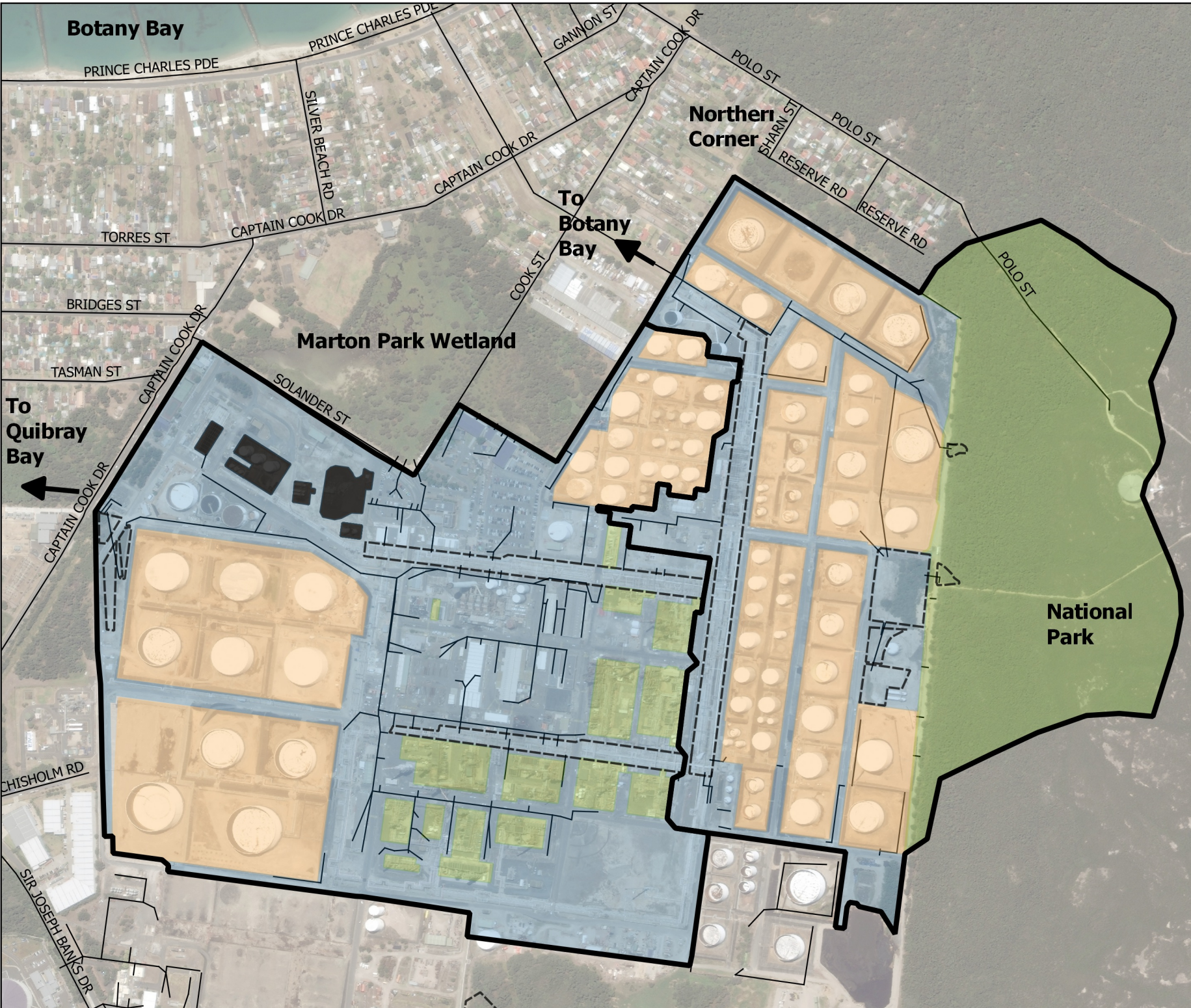
Figure 4-2

Legend

- Site Boundary
- Stormwater Pipes
- - - Detention Storage
- Catchment
- 10% Impervious
- 90% Impervious
- Oily Water System
- Bunded Tank Areas



0 100 200 300 m



4.3 Pre v Post Transformation Peak Discharge

The DRAINS models were run to derive Pre and Post Transformation peak discharge and corresponding critical durations for each of the site discharge locations, as provided in **Table 4-2**. The comparison found that peak flow did not increase at any of the discharge locations as a result of the site transformation. Therefore, the Council requirement is maintained, i.e.

“For changes to the site that impact stormwater discharge, the peak flow must not exceed existing for a full range of storm events up to and including the 1% AEP (100 year ARI) event.”

Although this outcome appears odd considering additional areas are discharging to the Stormwater System, it must be acknowledged that runoff from these areas previously surcharged from the Oil Water System in relatively minor events ending up in the Stormwater System. Also these areas were previously paved impervious areas and will be transformed to mostly pervious areas with a sandy base.

Table 4-2 Pre v Post - Transformation Peak Discharge (m³/s)

	Storm Event (ARI)	1 year	2 year	5 year	10 year	20 year	50 year	100 year
Botany Bay Outlet Pipe	Pre	0.60	0.92	1.53	1.65	1.66	1.67	1.68
	Critical Duration	25 min	25 min	1.5 hr	1.5 hr	25 min	25 min	25 min
	Post	0.60	0.93	1.53	1.65	1.66	1.68	1.68
	Critical Duration	25 min	25 min	1.5 hr	1.5 hr	25 min	25 min	25 min
Excess to Northern Corner	Pre	0.00	0.05	0.29	0.73	1.15	1.52	1.90
	Critical Duration	NA	25 min	25 min	1.5 hr	25 min	25 min	1.5 hr
	Post	0.00	0.05	0.29	0.73	1.15	1.53	1.90
	Critical Duration	NA	25 min	25 min	1.5 hr	25 min	25 min	1.5 hr
Quibray Bay	Pre	0.75	0.85	0.97	1.11	1.33	1.44	1.83
	Critical Duration	12 hr	12 hr	25 min	25 min	25 min	25 min	2 hr
	Post	0.75	0.84	0.97	1.12	1.34	1.44	1.82
	Critical Duration	12 hr	12 hr	25 min	25 min	25 min	25 min	2 hr
Excess to Marton Park Wetlands	Pre	2.17	3.00	4.14	5.12	6.42	8.15	9.45
	Critical Duration	25 min	25 min	2 hr	2 hr	1 hr	1 hr	1 hr
	Post	2.17	3.00	4.00	4.81	6.11	7.97	9.35
	Critical Duration	25 min	25 min	25 min	2 hr	1 hr	1 hr	1 hr

*ARI (Average Recurrence Interval)

5. Stormwater Management Options Assessment

5.1 Site Investigation / Meeting at Caltex to Confirm Options

A site investigation / meeting was undertaken on 7 October 2016 by Scott Marshall (MHL), Andrew Bisset (Caltex) and Pat Molloy (Caltex), to identify and discuss potential options for managing the site's stormwater. The options were identified and confirmed via email (10 October 2016). The options assessment proceeded on this basis. Key notes from the site visit were:

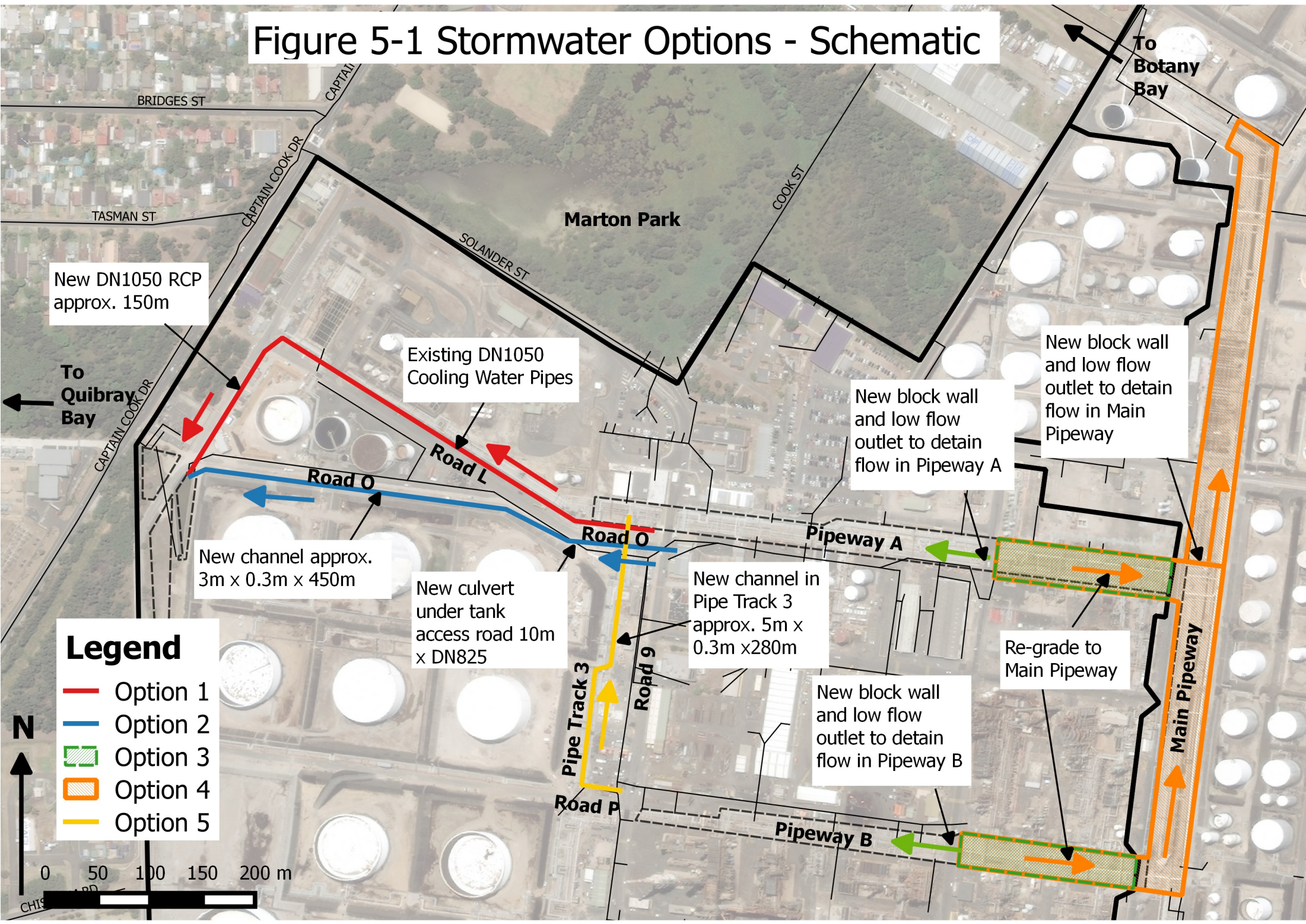
- Caltex would like Stormwater Management Options to cater for both Council requirements and to better manage flooding within the site.
- Within the site flooding occurs regularly on Road 9.
- The outlet pipe to Quibray Bay appears to have significant additional capacity during large storm events. This suggests the basins control the site discharge and not the outlet pipe. Hence it is likely that council would expect higher discharge flows from the site at this location.
- The pipes in the pipeways are being removed.
- The Cooling Water System is no longer required but the infrastructure is still in place
- The Main Pipeway has a large volume which could be used to detain runoff.
- During events when flooding is noted on Road 9, the upstream ends of Pipeways A and B are empty, i.e. there is no ponded flow.

5.2 Stormwater Management Options

It was determined in **Section 4.3** that the Council requirement is maintained for the Post-Transformation scenario. Therefore, additional on-site detention is not required for flows discharging from the site. However, during the site visit (discussed in **Section 5.1**), it was noted that flooding occurs regularly within the site on Road 9. Reducing the frequency and magnitude of flooding in this area would improve flooding within the site and hence the following stormwater management options were developed and assessed for the 2 year ARI event (refer to **Figure 5-1**). Peak discharge from the site was also checked for the events up to the 100 year ARI for each option. Options 1, 2 and 2a divert flow to and increase discharge from the Quibray Bay Outlet. As discussed in **Section 5.1**, the culvert appears to have additional capacity to discharge flow. Doing so may require negotiating with council where it should be noted that:

- The detention basins upstream of the culvert likely reduce peak flow from the original culvert design capacity.
- Discharging flow from Quibray Bay Outlet as opposed to Marton Park Wetlands is more direct and avoids more council infrastructure and residential areas.
- Any flow increase via the Quibray Bay Outlet would be maintained from the culvert only without overtopping Captain Cook Drive.

Figure 5-1 Stormwater Options - Schematic



Option 1 – Divert Flow to Quibray Bay via the Existing Cooling Water Pipes

As part of the site's transformation the cooling water system has been decommissioned. The existing infrastructure is still in place and includes a number of large pipelines which fall away from Road 9 to towards Quibray Bay. This option would involve utilising one or more of these pipelines to drain flow from Road 9. A connecting pipeline would be required at the downstream end of the pipeline near the intermediate separators to the Quibray Bay Basins. It is expected this new pipeline would be in the order of 150m x DN1050. This option would also require modifications at the upstream end of the pipeline to capture runoff on Road 9. This would likely involve installing a grated drain which crosses Road 9.

Option 2 - Divert Flow to Quibray Bay via Overland Flow

A preliminary assessment of LiDAR survey levels indicates there may be enough fall from Road 9 to the Quibray Bay Basins to divert flow overland. This option would involve constructing a speed hump to direct flow off Road 9 to a channel alongside Road O. Preliminary modelling indicates the channel would be in the order of 3m x 0.3m x 450m and a DN825 culvert would be required under the access road to Tank 603. Survey and detailed modelling is recommended if this option is adopted.

Option 3 – Detain Flow in Pipeways A and B

Pipeways A and B both spill at the downstream end before the upstream ends start to pond (refer to **Figure 5-2** for photo of a typical pipeway section). This unutilised volume would be suitable for detaining runoff. This option would involve installing detaining walls in the upstream section of the pipeways. Runoff would be detained in this upstream section and slowly released via a low flow outlet.

Figure 5-2 Photo of Typical Pipeway Section – Main Pipeway



Option 4 – Divert Flow to Botany Bay via the Main Pipeway

This option involves blocking Pipeway A and B at Road 6 effectively diverting runoff to the Main Pipeway. The retaining walls the Main Pipeway and Pipeway A and B would be removed. A detaining wall would be installed in the Main Pipeway on the downstream side of Pipeway A. The upstream ends of Pipeway A and B would be re-graded towards the Main Pipeway.

The road level at the end of Pipeway B is ~3.4 mAHD. Ideally, directing flow away from Road 9 at this location would solve much of the flooding further downstream. However, redirecting it into Pipeway B and to the Main Pipeway is not an option as the channel invert in the Main Pipeway at the intersection with Pipeway B is ~3.8 mAHD. Hence there is not enough fall to do this.

Option 5 - Divert Flow off Road 9 to Pipe Track 3

The high flows on Road 9 originate at the intersection of Road 9 and Road P. This location is a low point at the confluence of numerous flow sources. Currently, flow is discharged via 2x pumps and overland on Road 9. If the pipes on Pipe Track 3 are removed, it may be possible to redirect overland flow from Road 9 to the Pipe Track 3. Construction of a drainage channel in Pipe Track 3 would be required to run alongside Road 9, pass under the bridge on Road O and into Pipeway A. Preliminary modelling indicates the channel would be in the order of 5m x 0.3m x 280m. Survey and detailed modelling is recommended if this option is adopted.

5.3 Options Assessment

The aim of the flood management options was to reduce the frequency and magnitude of flooding on road 9. Hence the assessment was undertaken for the 2 year ARI event. Peak flows were assessed on Road 9 at the intersections with Road P and Road O. Results are provided in **Table 5-1**. The subsequent peak discharge from the site was also assessed and results are provided in **Appendix B**.

Table 5-1 Options Assessment - 2 Year ARI Peak Flows Within the Site (m³/s)

Scenario	Road 9 at Road P	Road 9 at Road O
Post	2.18	2.35
<i>Critical Duration</i>	<i>2 hr</i>	<i>2 hr</i>
Post – Option 1	2.18	1.73
<i>Critical Duration</i>	<i>2 hr</i>	<i>2 hr</i>
Post – Option 2	2.18	0.84
<i>Critical Duration</i>	<i>2 hr</i>	<i>2 hr</i>
Post – Option 3	2.18	2.35
<i>Critical Duration</i>	<i>2 hr</i>	<i>2 hr</i>
Post – Option 4	2.18	2.35
<i>Critical Duration</i>	<i>2 hr</i>	<i>2 hr</i>
Post – Option 5	0.00	1.40
<i>Critical Duration</i>	-	<i>25 min</i>

From the Options Assessment results, provided in **Table 5-1** and **Appendix B**, the following conclusions were made:

Option 1 – Divert Flow to Quibray Bay via the Existing Cooling Water Pipes

- Within Site: Road 9 at Road O peak flow was decreased slightly.
- From Site: Quibray Bay peak discharge increased but did not overtop Captain Cook Drive. Marton Park peak discharge decreased slightly.

Option 2 - Divert Flow to Quibray Bay via Overland Flow

- Within Site: Road 9 at Road O peak flow decreased.
- From Site: Quibray Bay peak discharge increased but did not overtop Captain Cook Drive. Marton Park peak discharge decreased slightly.

Option 3 – Detain Flow in Pipeways A and B

- Within Site: Peak flow on Road 9 was unchanged.
- From Site: Marton Park peak discharge increased slightly for the 100 year ARI event.

Option 4 – Divert Flow to Botany Bay via the Main Pipeway

- Within Site: Peak flow on Road 9 was unchanged.
- From Site: Marton Park peak discharge increased slightly for the 100 year ARI event.

Option 5 - Divert Flow off Road 9 to Pipe Track 3

- Within Site: Road 9 at Road P and Road O peak flow decreased.
- From Site: Peak site discharge remained the same.

5.4 Preliminary cost estimates

Preliminary cost estimates are provided in **Table 5-2** and are approximate estimates only developed for comparative purposes. Prices were estimated based on rates from Rawlinsons - Australian Construction Handbook 2015. Hence the rates are for 2015 and are likely slightly different for 2016. Details of the estimates are provided in **Appendix C**.

Table 5-2 Cost Estimates

Option	Cost Estimate
Option 1 – Divert Flow to Quibray Bay via the Existing Cooling Water Pipes	\$230k
Option 2 - Divert Flow to Quibray Bay via Overland Flow	\$110k
Option 3 – Detain Flow in Pipeways A and B	\$30k
Option 4 – Divert Flow to Botany Bay via the Main Pipeway	\$120k
Option 5 - Divert Flow off Road 9 to Pipe Track 3	\$110k

5.5 Advantages / Disadvantages

Advantages and disadvantages of each option are provided in **Table 5-3**.

Table 5-3 Advantages / Disadvantages

	Option	1	2	3	4	5
Advantages						
Reduces stormwater on Road 9 at Road O		x	x			x
Reduces stormwater on Road 9 at Road P						x
<\$50k				x		
Disadvantages						
Does not reduce peak flows on Road 9				x	x	
Increases peak flows to Quibray Bay		x	x			
Increases peak flows to Marton Park				x	x	
>\$200k		x				
May conflict with underground services		x	x			x

From the assessment Option 5 is considered the most effective option at managing stormwater on Road 9 and is in a similar ball park with regards to cost as Option 2 and Option 4. This option would also utilise the narrow area between Road 9 and the tank farm compounds, an area unlikely to be of use for storage due to its narrow shape but is out of the way with regards to vehicular and pedestrian traffic.

6. Conclusions and Recommendations

6.1 Conclusions

From the Options Assessment it was concluded that:

- Council requires that for changes to the site that impact stormwater discharge, the peak flow must not exceed existing for a full range of storm events up to and including the 100 year ARI event. However, this does not apply where discharge does not pass through Council stormwater drainage infrastructure. This report only deals with water quantity, not quality.
- The report for the Kurnell Oil Refinery Oily Water Drainage System Study (GHD, 1995) states suggests that substantial surcharging of the Oily Water Drainage System occurs for the 2 year ARI event and even greater surcharging would be expected for larger events. It is likely that most of this surcharging flow ends up in the Stormwater Drainage System or flows overland into Marton Park Wetlands.
- The previous DRAINS model developed as part of the Caltex Refinery Kurnell Stormwater Modelling project (MHL, 2016) was updated to account for interactions between the Oily Water System drainage and the Stormwater System drainage. This involved extracting surcharge hydrographs from the Oily Water System DARINS model and applying them to the Stormwater System DRAINS model.
- A Pre v Post - Transformation peak discharge analysis was undertaken to compare peak flows discharging from the site and to understand the increased load on the system resulting from the demolition of the refinery process areas. Details of the Pre and Post-Transformation Scenarios were provided and confirmed by Caltex. The comparison found that peak discharge did not increase at any of the discharge locations as a result of the site transformation. Therefore, the Council requirement is maintained. This outcome was a result of the Oily Water System surcharging to the Stormwater System in the Pre-Transformation scenario and the transformation of the process areas from mostly impervious to mostly pervious.
- Flooding occurs regularly on Road 9. Reducing the frequency/magnitude of flooding in this area would improve stormwater management within the site. Site stormwater options were assessed with regards to the 2 year ARI event.
- Option 1 – Divert Flow to Quibray Bay via the Existing Cooling Water Pipes
 - Within Site: Road 9 at Road O peak flow was decreased slightly.
 - From Site: Quibray Bay peak discharge increased but did not overtop Captain Cook Drive. Marton Park peak discharge decreased slightly.
 - Cost estimate - \$230k
- Option 2 - Divert Flow to Quibray Bay via Overland Flow
 - Within Site: Road 9 at Road O peak flow decreased.
 - From Site: Quibray Bay peak discharge increased but did not overtop Captain Cook Drive. Marton Park peak discharge decreased slightly.
 - Cost estimate - \$110k

- Option 3 – Detain Flow in Pipeways A and B
 - Within Site: Peak flow on Road 9 was unchanged.
 - From Site: Marton Park peak discharge increased slightly for the 100 year ARI event.
 - Cost estimate - \$30k
- Option 4 – Divert Flow to Botany Bay via the Main Pipeway
 - Within Site: Peak flow on Road 9 was unchanged.
 - From Site: Marton Park peak discharge increased slightly for the 100 year ARI event.
 - Cost estimate - \$120k
- Option 5 - Divert Flow off Road 9 to Pipe Track 3
 - Within Site: Road 9 at Road P and Road O peak flow decreased.
 - From Site: Peak site discharge remained the same.
 - Cost estimate - \$110k

6.2 Recommendations

Following the options assessment it is recommended to:

- Progress Option 5 - Divert Flow off Road 9 to Pipe Track 3 including undertaking survey to confirm levels for detailed design.
- Adopt sediment and erosion control measures in accordance with “The Blue Book” (Landcom) as part of the site transformation

7. References

- GHD. (1995). *Kurnell Oil Refinery Oily Water Drainage System Study*.
- Landcom. (n.d.). *Managing urban stormwater ("The Blue Book")*.
- MHL. (2016). *Caltex Refinery Kurnell Stormwater Modelling*.
- NSW Public Works - MHL. (2014). *Caltex Kurnell Refinery Flow Monitoring Progress Report, June 2014 – Novemebr 2014*.
- Sutherland Shire Council. (2015). *Draft Development Control Plan (DCP) 2015 - CHAPTER 37 Stormwater and Groundwater Management*.
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- WorleyParsons. (2011). *Kurnell Refinery Oily Water Sewer Model Design Report*.

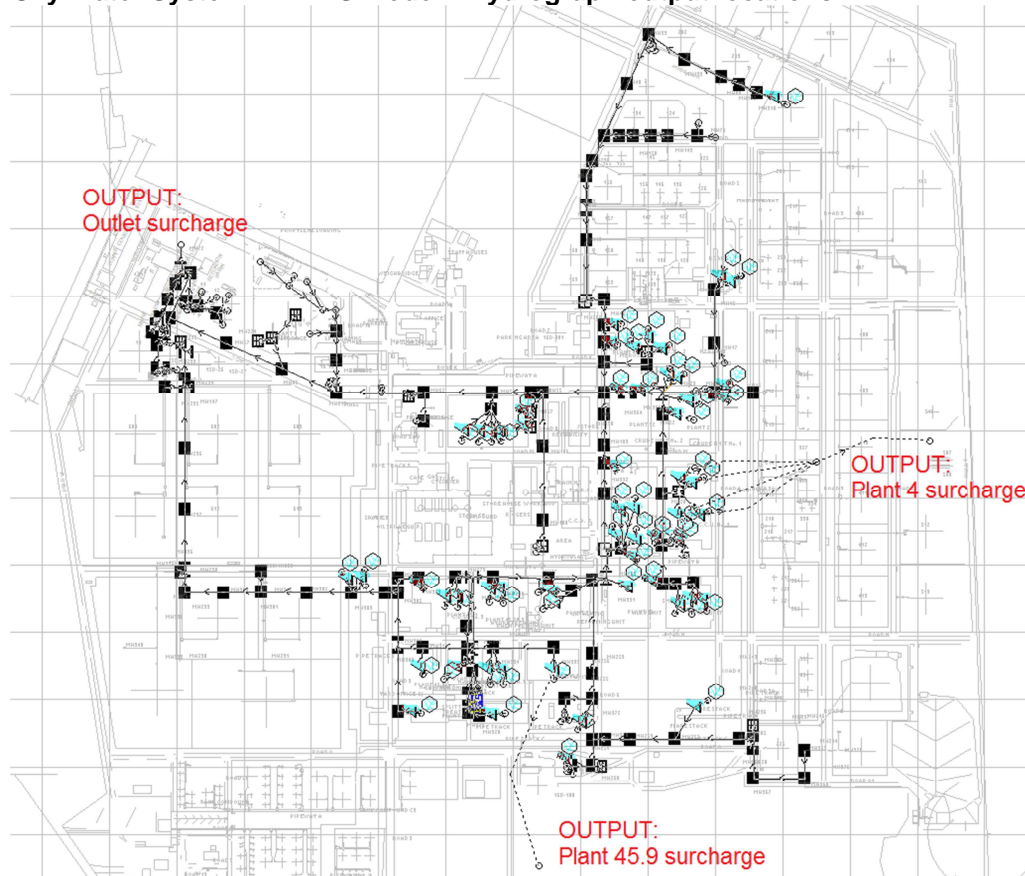
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Appendix A

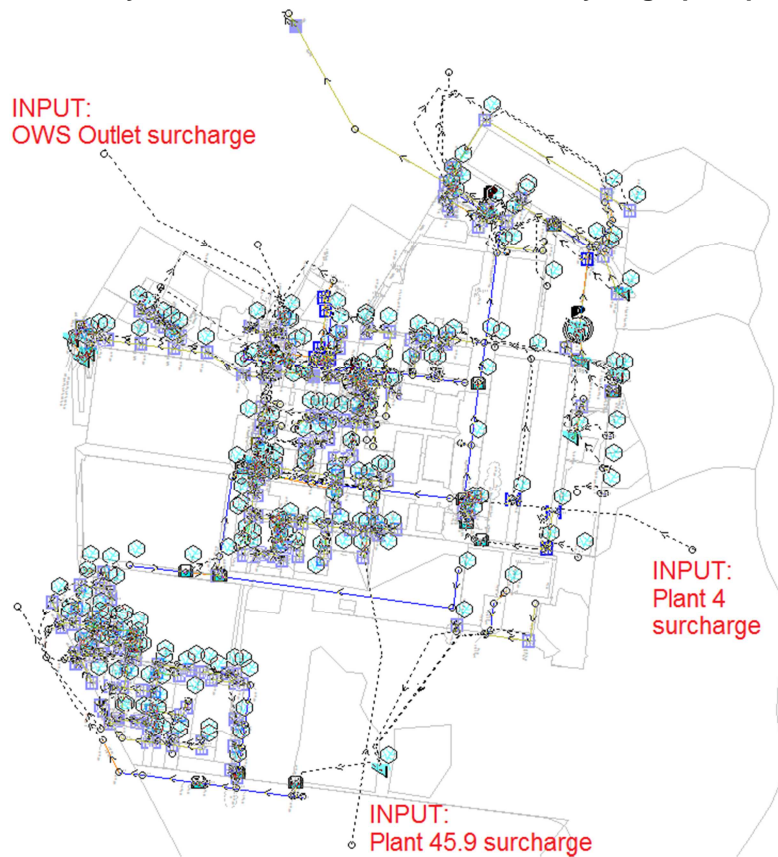
DRAINS Model Schematics (OWS & SWS)

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Oily Water System DRAINS model – hydrograph output locations



Stormwater System DRAINS model schematic – hydrograph input locations



Appendix B

Stormwater Management Options – Peak Flows & Notes

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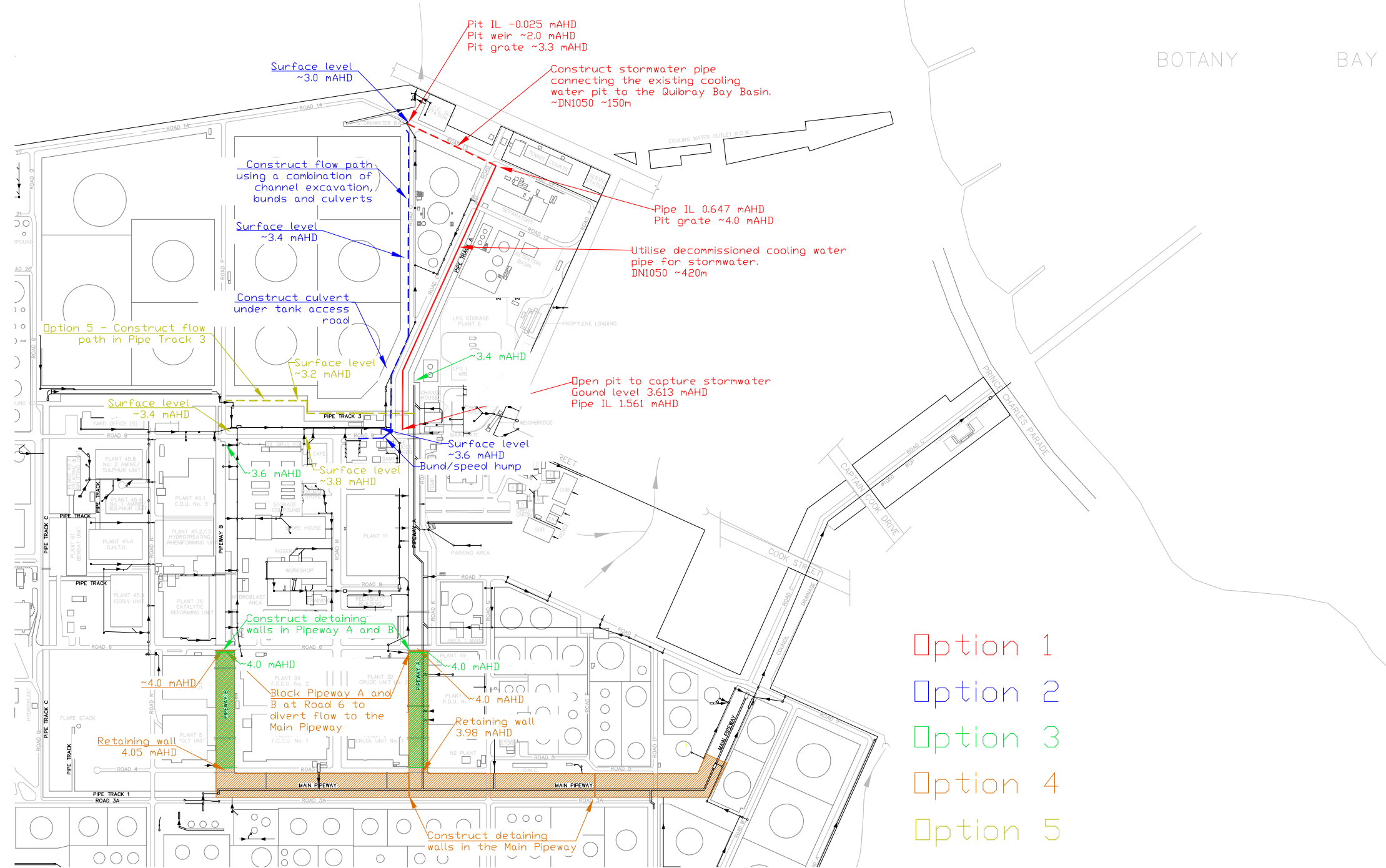
Stormwater Management Options: Pre v Post - Transformation Peak Flows (m³/s)

Exceeds Pre-Transformation conditions

	Storm Event	1 year ARI	2 year ARI	5 year ARI	10 year ARI	20 year ARI	50 year ARI	100 year ARI
Botany Bay Outlet Pipe	Pre	0.60	0.92	1.53	1.65	1.66	1.67	1.68
	Critical Duration	25 min	25 min	1.5 hr	1.5 hr	25 min	25 min	25 min
	Post	0.60	0.93	1.53	1.65	1.66	1.68	1.68
	Critical Duration	25 min	25 min	1.5 hr	1.5 hr	25 min	25 min	25 min
	Post – Option 1	0.60	0.93	1.53	1.65	1.66	1.68	1.68
	Critical Duration	25 min	25 min	1.5 hr	1.5 hr	25 min	25 min	25 min
	Post – Option 2	0.60	0.93	1.53	1.65	1.66	1.68	1.68
	Critical Duration	25 min	25 min	1.5 hr	1.5 hr	25 min	25 min	25 min
	Post – Option 3	0.60	0.92	1.53	1.65	1.66	1.68	1.68
	Critical Duration	25 min	25 min	1.5 hr	1.5 hr	25 min	25 min	25 min
Excess from Northern Corner	Pre	0.00	0.05	0.29	0.73	1.15	1.52	1.90
	Critical Duration	NA	25 min	25 min	1.5 hr	25 min	25 min	1.5 hr
	Post	0.00	0.05	0.29	0.73	1.15	1.53	1.90
	Critical Duration	NA	25 min	25 min	1.5 hr	25 min	25 min	1.5 hr
	Post – Option 1	0.00	0.05	0.29	0.73	1.15	1.53	1.90
	Critical Duration	NA	25 min	25 min	1.5 hr	25 min	25 min	1.5 hr
	Post – Option 2	0.00	0.05	0.29	0.73	1.15	1.53	1.90
	Critical Duration	NA	25 min	25 min	1.5 hr	25 min	25 min	1.5 hr
	Post – Option 3	0.00	0.05	0.29	0.73	1.14	1.53	1.90
	Critical Duration	NA	25 min	25 min	1.5 hr	25 min	25 min	1.5 hr
Quibray Bay	Pre	0.75	0.85	0.97	1.11	1.33	1.44	1.83
	Critical Duration	12 hr	12 hr	25 min	25 min	25 min	25 min	2 hr
	Post	0.75	0.84	0.97	1.12	1.34	1.44	1.82
	Critical Duration	12 hr	12 hr	25 min	25 min	25 min	25 min	2 hr
	Post – Option 1	1.13	1.20	1.37	1.46	1.63	2.02	2.48
	Critical Duration	3 hr	4.5 hr	12 hr	12 hr	4.5 hr	2 hr	2 hr
	Post – Option 2	1.19	1.57	1.93	2.14	2.27	2.43	2.86
	Critical Duration	2 hr	2 hr	4.5 hr	3 hr	4.5 hr	9 hr	2 hr
	Post – Option 3	0.75	0.85	0.97	1.12	1.33	1.43	1.82
	Critical Duration	12 hr	12 hr	25 min	25 min	25 min	25 min	2 hr
Excess to Marton Park Wetlands	Pre	2.17	3.00	4.14	5.12	6.42	8.15	9.45
	Critical Duration	25 min	25 min	2 hr	2 hr	1 hr	1 hr	1 hr
	Post	2.17	3.00	4.00	4.81	6.11	7.97	9.35
	Critical Duration	25 min	25 min	25 min	2 hr	1 hr	1 hr	1 hr
	Post – Option 1	2.17	2.99	3.98	4.59	5.48	7.32	8.70
	Critical Duration	25 min	25 min	25 min	25 min	2 hr	1 hr	1 hr
	Post – Option 2	2.17	3.00	4.00	4.61	5.37	6.35	7.70
	Critical Duration	25 min	25 min	25 min	25 min	25 min	1 hr	1 hr
	Post – Option 3	2.17	3.00	4.00	4.61	6.03	7.80	9.66
	Critical Duration	25 min	25 min	25 min	25 min	2 hr	1 hr	1 hr
Excess to Marton Park Wetlands	Post – Option 4	2.17	3.00	4.00	4.61	6.03	7.80	9.65
	Critical Duration	25 min	25 min	25 min	25 min	2 hr	1 hr	1 hr
	Post – Option 5	2.17	3.00	4.00	4.81	6.11	7.97	9.35
	Critical Duration	25 min	25 min	25 min	2 hr	1 hr	1 hr	1 hr

Stormwater Manage Options

BOTANY BAY



- Option 1
- Option 2
- Option 3
- Option 4
- Option 5

Appendix C
Cost Estimates

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Cost Estimates - Caltex Kurnell Stormwater Management Options

NOTES

Prices were estimated based on rates from Rawlinsons - Australian Construction Handbook 2015
The estimates are based on 2015 rates but are suitable for comparative purposes
Prices are approximate estimates only

ITEM No.	Description	No.	Units	unit	Cost per unit	Total
Option 1 – Divert Flow to Quibray Bay via the Cooling Water Pipes						
1 SITE ESTABLISHMENT						
1.1	Site establishment and disestablishment	1	Item	Lump Sum		\$5,000
1.2	Survey and Pegging out Works	1	Item	Lump Sum		\$1,500
2 ENVIRONMENTAL MANAGEMENT						
2.1	Erosion & Sedimentation Control Measures during Construction	1	Item	Lump Sum		\$4,000
2.2	OH&S Procedure	1	Item	Lump Sum		\$2,000
3 STORMWATER DRAINAGE WORKS						
3.1	Excavation - pipe trench in sand	450	m ³	\$52		\$23,400
3.3	Reinstating disturbed surfaces	1	Item	Lump Sum		\$10,000
3.4	Regrading of the upstream surface to capture runoff on Road 9 into the existing pipeline?					
3.5	Supply and Install connecting DN1050 RCP pipeline	150	m	\$485		\$72,750
3.6	Supply and Install grated drain to capture flow on Road 9	30	m	\$600		\$18,000
4 DETAILED DESIGN & CONTINGENCY						
4.1	Project supervision	10	%			\$13,665
4.2	SID	15	%			\$20,498
4.3	Contingency	45	%			\$61,493
Total						\$232,305
Option 2 - Divert Flow to Quibray Bay via Overland Flow						
1 SITE ESTABLISHMENT						
1.1	Site establishment and disestablishment	1	Item	Lump Sum		\$5,000
1.2	Survey and Pegging out Works	1	Item	Lump Sum		\$1,500
2 ENVIRONMENTAL MANAGEMENT						
2.1	Erosion & Sedimentation Control Measures during Construction	1	Item	Lump Sum		\$4,000
2.2	OH&S Procedure	1	Item	Lump Sum		\$2,000
3 STORMWATER DRAINAGE WORKS						
3.1	Excavation of channel - cut and fill sand (3m x 0.3m x 450m)	405	m ³	\$18		\$7,290
3.2	Disposal of Excess Materials	1	Item	Lump Sum		\$10,000
3.3	Stabilization of channel - Provide and Install Bidim A34 Geotextile (5m x 450m)	1350	m ²	\$20		\$27,000
3.4	Pipe-culvert under road access to tank farm DN 825mm includes excavation and backfilling	10	m	\$370		\$3,700
3.5	(2x) headwalls	2		\$1,500		\$3,000
3.6	Speed hump to direct flow off Road 9	1		\$2,000		\$2,000
4 DETAILED DESIGN & CONTINGENCY						
4.1	Project supervision	10	%			\$6,549
4.2	SID	15	%			\$9,824
4.3	Contingency	45	%			\$29,471
Total						\$111,333
Option 3 – Detain Flow in Pipeways A and B						
1 SITE ESTABLISHMENT						
1.1	Site establishment and disestablishment	1	Item	Lump Sum		5000
1.2	Survey and Pegging out Works	1	Item	Lump Sum		1500
2 ENVIRONMENTAL MANAGEMENT						
2.1	Erosion & Sedimentation Control Measures during Construction	1	Item	Lump Sum		4000
2.2	OH&S Procedure	1	Item	Lump Sum		2000
3 STORMWATER DRAINAGE WORKS						
3.1	Block Wall - Pipeway A (0.6m x 30m)	18	m ²	\$136		\$2,439
3.2	Block Wall - Pipeway B (1.0m x 28.6m)	28.6	m ²	\$136		\$3,875
4 DETAILED DESIGN & CONTINGENCY						
4.1	Project supervision	10	%			\$1,881
4.2	SID	15	%			\$2,822
4.3	Contingency	45	%			\$8,466
Total						\$31,984

ITEM No.	Description	No. Units	unit	Cost per unit	Total
Option 4 – Divert Flow to Botany Bay via the Main Pipeway					
1 SITE ESTABLISHMENT					
1.1	Site establishment and disestablishment	1	Item	Lump Sum	\$5,000
1.2	Survey and Pegging out Works	1	Item	Lump Sum	\$1,500
2 ENVIRONMENTAL MANAGEMENT					
2.1	Erosion & Sedimentation Control Measures during Construction	1	Item	Lump Sum	\$4,000
2.2	OH&S Procedure	1	Item	Lump Sum	\$2,000
3 STORMWATER DRAINAGE WORKS					
3.1	Block Wall - Pipeway A (0.6m x 30m)	18	m ²	\$136	\$2,439
3.2	Block Wall - Pipeway B (1.0m x 28.6m)	28.6	m ²	\$136	\$3,875
3.3	Block Wall - Main Pipeway (1.0m x 32.7m)	32.7	m ²	\$136	\$4,431
3.4	Regrade Pipeway A towards Main Pipeway - cut and fill sand (0.5m x 30m x 180m)	2700	m ³	\$10	\$27,000
3.5	Regrade Pipeway A towards Main Pipeway - cut and fill sand (0.5m x 30m x 180m)	2700	m ³	\$10	\$27,000
4 DETAILED DESIGN & CONTINGENCY					
4.1	Project supervision	10	%		\$5,843
4.2	SID	15	%		\$8,765
4.3	Contingency	45	%		\$26,294
Total					\$118,147
Option 5 - Divert Flow off Road 9 to Pipe Track 3					
1 SITE ESTABLISHMENT					
1.1	Site establishment and disestablishment	1	Item	Lump Sum	\$5,000
1.2	Survey and Pegging out Works	1	Item	Lump Sum	\$1,500
2 ENVIRONMENTAL MANAGEMENT					
2.1	Erosion & Sedimentation Control Measures during Construction	1	Item	Lump Sum	\$4,000
2.2	OH&S Procedure	1	Item	Lump Sum	\$2,000
3 STORMWATER DRAINAGE WORKS					
3.1	Excavation of channel - cut and fill sand (5m x 0.3m x 280m)	420	m ³	\$18	\$7,560
3.2	Disposal of Excess Materials	1	Item	Lump Sum	\$15,000
3.3	Stabilization of channel - Provide and Install Bidim A34 Geotextile (5m x 650m)	1400	m ²	\$20	\$28,000
4 DETAILED DESIGN & CONTINGENCY					
4.1	Project supervision	10	%		\$6,306
4.2	SID	15	%		\$9,459
4.3	Contingency	45	%		\$28,377
Total					\$107,202

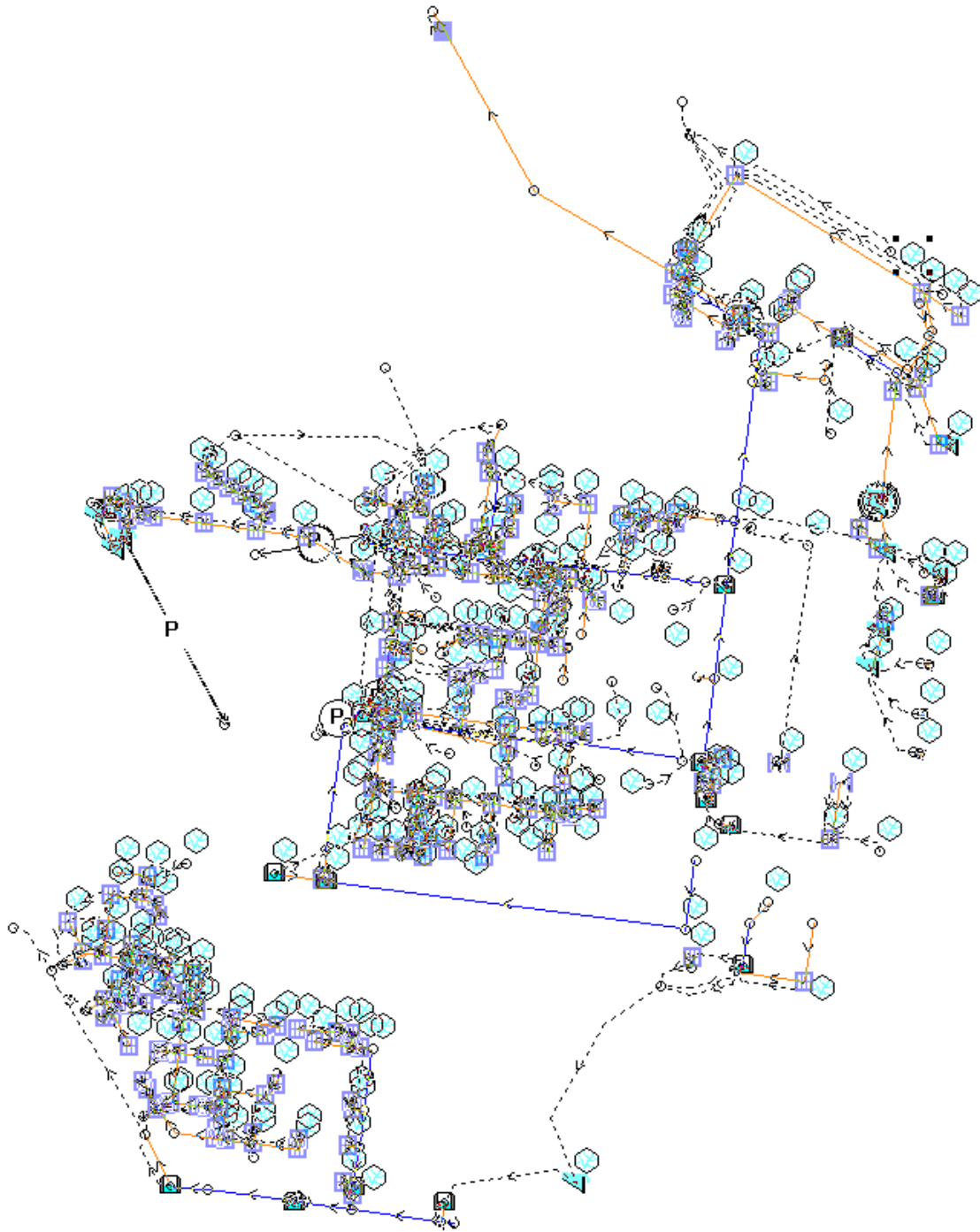
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Appendix B

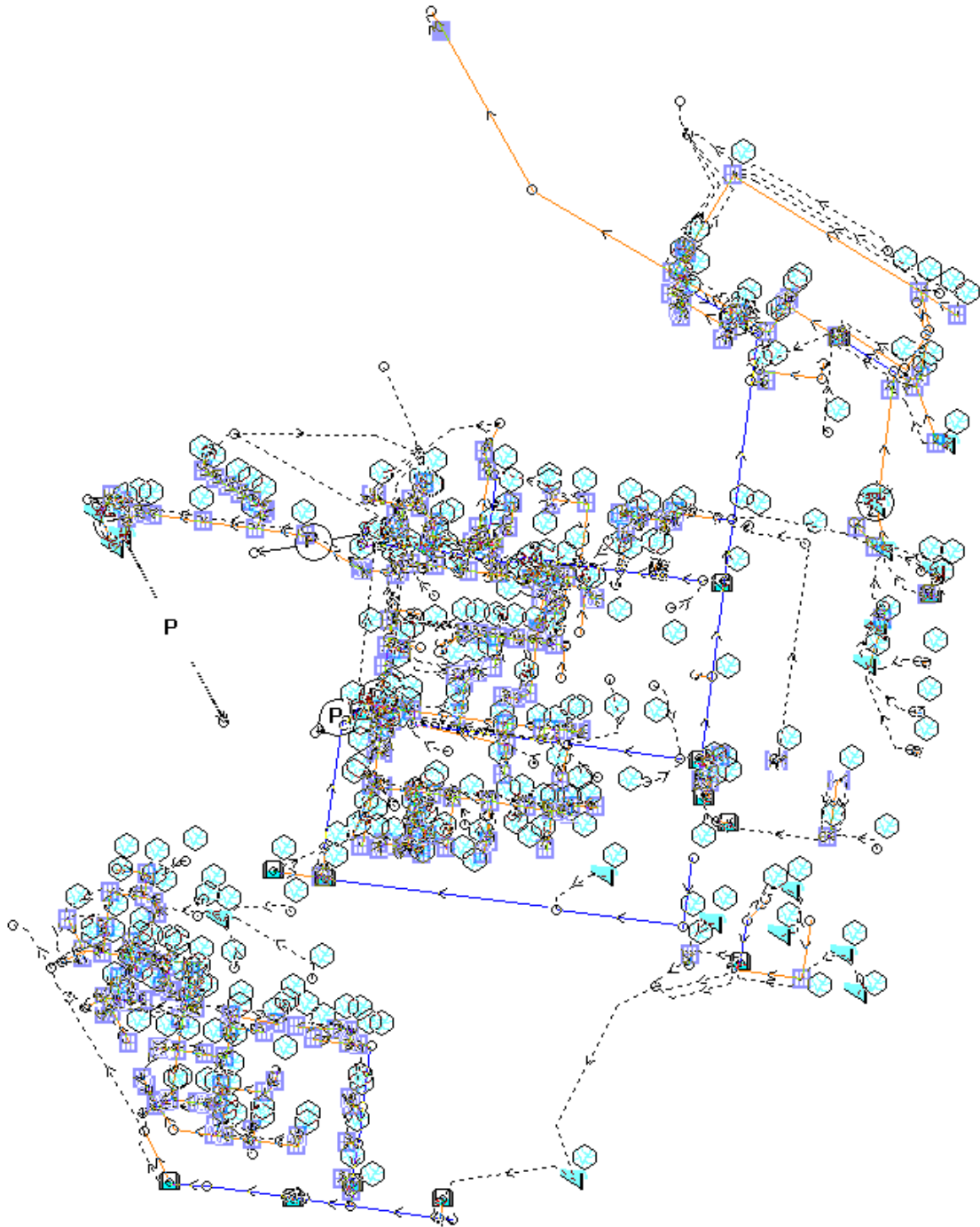
DRAINS Model Layouts

Appendix B DRAINS Model Layouts

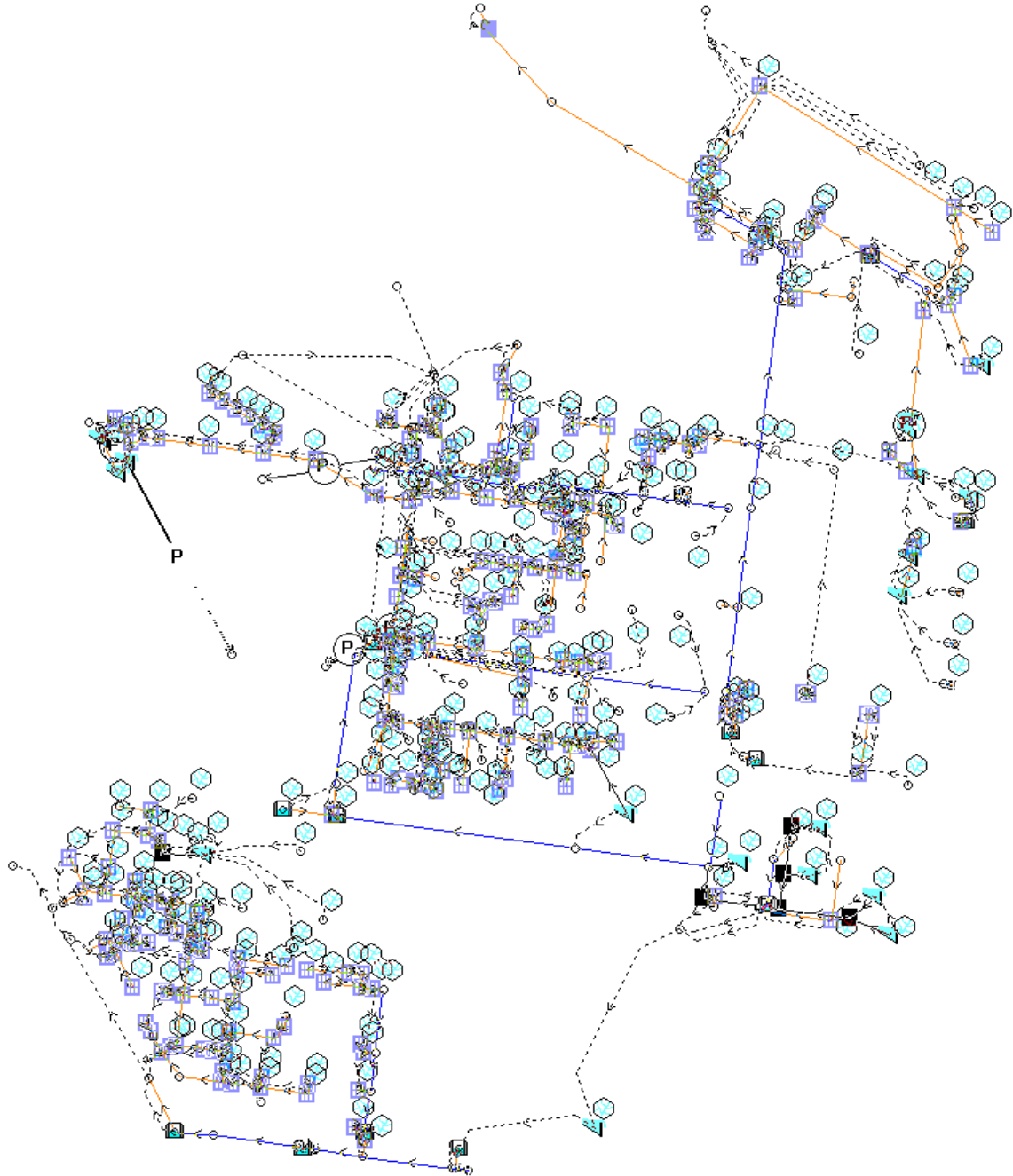
Pre-modification DRAINS model



Post-modification DRAINS model (without stormwater management measures)



Post-modification DRAINS model (with stormwater management measures)



Annexure B

Flood Modelling Report

Kurnell Terminal SSD-5544 MOD-7

Annexure B - Baseline Flood Modelling Report

30 Jan 2026

Kurnell Terminal SSD-5544 MOD-7

Annexure B - Baseline Flood Modelling Report

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Abbreviations

Abbreviation	Expansion
AECOM	AECOM Australia Pty Ltd
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
Ampol	Ampol Australia Petroleum Pty Ltd
ARF	Areal Reduction Factor
ARR	Australian Rainfall and Runoff
BESS	Battery Energy Storage System
BoM	Bureau of Meteorology
CLOR	Caltex Lubricating Oil Refinery
Council	Sutherland Shire Council
DCP	Development Control Plan
DEM	Digital Elevation Model
DPE	NSW Department of Planning and Environment
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EWL	Environment Protection Licence
FWS	Firewater System
HDPE	High-Density Polyethylene
IFD	Intensity-Frequency-Duration
IPCC	Intergovernmental Panel on Climate Change
KEIP	Kurnell Energy and Industry Precinct
KSSIP	Kurnell Stormwater Separation Improvement Project
LEP	Local Environmental Plan
LGA	Local Government Area
MHL	Manly Hydraulics Laboratory
MOD-7	Kurnell Terminal SSD-5544 Modification 7
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
OWS	Oily Water Sewer
RPIP	Refining Process Improvement Project
SGS	Sub-Grid Sampling
SLR	Sea Level Rise
SSD	State Significant Development
SSIP	Stormwater Separation Improvement Project
SSP	Shared Socio-economic Pathway
SWS	Stormwater System
WWTP	Wastewater Treatment Plant

1.0 Introduction

1.1 Background

The Kurnell Terminal (the Site) is located on the southern side of Botany Bay, in Kurnell, New South Wales (NSW). In 2012, Ampol Refineries (NSW) Pty Ltd (Ampol) decided that the oil refinery and fuel terminal would be converted to a finished product terminal (the approved project), ceasing refinery operations in 2014.

Development consent was received to complete the approved project under State Significant Development (SSD) application reference 5544 (SSD-5544). Ampol has modified SSD-5544 six times to complete the conversion and demolition works.

Ampol intends to consolidate operational infrastructure, remove redundant assets, and undertake remediation. Completion of these works (the proposed modification, MOD-7) would continue the viable, safe, reliable, and sustainable operation of the Kurnell Terminal. The location within the Site that these works would occur is referred to as the Project Area.

Further information on the Site and the proposed modification can be found in the Updated Stormwater, Wastewater and Flooding Report (Appendix G of the Submissions Report), to which this report is appended.

The purpose of this document is to show the existing conditions flooding within the Site. Existing conditions hydrologic and hydraulic modelling has been undertaken as part of this assessment to determine the current stormwater characteristics onsite. The analysis provides a detailed understanding of catchment behaviour, drainage performance, and offsite flooding interactions under a range of design storm events.

1.2 Catchment description

The Site is part of the Georges River catchment, which encompasses all areas draining the Georges River and tributaries to Botany Bay. The Georges River catchment spans approximately 960 square kilometres (km²). The Georges River originates about 60 km southwest of the Sydney Central Business District near the town of Appin and flows north towards Liverpool, before turning east at Chipping Norton Lakes to the mouth of the river at Botany Bay (Georges Riverkeeper, 2024a). The river has a number of key tributaries like Bunbury Curran Creek, Cabramatta Creek, Prospect Creek, Mill Creek and Woronora River. The Site is located within an area identified as “Waterways affected by urban development” and is bordered by estuaries and National Park areas.

The Site is located within Botany Bay, on the Kurnell Peninsula and is surrounded by marine and estuarine surface water bodies, which constitute the receiving environment for surface water discharges from the Site. The main water bodies in proximity to the Site include the Tasman Sea, Botany Bay, Quibray Bay, and the Marton Park Wetland, as shown in Figure 1-2.

The Botany Bay Catchment has four main sub-catchments, based on the major river systems and other areas which drain to it. The catchment encompasses an area of approximately 6.5km², of which approximately 25% is national park, 15% is residential, 20% is swamp or wetland, and 40% is industrial.

The upper reaches of the catchment are predominantly steep, particularly within Botany Bay National Park where slopes of up to 25% can be found. However, the lower reaches of the catchment, including the Kurnell Township itself, is typically flat and low lying. Elevations are generally below 3 m Australian Height Datum (AHD) apart from the northeast corner, which reaches approximately 19.5 m AHD.



Figure 1-1 Site boundary

There are no defined watercourses through the Site, but stormwater runoff from the external catchment and from within the Site are conveyed through the Site and discharge to Botany Bay. Stormwater runoff generated on the site are generally drained through Stormwater System (SWS). The purpose of the SWS is to collect runoff from areas of the Site that have been designated low risk with respect to interaction with petroleum products, including primarily the 'non-process' areas of the Site, such as roadways and building roofs. Stormwater is discharged offsite into receiving water bodies, Quibray Bay (including the Towra Point Nature Reserve Ramsar wetland area), Botany Bay, the Marton Park Wetland or coastal wetlands to the south of the Site.

The Site has a separate Oily Water System (OWS) to handle water that is or may be impacted by petroleum products, including a proportion of stormwater runoff collected from areas where there is or may be interaction with petroleum products such as tanks, bunds, and former refinery process areas. This water is treated at the Wastewater Treatment Plant (WWTP) prior to being discharged to the Tasman Sea under Environmental Protection Licence (EPL) 837.

There are six main stormwater catchments draining to the SWS. The detail of the sub-catchments are demonstrated in Table 1-1 and catchment boundary is shown in Figure 1-2.

Table 1-1 Existing stormwater catchments

Catchment	Area (ha)	Discharge point	Description
A	67	Botany Bay	Eastern and northern area of the Site which discharges directly to Botany Bay via a single piped outlet (A1).
B ¹	70	Quibray Bay	Central portion of the Site which drains to an on-site stormwater retention basin prior to discharging to an open channel on the northern side of Captain Cook Drive at outlet B1. This open channel then directly connects to Quibray Bay.
C	6	Marton Park Wetland	Northern corner of the Site which discharges directly to the Marton Park Wetland via six separate drainage outlets (C1-C6). The Marton Park Wetland eventually discharges further downstream, towards Quibray Bay.
E	26	Sir Joseph Banks Drive	South-western corner of the Site that discharges to an existing open channel along the western side of Sir Joseph Banks Drive via four separate drainage outlets (E1-E4). This open channel drains in a northerly direction, towards Quibray Bay.
F	108	Natural Retention Basin	South-eastern corner of the Site, which predominately comprises relatively undeveloped land including a large portion of the Kamay Botany Bay National Park. This catchment drains to a natural retention basin located at the southern end of the Site. When this retention basin spills, it overflows to an existing open channel along the southern boundary of the Site at outlet F1, which then connects to Sir Joseph Banks Drive.
G	19	Council-owned drains	North-eastern undeveloped area mostly outside of the Site boundary, which is part of the Kamay Botany Bay National Park. This area drains along the northern side of the Site via the Catchment G drain, towards a natural depression storage area at the north-eastern corner of the Site. This storage eventually spills to a Council-owned drainage system that connects to the Marton Park Wetland.

Notes: 1 – The formerly designated Catchment D is no longer a separate catchment and is now part of Catchment B.

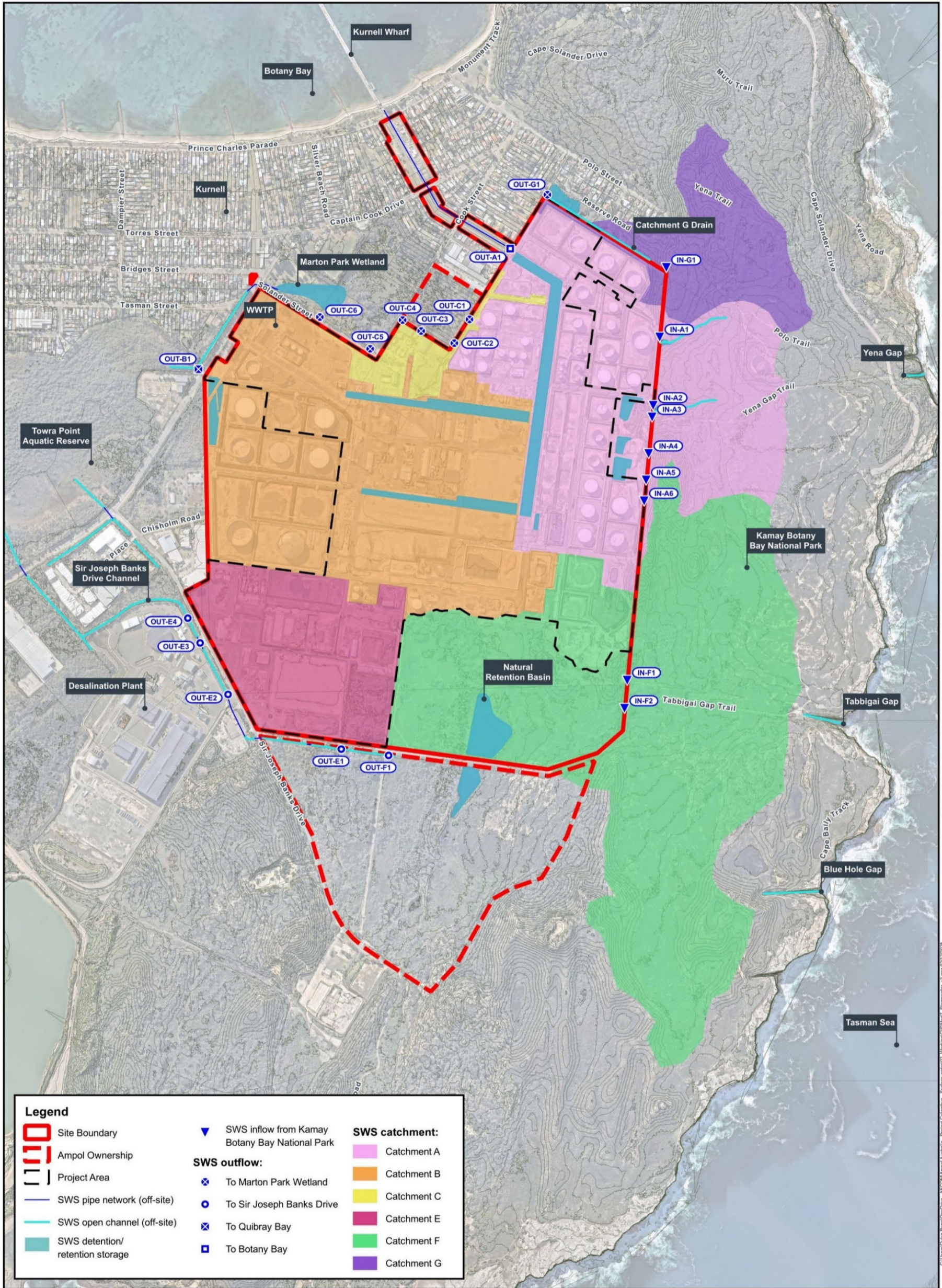


Figure 1-2 Catchment boundary

1.3 Existing stormwater improvements

Ampol has recently implemented the Kurnell Stormwater Separation Improvement Project (KSSIP) to minimise the risk of hydrocarbon-contaminated floodwater leaving the Site. This upgrade project was included in the baseline model and includes:

- A 1.5 to 1.8 m high levee wall around the OWS and adjacent retention basin
- Two new Stormwater pump pits with high-density polyethylene (HDPE) discharge piping to three vacant tank compounds, which will serve as retention basins for excess stormwater
- Two additional pump stations on existing pits
- A total of 13 pumps.

1.4 Methodology

The following activities were undertaken for this baseline flooding assessment:

- Data collection and review.
- Direct rainfall hydrological modelling applying the methods of Australian Rainfall & Runoff: A Guide to Flood Estimation (Commonwealth of Australia, 2019) version 4.2.
- Development of a two-dimensional TUFLOW hydraulic model including infiltration pits, basins, trunk drainage and pumping infrastructure.
- Simulations of the 20%, 5% and 1% Annual Exceedance Probability (AEP) events.

1.5 Codes, standards and guidelines

Hydrologic and/or hydraulic models were developed for the existing site conditions. These models were developed with consideration given to the industry guidelines mentioned below, using TUFLOW hydraulic modelling software and for the range of design events listed. This proposed modelling approach has been developed with consideration given to the following reference documents, where relevant:

- Australian Rainfall and Runoff: A Guide to Flood Estimation (Fourth Edition), Geoscience Australia, Commonwealth of Australia (2019) version 4.2.
- Review Of ARR Design Inputs For New South Wales, NSW Office of Environment and Heritage (2019).
- Floodplain Risk Management Guide – Modelling the Interaction of Catchment Flooding and Oceanic Inundation in Coastal Waterways, NSW Office of Environment and Heritage (2015).
- Coastal hazard technical guide - Determining coastal hazard areas (DES 2013)
- Project 15 (Two Dimensional Simulations in Urban Areas), representation of buildings in 2D numerical flood models (EA, 2012).
- Project 18 (Interaction of Coastal Processes and Severe Weather Events) Stage 2 Report (EA, 2012).
- Project 18 (Coincidence of Fluvial Flooding Events and Coastal Water Levels in Estuarine Areas) Stage 3 Report (EA, 2014).
- Australian Disaster Resilience Handbook 7. Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia (Third Edition), Australian Institute for Disaster Resilience (2017)
- Flood Emergency Planning for Disaster Resilience (First Edition), Australian Institute for Disaster Resilience (2020)

1.6 Flood modelling – limitations and assumptions

The following limitations apply to this study:

- This report has been prepared by AECOM for Ampol Australia Pty Ltd. The purpose of this report is to document the findings of this investigation. The modelling and results should not be used for any other purpose without permission from AECOM.
- This report was prepared between October 2025 and December 2025 and is based on the conditions encountered and information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred after this time.
- This report is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.
- This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners. Design flood events were assessed for a single critical duration, based on an analysis of multiple durations for the 1% AEP event.
- Aerial survey data (in the form of LiDAR) used to develop the topography for the hydraulic model has a vertical accuracy of ± 0.30 m on clear, hard surfaces and a horizontal accuracy of ± 0.80 m.
- Where information gaps existed in the underground drainage network, assumptions were made to fill these gaps, as described in Section 4.5.1. Other datasets, including design drawings and plans provided by Ampol were used wherever possible.
- The modelling does not consider residual flood mechanisms of an unforeseen nature e.g., blockage of hydraulic structures, infrastructure failure (e.g., levee/ dam failure etc.), wave damage, etc.
- The hydraulic model has not been calibrated to any historic events.
- Where model calibration has been undertaken, the level of model calibration achievable is limited by the quality and accuracy of available data.
- This study includes analysis of 1% AEP design events with ARR v4.2 approach (year 2030 and 2100). Actual flood events larger in magnitude than the design flood events assessed in this study can and will happen.
- Design flood events are a best estimate of an “average” flood for their probability of occurrence. The behaviour and characteristics of actual flood events may differ to the design flood events assessed in this study.
- Any use which a third party makes of this document, or any reliance on or decision to be made based on it, is the responsibility of such third parties. AECOM accepts no responsibility for damages, if any, suffered by any third party as a result of decisions or actions made based on this document.
- Where information has been supplied by Ampol or other external sources, the information has been assumed correct and accurate unless stated otherwise. AECOM has made no independent verification of this information except as expressly stated in the report. No responsibility is accepted by AECOM for incorrect or inaccurate information supplied by others.

Australian Rainfall and Runoff (ARR2019) outlines several fundamental themes which are also particularly relevant to this study:

- All models are coarse simplifications of very complex processes. No model can therefore be perfect, and no model can represent all of the important processes accurately.
- Model accuracy and reliability will always be limited by the accuracy of the terrain and other input data.
- Model accuracy and reliability will always be limited by the reliability/ uncertainty of the inflow data.

- No model is 'correct,' and therefore the results require interpretation.
- A model developed for a specific purpose is probably unsuitable for another purpose without modification, adjustment, and recalibration. The responsibility must always remain with the modeller to determine whether the model is suitable for a given problem.
- Recognition that no two flood events behave in exactly the same manner.
- Design floods are a best estimate of an "average" flood for their probability of occurrence.

1.6.1 Interpretation of results

The interpretation of results and other presentations in this report should be done with an appreciation of any limitations in their accuracy, as noted above.

Unless otherwise stated, presentations in this report are based on peak values of water surface level, flow, depth and velocity. Therefore, using flood levels as an example, the peak level does not occur everywhere at the same time and, therefore, the values presented are based on taking the maximum value which occurred at each computational point in the model during the entire flood. Hence, a presentation of peak levels does not represent an instantaneous point in time, but rather an envelope of the maximum values that occurred at each computational point over the duration of the flood event.

1.7 Purpose of this report

The primary purpose of this report is to establish an understanding of the baseline or existing flood behaviour at the Site. This assessment is critical for identifying existing flood risks, understanding the influence of natural and built features on flood behaviour, and informing future flood management strategies.

Establishing the baseline flood behaviour serves as a reference point for evaluating potential impacts of future developments, land use changes, or mitigation measures. The findings presented in this report will support stakeholder and regulatory authorities in making informed decisions that ensure the safety, resilience, and sustainability of the Site.

2.0 Available data

The following table summarises the key data sources and references that were utilised in the development of the baseline hydraulic model.

Table 2-1 Available data

Data Source	Description	Reference
Aerial photography	Near Map imagery and QGIS-embedded Google Satellite imagery (approximate year 2024) were used. Imagery years were estimated through comparison with Google Earth.	Near Map Imagery 2019 (Accessed 30/10/2025) Google Satellite 2024 (Accessed 30/10/2025)
Site stormwater infrastructures (drainages & pits, and pumps)	The existing stormwater infrastructure was originally derived from Ampol's provided DRAINS model and later revised by AECOM. Infrastructure details, including pipe size and invert levels, were extracted as GIS layers and incorporated into the TUFLOW model. The Stormwater Infrastructures were cross-checked with Drawings and Ampol Stormwater System Process Description Kurnell Terminal Document (2023).	Revised DRAINS Model (Kurnell_Mod7_PostMod_2030yr.drn) (Received 4/11/2025) Ampol Stormwater Drainage System Schematic Plan Drawing (0535-147300-0-4) (Received 5/11/2025) KSSIP Proposed Stormwater Modification Drawings (0535-154761-0-0) (Received 19/11/2025) Ampol Stormwater System Process Description Kurnell Terminal Document (2023) (Received 1/12/2025)
Road alignment	Road line features obtained from NSW spatial collaboration portal.	NSW Government (https://portal.spatial.nsw.gov.au/) (Accessed 4/11/2025)
GIS data	The Site SWS and OWS assets, as well as existing and future land use boundaries have been digitised in GIS interspace by AECOM.	AECOM MOD7 GIS session (Received 30/10/2025)
Topographic data	Light Detection and Raging (LiDAR) data 2020 – processed into 1m grid Digital Elevation Model (DEM) was obtained from ELVIS web site.	ELVIS Web Site (https://elevation.fsdf.org.au/) (Accessed 24/10/2025)
Site survey	A detailed site survey undertaken on 23/4/2024 was received on 3/11/2025. The cut-off levels within the stormwater trench and the ridge levels along Bund 602 and the Northwest WWTP bunds were extracted and represented as 2D Z-shape breaklines for modelling purposes.	1801014 SUPERTIN_3 240423.dwg (Received 3/11/2025)
KSSIP terrain data	A terrain model TIFF created on 25/11/2023 for the KSSIP was adopted to represent post-LiDAR development conditions, including recent design and construction works.	Terrainaa0151WITHQUIB-CULVERTANDLEVEEClone.tif (Received 1/12/2025)

3.0 Hydrological approach

3.1 Design rainfall

Site specific Intensity Frequency Duration (IFD) data was determined using the design rainfall database from the Bureau of Meteorology (BOM) as per advice within the ARR 2019 guidelines.

The 2016 BOM design rainfall depths extracted at the centroid of the Kurnell refinery site have been presented in Table 3-1 below.

Table 3-1 BOM design IFD (2016) rainfall depths (sourced October 2025)

Duration	Annual Exceedance Probability (AEP)						
	1EY	50%	20%	10%	5%	2%	1%
30 min	22.4	24.9	32.6	37.8	42.8	49.4	54.5
1 hour	29.4	32.6	42.7	49.6	56.3	65.3	72.2
2 hours	37.9	42.1	55.4	64.6	73.7	86.1	95.8
3 hours	44.0	49.0	64.8	75.9	87.0	102	114
6 hours	57.2	64.0	86.2	102	118	140	157
12 hours	74.9	84.6	116	139	162	194	219
24 hours	97.2	111	156	188	221	265	300

The 2016 design rainfall depths presented above have been factored up to represent the present day (year 2030) and future climate (year 2100) scenarios as outlined in the climate change approach (Section 3.5).

Revised design rainfall depths were applied to the East Coast South ensemble temporal patterns as prescribed in the ARR 2019 guidelines. The resultant design rainfall hyetographs were then applied to the TUFLOW hydraulic model as direct rainfall on grid.

3.2 Initial and continuing loss

Work undertaken by WMA Water for the NSW Office of Environment and Heritage (2019) found that there is a considerable underestimation bias in the standard ARR 2019 method within NSW. A paper was released to assist in addressing this underestimation to ensure that flood behaviour and impacts are not understated and new waterway infrastructure not undersized leading to increased exposure of the community to flood risk.

The paper recommends that practitioners use a hierarchical approach to loss selection: Where good local initial loss data is not available, the probability neutral burst initial loss values calculated in this study should be used in all instances unless a detailed Monte Carlo assessment of pre-burst and losses has been carried out. Arrangements have been made so that these values can be obtained from the ARR Data Hub.

For this study, the initial loss has been taken as the ARR Data Hub recommended initial loss minus the probability neutral burst loss. The continuing loss was also sourced from the ARR Data Hub and multiplied by 0.4 as recommended.

The ARR Data Hub recommended initial loss and continuing loss values for the Kurnell site are listed in Table 3-2 below.

Table 3-2 ARR data hub initial and continuing loss (Sourced Oct 2025)

Parameter	Value
ARR initial loss (mm)	28.0
ARR continuing loss (mm/hr)	1.6
ARR modified continuing loss (mm/hr)	0.64

Design loss values have been applied directly to pervious areas through the TUFLOW materials layer, as discussed in Section 4.4.

3.3 Pre-burst rainfall

The Review of ARR Design inputs for NSW (Office of Environment and Heritage, 2019) also provides specific guidance on the application of pre-burst rainfall in New South Wales.

As per the recommendations in the review paper, pre-burst rainfall has been back calculated into the initial loss value by subtracting probability neutral burst initial losses (refer Table 3-3).

Table 3-3 ARR probability neutral burst initial loss in mm (sourced Oct 2025)

Storm duration min (h)	AEP (%)					
	50%	20%	10%	5%	2%	1%
≤ 60 (1.0)	15.5	8.9	9.0	9.9	8.6	5.9
120 (2.0)	15.0	9.0	9.7	9.1	8.6	6.3
180 (3.0)	16.1	10.1	10.8	9.9	10.0	6.3
360 (6.0)	16.5	10.7	11.2	10.1	9.8	5.0
720 (12.0)	20.7	14.9	14.3	13.4	12.0	5.5
1440 (24.0)	23.5	18.2	17.5	15.5	15.6	6.6

3.4 Areal Reduction Factors (ARF)

Design rainfall intensities at a point are not representative of the areal average rainfall intensity across the large catchment areas. The ratio between the design values of areal average rainfall and point rainfall, computed for the same duration and AEP, is called the Areal Reduction Factor (ARF). This allows for the fact that larger catchments are less likely than smaller catchments to experience high intensity storms simultaneously over the whole of the catchment area.

As the critical duration for the catchment was found to generally be less than 12 hours, short duration ARF values calculated as per the ARR guidelines have been used, as presented in Table 3-4. The ARF values were calculated based on a discrete catchment area incorporating the active areas of the Kurnell refinery (total area 1.84 km²). As shown in the tables, the resultant ARF's are very close to 1, and hence a static ARF of 1 has been applied to all storm events for this study.

Table 3-4 Short duration ARFs

Storm Duration	Aerial Reduction Factor (ARF) by AEP					
	50%	20%	10%	5%	2%	1%
30 minutes	0.991	0.990	0.989	0.989	0.988	0.988
1 hour	0.993	0.993	0.992	0.992	0.991	0.990
2 hours	0.996	0.995	0.994	0.993	0.992	0.991
3 hours	0.996	0.995	0.994	0.994	0.992	0.992
6 hours	0.998	0.997	0.997	0.996	0.996	0.995
12 hours	0.999	0.998	0.998	0.998	0.997	0.997

3.5 Climate change considerations

ARR provides guidance for estimating design floods, supporting both standards-based and risk-based approaches by addressing the randomness (aleatory uncertainty) in flood-related factors. For rainfall-based estimates, this includes IFD rainfall bursts, temporal rainfall patterns, and event losses. In flood data analysis, these uncertainties are reflected in observed data variability. Climate change is disrupting the frequency and behaviour of flood drivers, introducing non-stationarity and shifting aleatory uncertainty.

Beyond understanding changes in flood risk drivers, climate change also increases uncertainty in design flood estimates. This stems from limited data and knowledge - particularly uncertainties in future emissions, global and regional temperature changes, and their impacts on flood-related processes.

As part of the v4.2 ARR update (2024), previously reported Representative Concentration Pathways (RCPs) were updated to match the Intergovernmental Panel on Climate Change (IPCC) temperature projections based on Shared Socioeconomic Pathways (SSPs). The SSPs cover a broad range of potential future development options often referred to as very low (SSP1-1.9), low (SSP1-2.6), medium (SSP2-4.5), high (SSP3-7.0) and very high (SSP5-8.5) emissions pathways.

3.5.1 Design rainfall updates

The current IFD curves that are included in the 2016 IFD portal were derived using historical data. As global temperatures have risen since this period, design rainfall estimates require factoring to account for this temperature increase.

To account for changes since the period represented by the IFD curves in the 2016 IFD portal, ARR v4.2, Book 1, Chapter 6 recommends IFD values be scaled up using Equation 1.6.1 and global temperature increase projections (ΔT) presented in Table 3-5.

Table 3-5 Global mean surface temperature projections (ΔT) for AR6 socioeconomic pathways (ARR v4.2, 2024 – Table 1.6.2)

Climate scenario	Global mean temperature increase projection (ΔT) in °C [90% uncertainty interval]			
	SSP1 2.6	SSP2 4.5	SSP3 7.0	SSP5 8.5
Current and near-term (2021-2040)	1.2 [0.9-1.5]	1.2 [0.9-1.5]	1.2 [0.9-1.5]	1.3 [1.0-1.6]
Medium-term (2041-2060)	1.4 [1.0-1.9]	1.7 [1.3-2.2]	1.8 [1.4-2.3]	2.1 [1.6-2.7]
Long-term (2081-2100)	1.5 [1.0-2.1]	2.4 [1.8-3.2]	3.3 [2.5-4.3]	4.1 [3.0-5.4]

Multiplication factors presented in Table 3-6 were applied to the BOM 2016 IFD rainfall (refer Section 3.1) to scale the design rainfall depths up to meet the present day (2030) and future climate (2100) scenarios based on the change in temperature shown in Table 3-5.

Table 3-6 Climate change rainfall factors (SSP3-7.0) (ARR Data Hub, sourced October 2025)

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2030	1.18	1.17	1.16	1.14	1.13	1.12	1.12	1.11	1.1	1.1
2100	1.66	1.59	1.55	1.5	1.45	1.42	1.39	1.37	1.34	1.32

3.5.2 Initial and continuing loss updates

The updated ARR guidance also presents evidence that historical changes in antecedent moisture conditions (the expected conditions prior to an extreme rainfall event) have impacted frequent flood event peaks, with smaller proportional impacts for rarer events.

To adjust the loss parameters for climate change, design values can be scaled up using the same equation 1.6.1 (ARR v4.2, Book 1, Chapter 6) with rate of change (ΔT) values in Table 3-7.

Table 3-7 Rates of change for initial loss (IL) and continuing loss (CL) parameters per degree global temperature change (%/°C) (ARR v4.2, 2024 – Table 1.6.3)

Natural resource management cluster	Rates of change for loss parameters per degree global temperature change (%/°C) [66% range values]	
	Initial Loss	Continuing Loss
East Coast South	2.0 [0.6 to 4.3]	3.8 [1.1 to 8.0]

The following multiplication factors were applied to the ARR Data Hub design losses (refer Section 3.2) to scale the initial and continuing loss values to meet the present day (2030) and future climate (2100) scenarios:

- Present day (year 2030): 1.02 (IL), 1.05 (CL)
- Future climate (year 2100): 1.07 (IL) and 1.13 (CL).

3.5.3 Sea Level Rise

The updated ARR v4.2 guidelines state that there is significant evidence that sea levels are increasing and will continue to increase due to climate change. The guidelines also acknowledge that sea level rise and changes in storm surges vary regionally and refers to the 4th Edition of the *Guidelines for Responding to the Effects of Climate Change in Coastal and Ocean Engineering* (Harper, 2017) as well as their own jurisdictional guidance on changes in the sea level.

To account for future climate scenarios, design sea levels were adjusted by the following factors for the two climate scenarios using median values for SSP3-7.0 obtained from the [NASA Sea Level Projection Tool](#):

- Present-day (year 2030): +0.10 m
- Future climate scenario (year 2100): +0.68 m.

3.6 Identification of critical storm durations and temporal patterns

The ARR 2019 guidelines require the use of ten temporal patterns for each design Annual Exceedance Probability (AEP) event and storm duration combination.

As part of the hydrologic rain-on-grid modelling approach, each storm duration was simulated for the ten temporal patterns with the median value processed for each duration. Standard event durations as per ARR v4.2 Book 2, Chapter 3 were simulated being the 30-minute, 1-hour, 2-hour, 3-hour, 6-hour, 12-hour and 24-hour storms.

Following this the maximum envelope of the median value across the range of storm durations was determined for each AEP event.

This process was automated using the TUFLOW ARR ensemble processing tools.

4.0 Hydraulic modelling setup

4.1 TUFLOW Parameters

To simulate floodplain behaviour, overland flow, tidal behaviour, storm tide and pipe flow, a fully dynamic 1D/ 2D hydraulic model was developed using TUFLOW software. TUFLOW is an industry accepted benchmarked hydraulic model for simulating depth-averaged 1D and 2D free-surface flows.

To minimise model runtimes and increase modelling efficiency, TUFLOW's 2D HPC (Heavily Parallelised Compute) solver together with the ESTRY 1D engine was used together with GPU hardware for the simulations.

The TUFLOW model was prepared using the modelling guidelines described in Section 1.5. A summary of the Kurnell TUFLOW model parameters has been provided in Table 4-1.

Table 4-1 TUFLOW Hydraulic Model Setup Overview

Parameter	Approach
Design AEPs assessed	20%, 5% and 1% AEP for the present day (2030) and future climate (2100) scenarios.
Scenario modelled	Baseline (existing conditions) model
Hydrologic modelling	Direct rainfall on grid. Refer Section 4.2.1.
IFD input parameters	BOM 2016 IFD's with scaling factors ARR 2019 v4.2. Refer Sections 3.1 and 3.5.1
Model software	TUFLOW version 2025.2.1-w64-isP
Grid size	4m (with 1m SGS)
Base topography	2020 LIDAR
Roughness	Spatially varying and depth varying Manning's 'n' values, refer Section 4.4
Eddy viscosity	Wu Formulation
Model boundaries	Tidal – HT boundaries Minor Outfalls – HQ boundaries
Timesteps	Adaptive Timestep

4.2 Model boundaries

The intent behind the derivation of the Kurnell TUFLOW model boundary was to capture all areas of upstream inflow through the Site, as well as all areas downstream that influence tailwater levels on the site outflows. The 2D model boundary, rain-on-grid boundary and boundary conditions adopted for this study is shown in Figure 4-1 and discussed in the subsections below.

4.2.1 Rain-on-grid boundary

The rain-on-grid boundary was applied to cover the Kurnell site area, as well as any upstream catchment areas where inflows enter the site or where outflows from site are influenced by possible 'tail water' effects.

As confirmed with site stakeholders, bunded areas including storage tanks are fully contained within the oily water system (OWS) and associated drainage infrastructure. As such, the OWS catchments have been excluded from the rain on grid extent within the stormwater model (with no runoff generated from the OWS catchments).

This approach is consistent with previous modelling undertaken in the area as part of the Kurnell Flood Study (WMA Water, 2009). The OWS discharges at a singular location in the north-western corner of the site where runoff is treated prior to discharge.

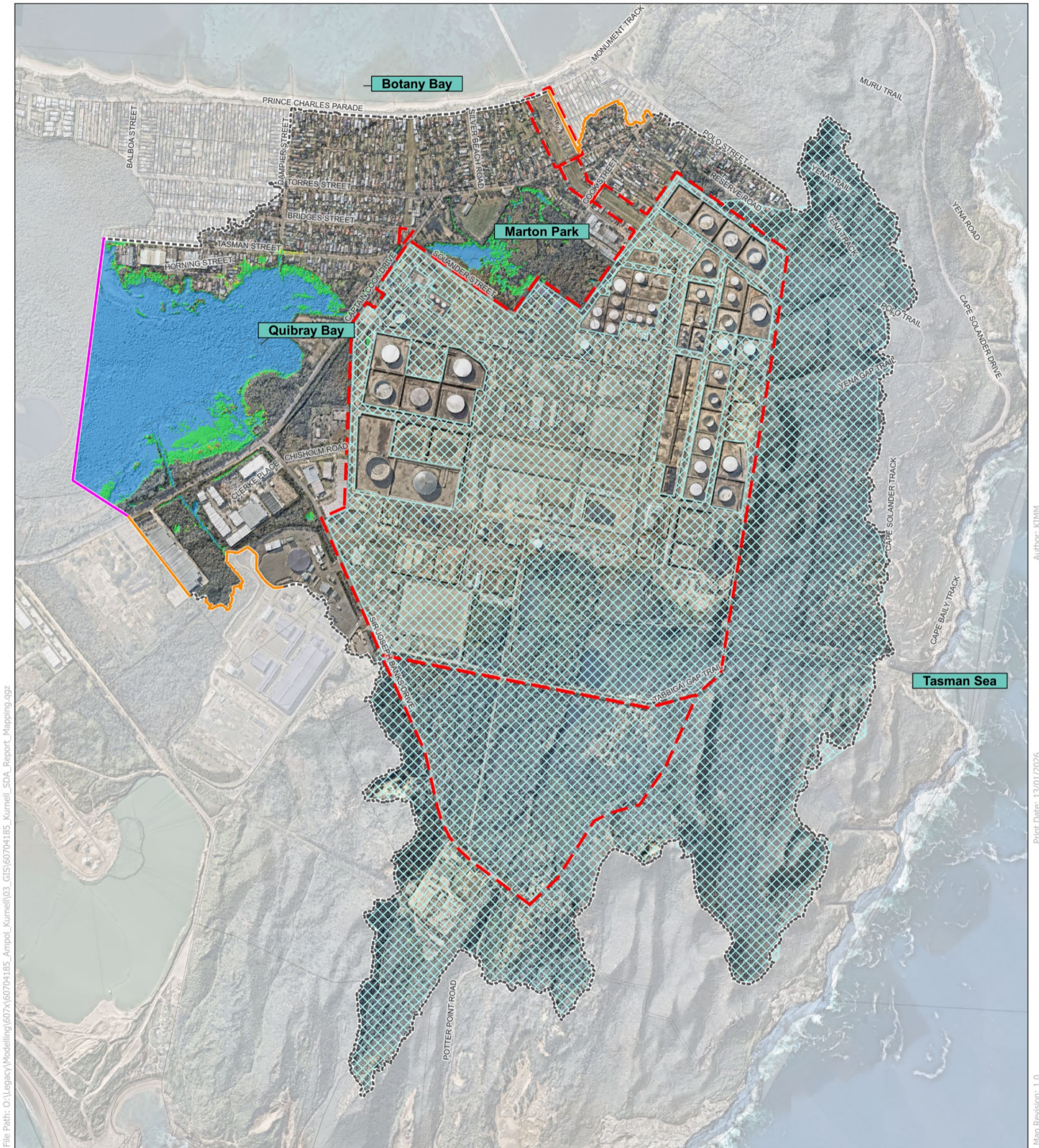
It is to be noted that there are areas in the central and southern extent of the site that are being converted from OWS catchments to stormwater catchments as part of the MOD7 remediation works. These areas have been included in the stormwater catchments as part of the baseline model.

4.2.2 Tidal boundary conditions

Tidal tailwater levels in Quibray Bay have been based on the latest version of *NSW's Floodplain Risk Management Guide – Modelling the Interaction of Catchment Flooding and Oceanic Inundation in Coastal Waterways* (2015). For a 'Type A Waterway Entrance Type' (Group 1 Oceanic Embayment for Botany Bay), the following tidal levels have been adopted as per the guidelines (noting that only the 20%, 5% and 1% AEP events are proposed for simulation as part of this study):

- 20% AEP catchment flood: HHWS (SS) tide level of 1.05 m AHD
- 5% AEP catchment flood: HHWS (SS) tide level of 1.05 m AHD
- 1% AEP catchment flood, envelope or greater of:
 - 1% AEP rainfall + 5% AEP tide level of 1.40 m AHD
 - 1% AEP coastal tide level of 1.45 m AHD

The tidal levels above were applied to the TUFLOW hydraulic model as static HT (height versus time) boundaries. The influence areas of these tidal levels on the on the model extent has been presented in Figure 4-1.



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Boundary Conditions

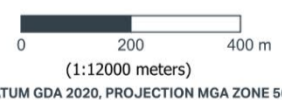
- HT
- HQ

Stormwater Receiving Environment

- Cadastre
- ▤ Direct Rainfall Extent
- ▭ Ampol Site Boundary
- ▭ TUFLOW Extent

Tide Influences

- HHWS (SS) Tide - 1.05 m AHD + 0.1m for 2030 Projections
- 5% AEP Tide - 1.40 m AHD + 0.1m for 2030 Projections
- 1% AEP Tide - 1.45 m AHD + 0.1m for 2030 Projections



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Figure 4-1 Hydraulic model boundaries

4.3 Model topography

The model topography was layered as shown in the below list. The base layer LiDAR was adopted initially for the entire model domain, and each successive layer is to supersede it where data exists.

1. Base layer (2020) LIDAR DEM – Digitised recent development/ design areas (post LiDAR capture), including the KSSIP works in KSSIP terrain model TIFF (received in 1/12/2025)
2. Topographic edits for hydraulic conveyance – Supported by survey data in 1801014 SUPERTIN_3 240423.dwg.towards some regions.
3. Manual topography stamping/ enforcement

The final model topography, including locations of manual edits is shown in Figure 4-3 and discussed further in the following sections.

4.3.1 Topographic edits

Road crossings of the open drain pipeways were removed from the LiDAR survey to ensure that overland flow paths were not artificially obstructed within the hydraulic model. This adjustment allowed flow to pass through the pipeway channels in accordance with observed site conditions.

To maintain representation of the physical structures, a 2d_bg layer was incorporated into the TUFLOW model to simulate the bridge deck crossings. This approach provided a realistic depiction of hydraulic connectivity while preserving the influence of the bridge decks on flow conveyance and potential afflux.

2D Z-shapes were used to schematically represent the levee walls around the WWTP implemented as part of the KSSIP.

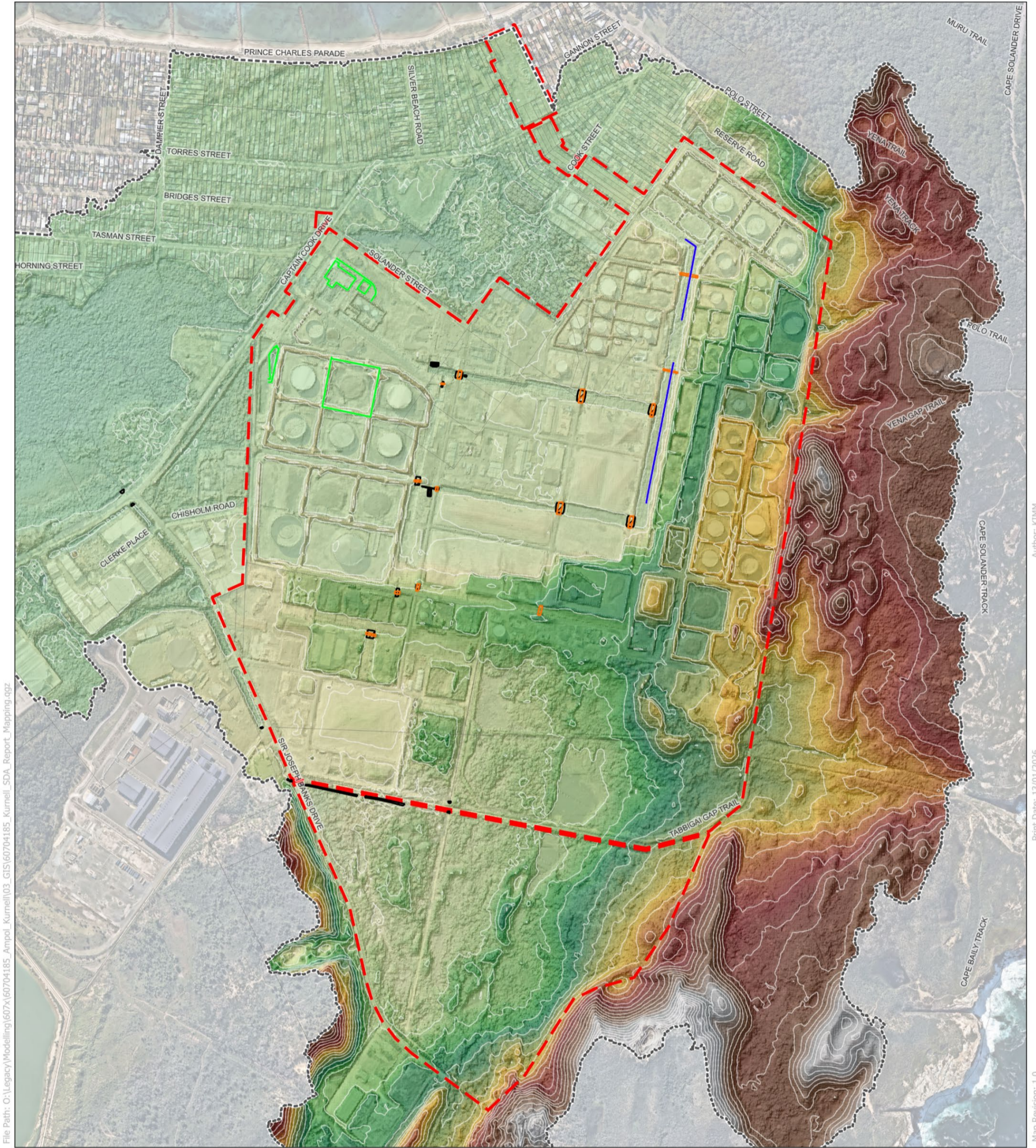
4.3.2 Topographic stamping/ enforcement

The network of road crests, bunds and embankments throughout the site are important to capture within the hydraulic model surface due to their influence on overland flow patterns. To ensure these critical hydraulic control points are represented in the TUFLOW model, topographic stamping/ enforcement was undertaken using 2D Z-shapes.

This is especially important in models that utilise sub-grid sampling (SGS) as there is a tendency for cells to artificially 'leak' flow if the minimum Z value is not directly stamped. TUFLOW (2021) explains this schematically in Figure 4-2. Current best practice is to manually assign hydraulic control points using 2D Z-shapes.



Figure 4-2 TUFLOW leaky weirs (TUFLOW Wiki, 2021)



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Author: KIMM

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|-------------------------------|-----------------------|----------------------------------|
| — Contours (2m Interval) | □ Cadastre | Topography (m AHD)
50
-0.6 |
| — Topographic Edits | □ Ampol Site Boundary | |
| — Bunds and Levees | □ TUFLOW Extent | |
| — Stormwater Trenches | | |
| — Bridge Deck Crossing | | |
| — Flow Conveyance Adjustments | | |



0 200 400 m
(1:9000 meters)
DATUM GDA 2020, PROJECTION MGA ZONE 56



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Figure 4-3 Model topography

4.4 Hydraulic roughness

Land uses across the site were categorised and digitised using the latest site aerial imagery to assist in delineating hydraulic roughness for the 2D model domain. Building and tank footprints were also digitised as part of this process.

It is noted that footprints have been based on roof outlines, which may not correspond to the actual building footprint when there are a complex roof shape and overhang of eaves. It is unlikely this will have significant impact on flood behaviour since the variation in building area and extent is typically small compared to the model grid size. A depth varying Manning's 'n' was applied over these footprints to encourage overland flow around buildings and tanks, whilst allowing shallow flow to runoff as the rainfall is applied, as per findings from ARR Revision Project 15.

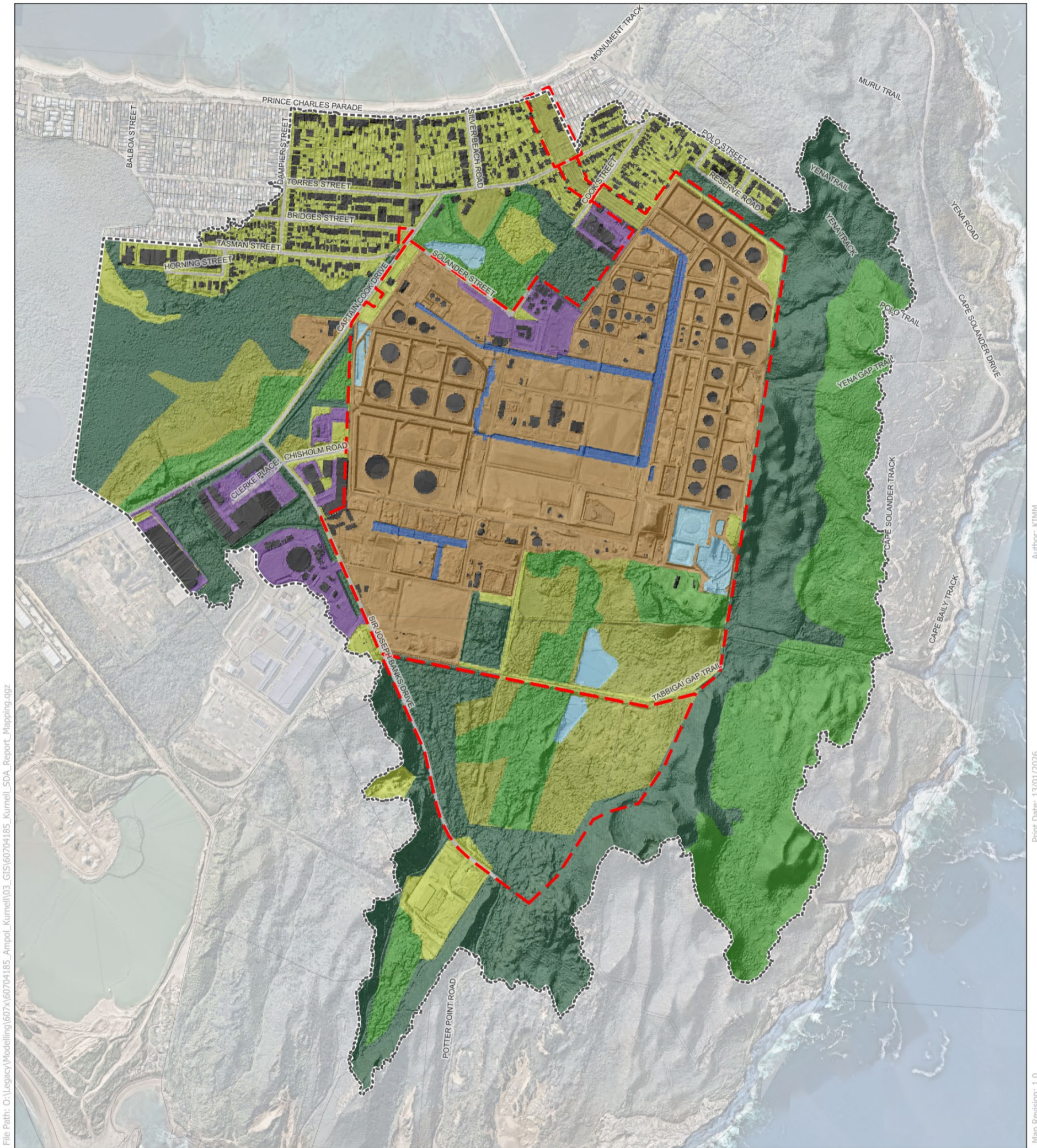
A hydraulic roughness profile was applied to each of the land use classifications determined in the land use database. Where surface characteristics are generally consistent with increasing flood depth (such as concrete and roads), a depth-constant Manning's 'n' was assigned. Where surface characteristics vary with depth, a depth-varying Manning's 'n' and associated trigger depths was assigned.

Fraction impervious and Manning's 'n' values applied to the hydraulic model are outlined in Table 4-2 with the land use delineation presented in Figure 4-4.

Table 4-2 Proposed hydraulic roughness values (Manning's 'n')

Land use class	Fraction impervious (%)	Initial depth (m)	Initial Manning's 'n'	Final depth (m)	Final Manning's 'n'
Buildings/ tanks	100%	0.100	0.018	0.300	0.500
Sealed roads	100%	0.020			
Concrete areas (including lined drains, footpaths and carparks)	100%	0.013			
Pipeway sections	100%	Varies*	0.013	Varies*	0.500
Waterbodies/ basins	100%	0.030			
Hardstand/ compacted areas	70%	0.025			
Grassed open space	0%	0.035			
Low density vegetation	0%	0.045			
Medium density vegetation	0%	0.055			
High density vegetation	0%	0.065			

Initial and continuing losses were applied directly to the land use materials (through the .tmf file) based on the design values outlined in Section 3.2 and assigned fraction impervious percentages.



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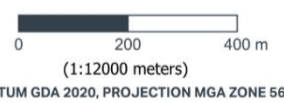
Author: KJMM

Print Date: 13/01/2026

Map Revision: 1.0

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|---------------------|-----------------------------------|---|
| Cadastre | TUFLOW Roughness Layers | 0.025 Hardstand / Compacted Areas |
| Ampol Site Boundary | 0.035 Grassed Open Space | 0.030 Waterbodies / Basins |
| TUFLOW Extent | 0.045 Low Density Vegetation | 0.020 Sealed Roads |
| | 0.055 Moderate Density Vegetation | 0.013 Concrete Areas (Lined Drains / Carpark & Footpaths) |
| | 0.065 High Density Vegetation | Pipeway Sections |
| | | 0.013 below Initial Depth / 0.500 above Final Depth |
| | | Buildings / Tanks |
| | | 0.018 below Initial Depth / 0.500 above Final Depth |



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Figure 4-4 Hydraulic roughness layer

4.5 Stormwater Infrastructure

The site's stormwater infrastructure, comprising the piped network, pumps, and open drains/ pipeways, has been represented within the TUFLOW hydraulic model to capture the key elements influencing stormwater conveyance and discharge.

Infrastructure included in the model has been presented in Figure 4-7 and is discussed further in the following subsections.

4.5.1 Stormwater network

Culvert structures and subsurface pipes networks within the site were represented as dynamically linked 1D elements. The stormwater network was modelled with a consistent pipe Manning's 'n' of 0.015.

As part of this investigation, only the stormwater network (as shown in Figure 4-7) was included in the TUFLOW hydraulic model as it drains to the receiving environment. There are three main stormwater discharge locations, being:

- Botany Bay (note: excess flow spills to the northern corner of the site)
- Quibray Bay (note: excess flow spills to Marton Park Wetland)
- Sir Joseph Banks Drive

Stormwater pipe sizes and invert levels were sourced from the SWS plan provided by Ampol (Drawing 0535-147300-0-4, received 5/11/2025) and information contained within the provided DRAINS model (Kurnell_Mod7_PostMod_2030yr.drn, received 4/11/2025). Where data gaps were identified, assumptions were made on pipe sizing and invert levels to ensure minimum grade and cover requirements were satisfied.

4.5.2 Pumps

Pumps have been represented within the TUFLOW model to match the provided site information and pumping information included in the provided DRAINS SWS model (Kurnell_Mod7_PostMod_2030yr.drn, received 4/11/2025). All pumps were set up with operational trigger levels and constant flow rates.

Pumps included in the TUFLOW model were directly connected to the 1D stormwater network mentioned above and have been listed in Table 4-3 and shown spatially in Figure 4-7.

Table 4-3 Pumps included in TUFLOW Model

ID	Modelled Pumps	Location	Catchment	Modelled No. Pumps
1	S1_Main_PipeW S2_Main_PipeW S3_Main_PipeW S4_Main_PipeW S5_Main_PipeW	Adjacent to east Gate 5	Catchment A	5
2	S1_Basin_A1 S2_Basin_A1 S3_Basin_A1	Tank 502 near Road G and Road 1	Catchment A	3
3	Pump Skyes 15GM-10	Adjacent corner of Road 9 and L, South of Gatehouse	Catchment B	2
4	15G-11 15G-11A 15G-11B	North end of Road 8 adjacent pipeway A	Catchment B	3
5	G15-12A	Adjacent corner Road 9 and P	Catchment B	1
6	B1-A Siphon	Adjacent corner of Road O and 14	Catchment B	1

ID	Modelled Pumps	Location	Catchment	Modelled No. Pumps
7	B1A1 B1A2	Adjacent to tank 601 near SES 5 area between B1A and B1B basin. Pumps drain to bund 622	Catchment B	2
8	PitB1 PitB2 PitB3	Near the pipeway B, adjacent to the corner of Road 9, Road P, and Pipe Trak 3	Catchment B	3
9	Pump_PitA1 Pump_PitA2 Pump_PitA3	Adjacent to Tank 18, Pipe Track A to Pipeway A	Catchment B	3
10	WWTP_CP220 WWTP_CP150	Adjacent to the southern corner Road 12 and Pipe Track A	Catchment B	2

4.5.3 Open drains/ pipeways

Throughout the site there are a series of pipeways (with pumped petroleum pipes) that also serve as major overland flow channels. A typical pipeway/ open drain configuration is shown in Figure 4-5.



Figure 4-5 Photo of typical pipeway/ open drain section – Main Pipeway (MHL, 2016)

Within the TUFLOW hydraulic model, these channels were schematised as per the typical section below (refer Figure 4-6), where:

- The low flow channel through the centre of the Pipeway has been represented as a constant 'smoother' Mannings 'n' roughness to not impede flow
- The high flow channel (with associated pipework) has been represented as a depth varying Mannings 'n' roughness where lower flow can flow more freely under the pipes, to a point where there is a higher hydraulic resistance (increased roughness) at the level of pipes.

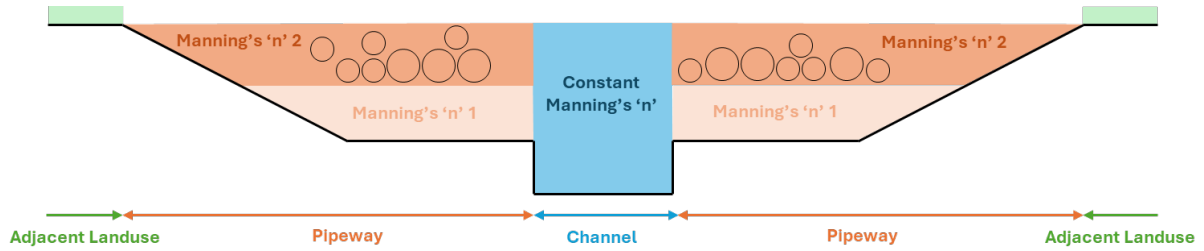
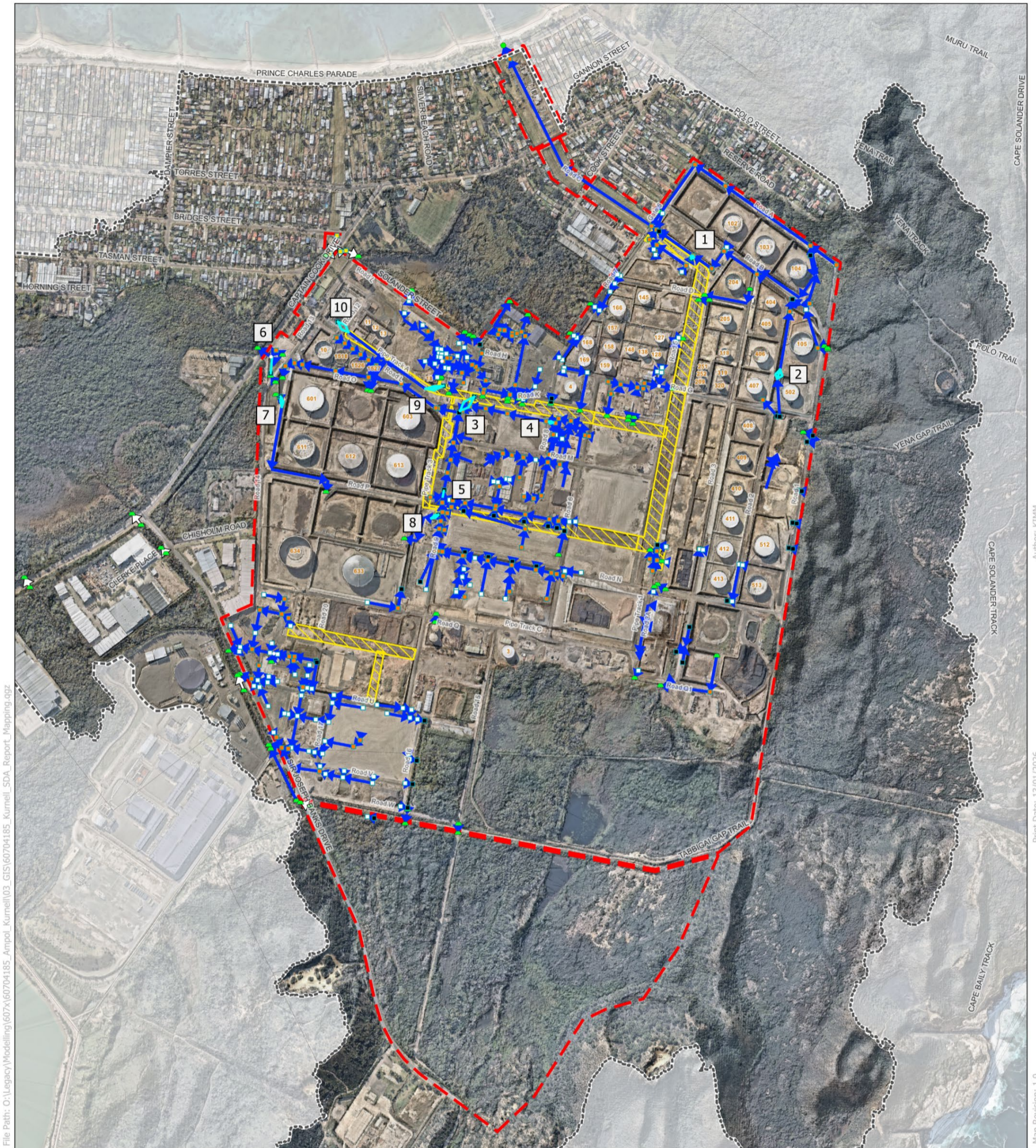


Figure 4-6 Typical Section of Manning's 'n' Roughness Assignment Through Pipeway/ Open Drain

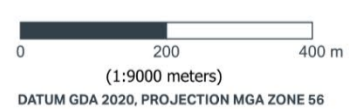


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Map Revision: 1.0

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- 1d Boundary Condition (HQ)
- Modelled Nodes
- ▨ Pipeways
- ▭ Modelled Pits
- ▲ Modelled Headwalls
- ▭ Cadastre
- Field Inlets
- ▭ Modelled Pumps
- ▭ MH Pits
- ▭ Modelled Pipes
- ▭ CB Pits
- ▭ Modelled Culverts
- ▭ Ampol Site Boundary
- ▭ TUFLOW Extent



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Figure 4-7 Modelled stormwater infrastructures

5.0 Results and conclusion

5.1 Results

The results of the baseline hydraulic model simulations have been presented in Appendix A. Results were processed using TUFLOW ARR ensemble processing tools as outlined above.

Map A1 through Map A3 in Appendix A show the peak flood depth for the 20%, 5% and 1% AEP events in present day (2030) conditions.

Map A4 through Map A6 in Appendix A show the anticipated peak flood depth for the 20%, 5% and 1% AEP events in the future climate (2100) scenario.

5.2 Conclusion

The information presented within this report provides a summary of the baseline site TUFLOW model build and the associated inputs adopted to represent existing flooding conditions for the Site.

The modelling outputs show flood mapping that illustrates current site behaviour under design storm events, forming a robust foundation for subsequent assessment phases. These results establish a clear understanding of existing Site flooding behaviour, ensuring that future investigations and design considerations can be undertaken to ensure that offsite impacts are mitigated.

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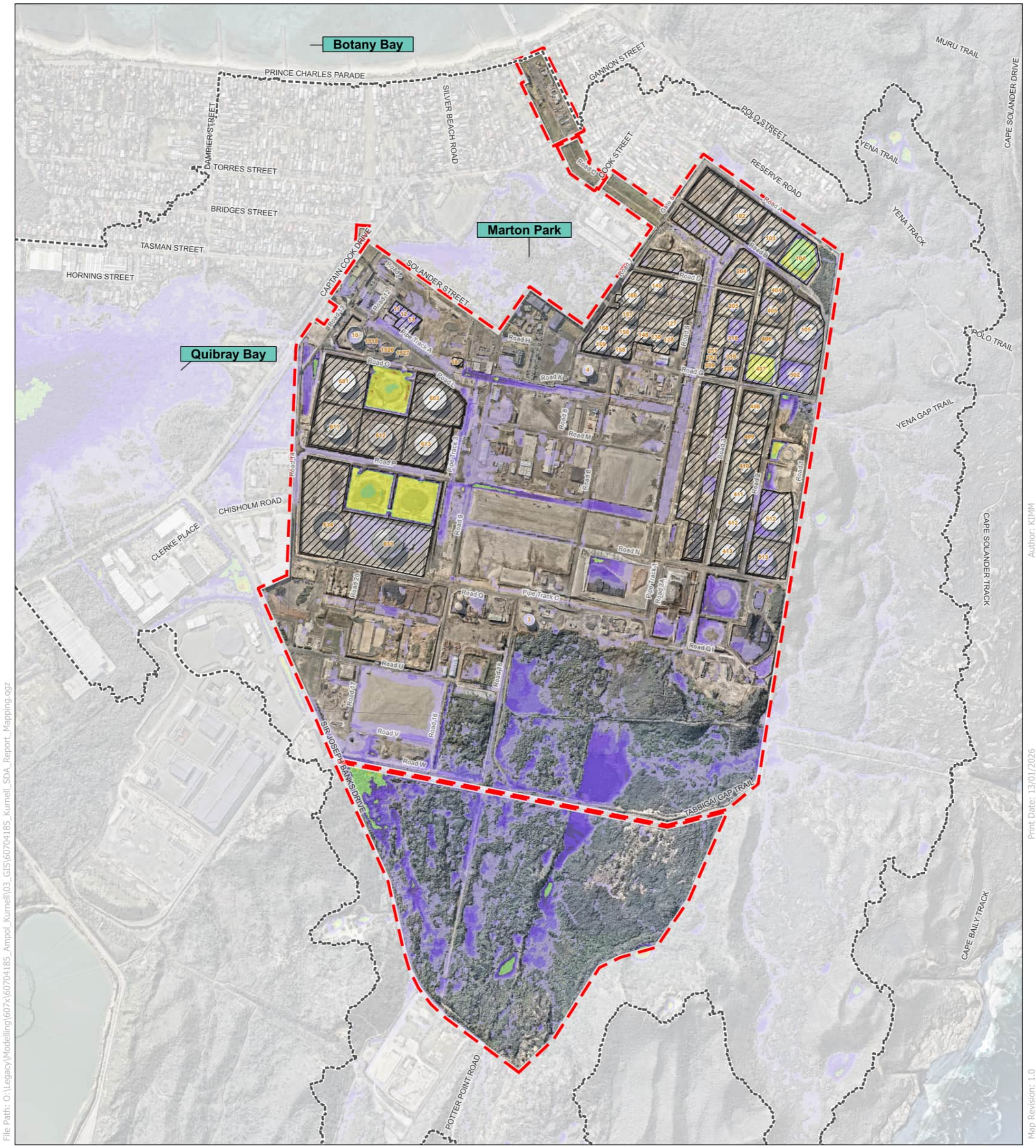
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Appendix A

Hydraulic modelling
results mapping



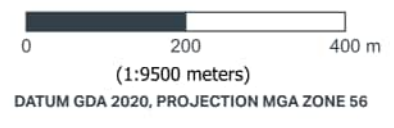
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Author: KIMM

Peak Flood Depth - 20% AEP with 2030 Climate Change

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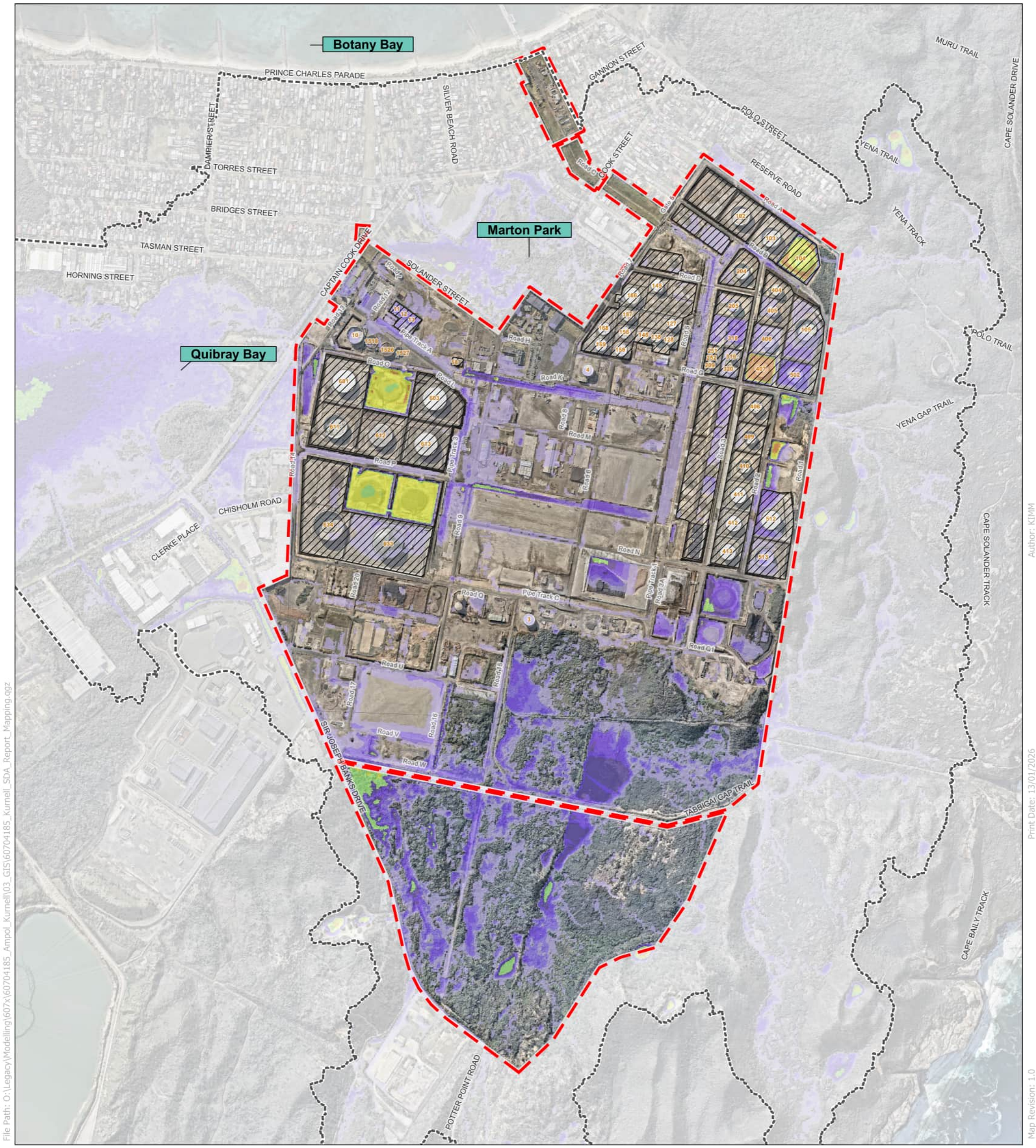
Cadastre	Peak Flood Depth (m)	1.00 - 1.50
Oily Water System Extent	<= 0.30	1.50 - 2.00
Ampol Site Boundary	0.30 - 0.50	2.00 - 3.00
TUFLOW Extent	0.50 - 0.75	> 3.00
Stormwater Receiving Environment	0.75 - 1.00	



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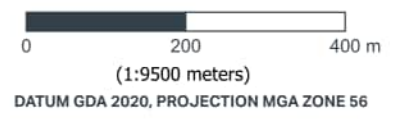
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Print Date: 13/01/2025
Author: KIMM

Peak Flood Depth - 5% AEP with 2030 Climate Change

Legend

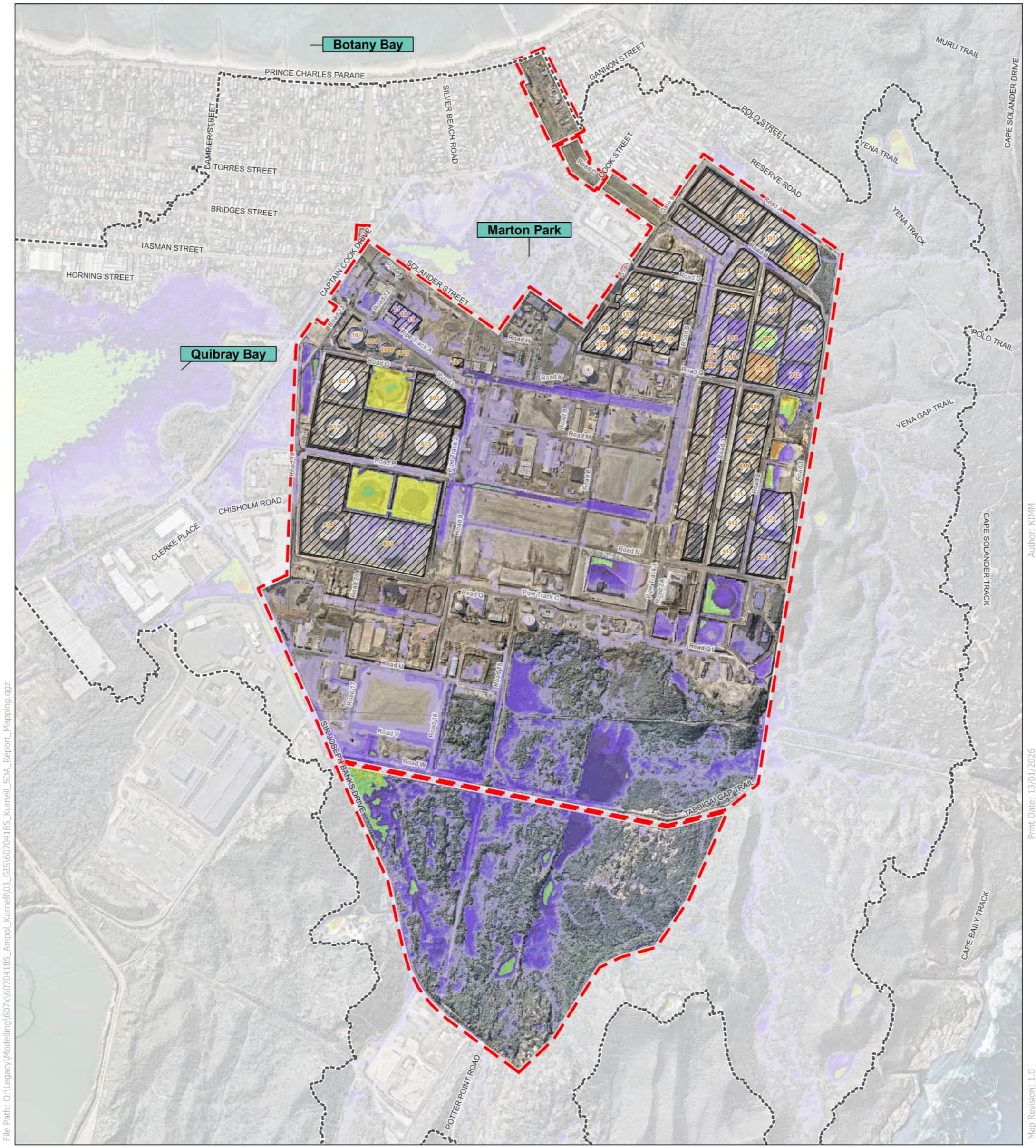
	Cadastre		Peak Flood Depth (m)		1.00 - 1.50
	Oily Water System Extent		<= 0.30		1.50 - 2.00
	Ampol Site Boundary		0.30 - 0.50		2.00 - 3.00
	TUFLOW Extent		0.50 - 0.75		> 3.00
	Stormwater Receiving Environment		0.75 - 1.00		



Data Sources:
Base data - (C) AECOM, 2025
LIDAR - ELVIS, 2020

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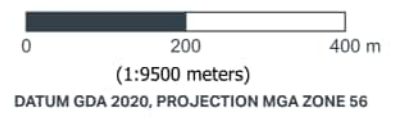
Map Revision: 1.0
Print Date: 13/01/2025
Author: KIMM

Peak Flood Depth - 1% AEP with 2030 Climate Change

Legend

Cadastre	Peak Flood Depth (m)	1.00 - 1.50
Oily Water System Extent	<= 0.30	1.50 - 2.00
Ampol Site Boundary	0.30 - 0.50	2.00 - 3.00
TUFLOW Extent	0.50 - 0.75	> 3.00
	0.75 - 1.00	

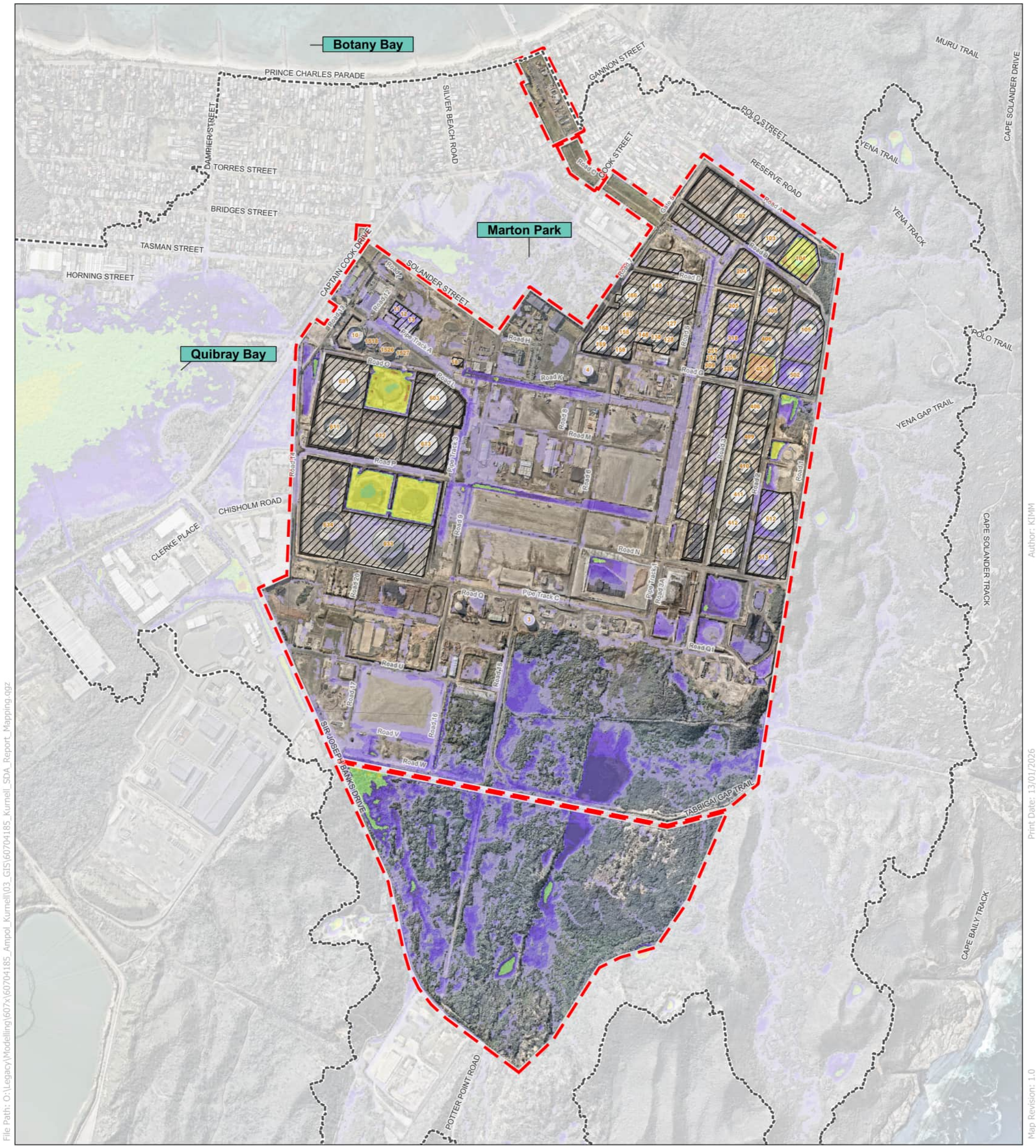
Stormwater Receiving Environment



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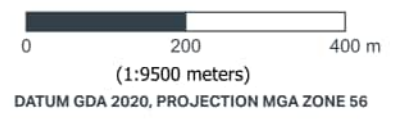
Map Revision: 1.0
Print Date: 13/01/2025
Author: KIMM

Peak Flood Depth - 20% AEP with 2100 Climate Change

Legend

Cadastre	Peak Flood Depth (m)	1.00 - 1.50
Oily Water System Extent	<= 0.30	1.50 - 2.00
Ampol Site Boundary	0.30 - 0.50	2.00 - 3.00
TUFLOW Extent	0.50 - 0.75	> 3.00
	0.75 - 1.00	

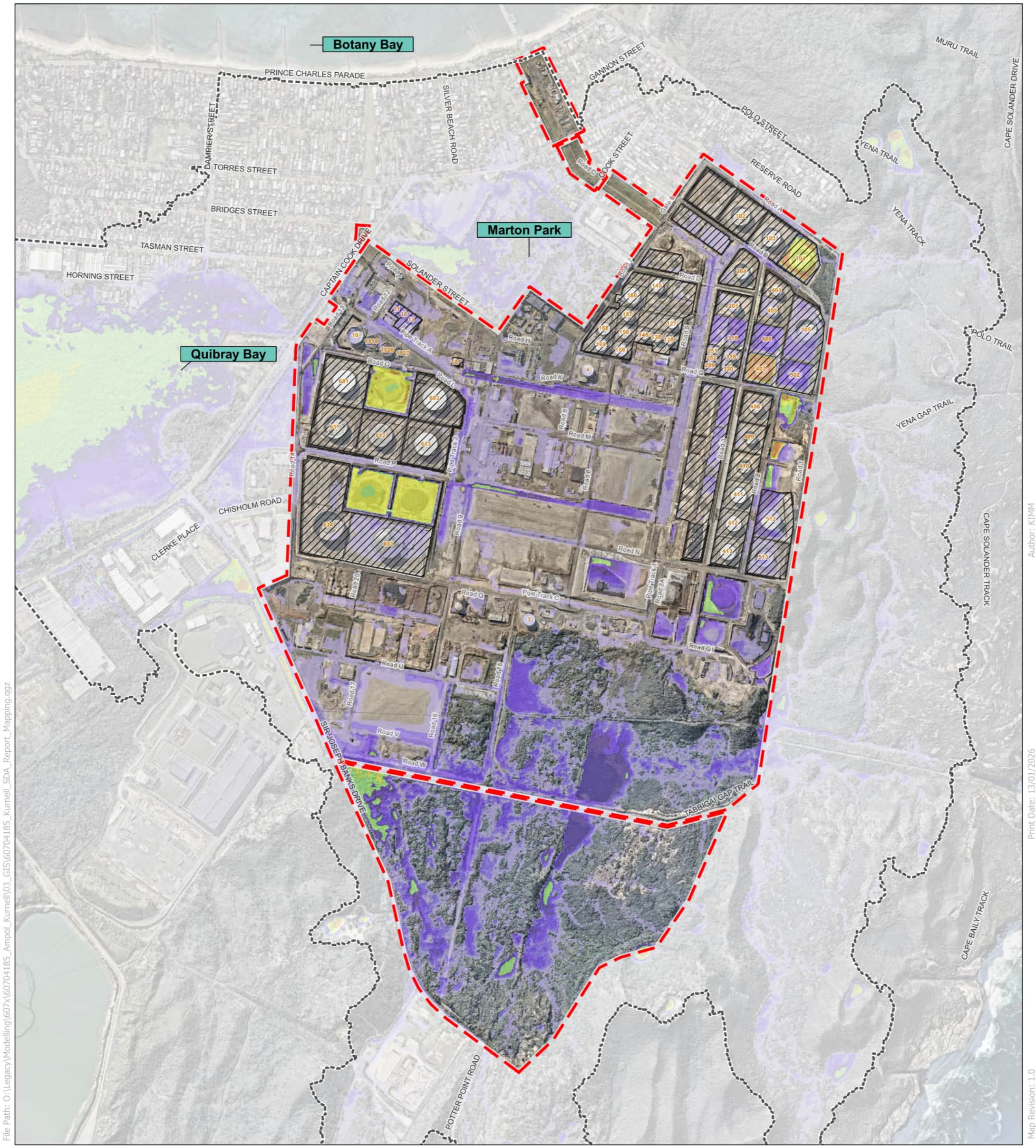
Stormwater Receiving Environment



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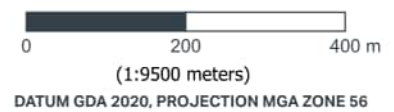
Map Revision: 1.0
Print Date: 13/01/2025
Author: KIMM

Peak Flood Depth - 5% AEP with 2100 Climate Change

Legend

- | | | |
|--------------------------|-----------------------------|-------------|
| Cadastre | Peak Flood Depth (m) | 1.00 - 1.50 |
| Oily Water System Extent | <= 0.30 | 1.50 - 2.00 |
| Ampol Site Boundary | 0.30 - 0.50 | 2.00 - 3.00 |
| TUFLOW Extent | 0.50 - 0.75 | > 3.00 |
| | 0.75 - 1.00 | |

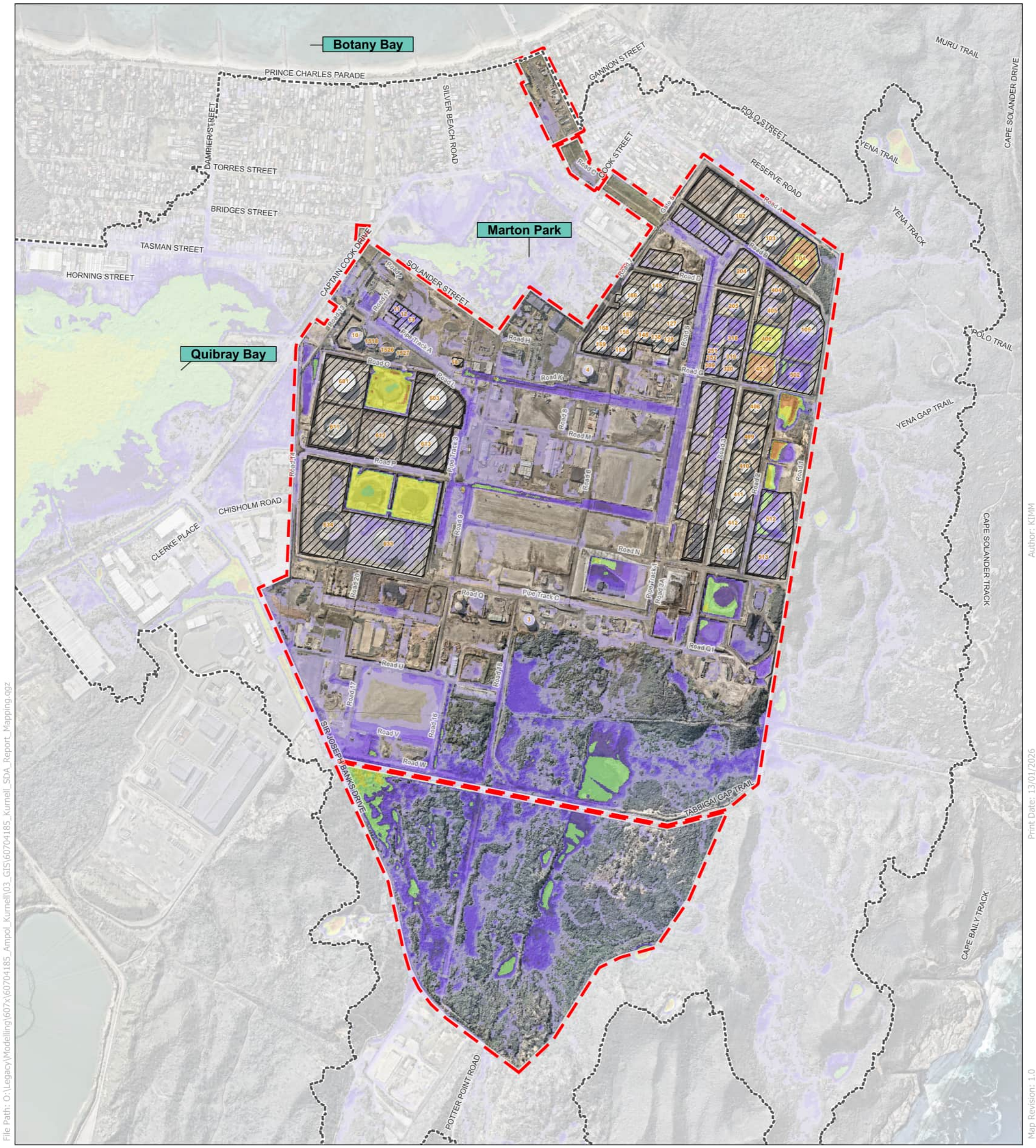
Stormwater Receiving Environment



Data Sources:
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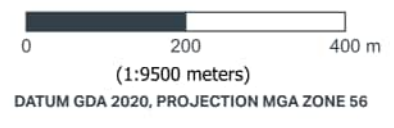
Map Revision: 1.0
Print Date: 13/01/2025
Author: KIMM

Peak Flood Depth - 1% AEP with 2100 Climate Change

Legend

- | | | |
|--------------------------|-----------------------------|-------------|
| Cadastre | Peak Flood Depth (m) | 1.00 - 1.50 |
| Oily Water System Extent | <= 0.30 | 1.50 - 2.00 |
| Ampol Site Boundary | 0.30 - 0.50 | 2.00 - 3.00 |
| TUFLOW Extent | 0.50 - 0.75 | > 3.00 |
| | 0.75 - 1.00 | |

Stormwater Receiving Environment



Data Sources:
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Annexure C

Yearly Summary
Monitoring Data at Yara
Gap (2021-22)



Yearly summary monitoring data

Licence Details: Ampol Refineries (NSW) Pty Ltd, 2 Solander St, Kurnell, NSW, 2231, EPL # 837

EPA Point		Point 27, Yena Gap Effluent, Normal Operating Conditions									Date last data were obtained	Publishing Date	
Pollutant	Temperature	pH	Volumetric Flowrate	Oil and Grease	Phenols	Sulfide (un-ionised hydrogen)	Nitrogen (ammonia)	Total Suspended Solids	Biochemical Oxygen Demand				
Unit of Measure	°C		kl/day	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l				
Monitoring Frequency Required by Licence	Continuous	Continuous	Continuous	Once during any discharge	Once during any discharge	Once during any discharge	Once during any discharge	Once during any discharge	Once during any discharge				
Averaging Period	1 Hour Block	6 Minute Rolling	1 Day Block	Grab Sample	Grab Sample	Grab Sample	Grab Sample	Grab Sample	Grab Sample				
Reporting Period													
2 May 2021- 1 May 2022	No. Samples Collected	8760	525600	365	45	45	45	45	45				
	100%tile	Licence Limit	40	6.0 - 9.0	None	None	2.7	None	7.5	50	30	4-May-22	16-May-22
		Lowest	18.0	6.5	0	<5	<0.05	<0.1	<0.01	2	<2		
		Mean	21.5	7.0	5523	<5	<0.05	<0.1	<0.01	6	<2		
		Highest	26.6	7.9	30156	7	<0.05	0.1	0.07	17	8		
	Exceedance (yes/no)	No	No	N/A	N/A	No	N/A	No	No	No			
	90%tile	Licence Limit		6.5 - 8.5		10							
		Lowest		6.5		<5							
		Mean		7.0		<5							
		Highest		7.5		<5							
	Exceedance (yes/no)		No		No								
	50%tile	Licence Limit				0.3				35	20		
		Lowest				<0.05				2	<2		
		Mean				<0.05				4	<2		
		Highest				<0.05				6	<2		
	Exceedance (yes/no)				No				No	No			

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Yearly summary monitoring data

Licence Details: Ampol Refineries (NSW) Pty Ltd, 2 Solander St, Kurnell, NSW, 2231, EPL # 837

EPA Point		Point 27, Yena Gap Effluent, Wet Weather By-Pass Conditions				Date last data were obtained	Publishing Date
Pollutant	Oil and Grease (Wet)	Phenols (Wet)	Total Suspended Solids (Wet)	Biochemical oxygen demand (Wet)			
Unit of Measure	mg/l	mg/l	mg/l	mg/l			
Monitoring Frequency Required by Licence	Daily only during any discharge under bypass conditions of the biotreater wastewater treatment plant						
Averaging Period	Grab Sample	Grab Sample	Grab Sample	Grab Sample			
Reporting Period	No. Samples Collected	6	6	6	6		
2 May 2021- 1 May 2022	100%tile	Licence Limit	70	5	100	350	
		Lowest	<5	<0.05	9	<2	
		Mean	<5	<0.05	14	6	
		Highest	5	0.05	29	8	
		Exceedance (yes/no)	No	No	No	No	

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Yearly summary monitoring data

Licence Details: Ampol Refineries (NSW) Pty Ltd, 2 Solander St, Kurnell, NSW, 2231, EPL # 837

EPA Point		Point 27, Yena Gap Effluent, Normal Operating Conditions										Date last data were obtained	Publishing Date
Pollutant	Arsenic	Ethyl Benzene	Lead	Naphthalene	Nickel	Phenanthrene	Benzene	Toluene	Polycyclic Aromatic Hydrocarbons	2,4-Dimethylphenol			
Unit of Measure	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l		
Monitoring Frequency Required by Licence	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly		
Averaging Period	Grab Sample	Grab Sample	Grab Sample	Grab Sample	Grab Sample	Grab Sample	Grab Sample	Grab Sample	Grab Sample	Grab Sample	Grab Sample		
Reporting Period 2 May 2021- 1 May 2022	No. Samples Collected	12	12	12	12	12	12	12	12	12	12	4-May-22	16-May-22
	Licence Limit	0.07	None	0.025	None	0.03	None	None	None	0.5	None		
	Lowest	<0.001	<0.002	<0.001	<0.0002	<0.001	<0.0002	<0.001	<0.002	<0.0002	<0.0002		
	Mean	0.001	<0.002	<0.001	<0.0002	0.001	<0.0002	<0.001	<0.002	<0.0002	<0.0002		
	Highest	0.002	<0.002	<0.001	<0.0002	0.003	<0.0002	<0.001	<0.002	<0.0002	0.001		
	Exceedance (yes/no)	No	N/A	No	N/A	No	N/A	N/A	N/A	No	N/A		
	Licence Limit									0.03			
	Lowest									<0.0002			
	Mean									<0.0002			
	Highest									<0.0002			
	Exceedance (yes/no)									No			

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