

Surface Water Assessment

Proposed Port Kembla Bulk
Liquids Terminal

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Prepared for
TQ Holdings Australia Pty Ltd

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Executive Summary

The Surface Water Assessment has been completed by Cardno on behalf of TQ Holdings Australia Pty Ltd (TQ) to support an application to construct and operate the Port Kembla Bulk Liquids Terminal (PK BLT). The assessment has been conducted in accordance with the SEARs issued for the project. It is considered that with application of the recommended mitigation measures, the proposal will have minimal impacts to flow regimes, flooding and water quality.

The proposed PK BLT would be located within the downstream extent of the Gurungaty Waterway catchment (7.3 km²), which includes large urban areas as well as industrial sites. In addition, flows from the southern extent of the project area discharge directly into Port Kembla Inner Harbour. Water quality in Port Kembla Inner harbour is affected by urban runoff from the urban catchment as well as industrial runoff from the Port Kembla precinct. Elevated levels of metals, organic pollutants and moderate turbidity have been reported as a result of historic and ongoing industrial operations within the catchment.

In the current conditions the PK BLT site predominantly consists of gravel hardstand surfaces, which are considered to be 90% impervious due to compactation over time. The proposed PK BLT would include large paved areas, thereby resulting in minor increase in the total impervious factor within the project site. However, large part areas of the PK BLT are proposed to be bunded to increase operational safety, therefore peak stormwater discharge rates from the site into the Inner Harbour would be reduced due to the amount of temporary storage within the bunded areas. Stored stormwater would be released in a controlled manner following water quality treatment. The total quantity of stormwater runoff from the site would slightly increase due to increased impervious surfaces, however this has no impact on hydraulic loads in Port Kembla Inner Harbour.

The subject sites have been gradually reclaimed as part of Port Kembla Inner Harbour port reclamation works. The sites do not have flooding history due to these earthworks and the resulting finished ground levels. Wollongong City Flood Study (WCFS 2013) indicates that the PK BLT site is not susceptible to flooding from Gurungaty Waterway since all site levels are a minimum of 1.8m above the PMF levels reported in the watercourse. However, the western extent of the proposed PK BLT (Site 2) is traversed by an existing overland flow path originating from a 9.9ha industrial upstream catchment. In the ultimate development scenario this overland flowpath is required to be diverted around the site by upgrading the drainage on Morton Way. In contrast, Site 1 and Site 3 are not likely to be affected by external flows.

The location of the PK BLT adjacent to Inner Harbour ensures that no flood impacts are caused downstream. Upstream flood affectation is only relevant to Site 2, in that development of Site 2 could potentially increase ponding on Morton Way and within the adjacent industrial property. In order to mitigate these impacts, the stormwater network on Morton Way will be upgraded to cater for major storms.

This assessment outlines a range of mitigation measures to be implemented in both construction phase and operational phase. These include development of an Erosion and Sediment Control Plan (ESCP) with measures to be in place prior to any works commencing at the site. The ESCP would be maintained for the duration of construction, to prevent any polluted water and sediment entering receiving waterbodies.

Stormwater management measures during operation include multi-staged containment and treatment using a hydrocyclone oil water separator, to prevent any spill of products, slops or contaminated stormwater into the Inner Harbour. This includes treatment of first-flush from paved areas, as well as treatment of runoff temporarily stored within bund walls. The bunds would provide sufficient capacity for storing any major storm event while containing a major product spill within the bunded area. In addition, the existing sediment pond on Site 3 would be replaced by a Gross Pollutant Trap catering for the existing road catchment.

The PK BLT requires only minimal potable water supply during operation and therefore does not generate large quantities of process water. The PK BLT would connect to the existing potable water main located on Tom Thumb Road. Fire tanks, fire pumps as well as firefighting foam and cooling water sprays (as required by AS1940) would be incorporated with each of the bulk storage tanks. The office building on Site 3 will use harvested rainwater from the roof of the building. Sewage and wastewater from amenities on Site 3 will be discharged into the existing rising main located on Tom Thumb Road on the western side of Gurungaty Waterway. Oily water generated from the slops system on Sites 1 and 2 will be collected into oily water tanks located on either site and transported offsite for further processing.

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1 Introduction

1.1 Purpose of Report and Legislative Context

This Surface Water Assessment has been undertaken on behalf of TQ Holdings Australia Pty Ltd (TQ) to identify potential impacts related to soils, contamination and groundwater specific to the proposed Port Kembla Bulk Liquids Terminal (PK BLT) at Lot 301 DP 1148391, Lot 2 DP 1125445 and Lot 11 DP 1182111 in Port Kembla. The site also includes license to operate on Berth 104 (Lot 70 DP 1182824).

This assessment has been developed to support an EIS to be submitted to the Department of Planning and Environment (DP&E) in accordance with the Secretary's Environmental Assessment Requirements (SEARs) as detailed in **Table 1-1** and in consideration of the meeting minutes from NSW Ports consultation (4 September 2015) and State Government and Wollongong City Council (WCC) Floodplain Management Policies which are discussed in **Section 4**.

Table 1-1 Secretary's Environmental Assessment Requirements (SEARs)

Secretary's Environmental Assessment Requirement
Soil & Water – Including:
<ul style="list-style-type: none">> Details of water supply including annual volumes of surface and groundwater required by the proposal and options for reuse of process water;> A detailed consolidated site water balance> Proposed erosion and sediment controls (during construction) and the proposed stormwater management system (during operation);> An assessment of the potential soil, groundwater and surface water impacts and the measures proposed to mitigate these impacts;> An assessment of pollutant loads and concentrations, contaminated groundwater and soils, acid sulfate soils and proposed mitigation and management measures, particularly in the event of a product spill; and> Potential impacts of flooding, with consideration of climate change and projected sea level rises.

1.2 Site Description

The PK BLT site is located within the Port Kembla Port precinct approximately 70 km from Sydney and 3 km from the Wollongong City Centre in the Wollongong Local Government Area (LGA). The port is connected to Wollongong via the arterial road Spring Hill Road and to Sydney via the Princes Motorway. The Port is located on a trained and highly modified estuary at the outfall of Allans Creek and Gurungaty Waterway, with the Tasman Sea to the east. Port Kembla consists of a number of industrial land uses with various berths for the loading and unloading of cargo ships. The locality (within 5km of the subject site) consists of predominantly cleared and/or disturbed lands largely due to industrial, commercial and residential development. The remnant Tom Thumb Lagoon is located to the north of the study area, which is connected to Gurungaty Waterway.

TQ is proposing to construct and operate the PK BLT with capacity of up to 288 ML of storage for combustible and flammable liquids, on land situated between existing Graincorp and Port Kembla Coal Terminal operations in the Inner Harbour area of Port Kembla. The proposed development will occur on land zoned SP1 – Special Activities under *State Environmental Planning Policy (Three Ports) 2013*. The subject site consists of three parcels of land and a berth as summarised in **Table 1-2** which are also identified in the Catchment Plan provided in **Appendix A**.

Table 1-2 Site Description

Site	Current Land Use	Proposed Land Use
Site 1	Graded gravel surface, not currently used	Combustible and flammable bulk liquids storage and pump bay.
Site 2	Graded gravel surface currently used for temporary storage of large building materials such as metal beams and fill for construction activities on neighboring sites	Combustible and flammable bulk liquids, pump bay and truck loading facilities.
Site 3	Grassed unused area with evidence of vehicle movement	Site control room & office block, maintenance work shop and utilities.
Berth 104	Solid concrete working berth utilised for loading and unloading bulk goods, including bulk liquids.	As per current, with additional bulk liquids unloading facilities.

2 Available Data

2.1 Previous Studies

2.1.1 Wollongong City Catchment Flood Study (2013)

The Wollongong City Flood Study (WCFS 2013) was commissioned by Wollongong City Council (WCC) to define the existing flood behaviour in the Gurungaty Waterway catchment and consider the influence of potential climate change on future flood behaviour. The final flood study report has been adopted in April 2013. The primary objectives of the study were to:

- > Determine the flood behaviour including design flood levels and velocities over the full range of flooding up to and including the Probable Maximum Flood (PMF) from storm runoff in the Wollongong City Catchment and from tidal influences;
- > Provide a model that can establish the effects on flood behaviour of future development;
- > Assess the sensitivity of flood behaviour to potential climate change effects such as increases in rainfall intensities and sea level rise; and
- > Assess the provisional hydraulic categories and undertake mapping of provisional hazard, preliminary emergency response planning classifications, and preliminary flood planning extent areas.

The topographic survey (ALS data) adopted in the flood study has been collected between 2005 and 2007 and thereby it does not include the site upgrade works and Inner Harbour reclamation works undertaken since 2008. Hence the flood extents and overland flowpaths shown in WCFS 2013 in the vicinity of the proposed PK BLT are considered indicative only. Further discussion on flooding in the vicinity of the project site is provided in **Section 4**.

2.1.2 Wollongong City Catchment Floodplain Risk Management Study & Plan (2015)

The Draft Wollongong City (Gurungaty Waterway) Floodplain Risk Management Study & Plan (FRMS&P) was commissioned by WCC to identify and compare various flood risk management options, including their social, economic and environmental impacts. The primary objectives of these management options are to reduce the flood hazard and risk to people and property in the existing community; and to ensure future development is controlled in a manner consistent with the flood hazard and risk.

The FRMS&P includes modelling of additional flood events that occurred in February 2012 and March 2014 following the completion of flood modelling undertaken as part of the WCFS 2013. These additional storms were modelled to validate the model performance. As the model reproduced observed behaviour well, no revision of the modelling was undertaken.

A large number of flood modification measures were proposed in the initial stages of the FRMS&P. Preliminary investigations and feasibility assessments were then undertaken to identify the most beneficial catchment-wide measures and prioritise implementation.

The only recommended modification measure relevant to the development within Port Kembla Inner Harbour is the reduction of the crest level of the Gurungaty Waterway causeway (Flood Modification Measure 'L17'), which was identified as the highest priority measure within the catchment. The causeway is located 50m to the north of Port Kembla railway and separates Gurungaty Waterway from the tidal influences of Inner Harbour. It is anticipated that lowering the causeway is unlikely to have any detrimental flood impacts downstream of Port Kembla railway. Further discussion on flood behaviour and flood impacts are provided in **Section 4**.

2.1.3 Environmental Assessment 2008 (National Biodiesel Pty Ltd)

An Environmental Assessment (EA) was prepared for National Biodiesel Pty Ltd on 5 December 2008. The EA discusses approximately the same project area as proposed for the PK BLT and thereby has been used as background information where appropriate.

2.1.4 Wollongong City Council Coastal Zone Study (2010)

A Coastal Zone Study (CZS 2010) for the Wollongong Local Government Area (LGA) was commissioned by WCC and was conducted between June 2009 and May 2010. The study included a series of site inspections of the study area, detailed studies of the coastal and geotechnical processes affecting the study area and targeted stakeholder consultation.

The study area includes the coastal zone of the Wollongong LGA, extending from the shores of Lake Illawarra and the Windang Peninsula in the south to the Royal National Park in the north. It covers approximately 60km of coastline and includes those portions of the coastal zone that are under the influence of coastal processes, including the beaches, dunes, headlands, bluffs, estuary entrances and near shore waters. The coastline consists of a series of embayed sandy beach compartments with a headland or rock shelf at each end and separated by sandstone cliffs.

It is noted that Port Kembla Harbour was excluded from the study area as it is managed under a separate legislative and policy framework. However this study includes water level data from Port Kembla and thereby has been referenced in **Section 4**.

2.1.5 Berth 104 – Pollution Incident Reduction Management Plan (2015)

NSW Ports has prepared a Pollution Incident Reduction Management Plan (PIRMP) for Berth 104 in March 2015.¹ The objectives of the plan are to:

- > Ensure effective and timely communication about a pollution incident to staff at the premises, the Environment Protection Authority (EPA), other relevant authorities specified in the Act and people outside the facility who may be affected by the impacts of the pollution incident;
- > Minimise and control the risk of a pollution incident at the facility by identifying risks and planning actions to minimise and manage those risks; and
- > Ensure that the plan is properly implemented by trained staff, identifying persons responsible for implementing it, and ensuring that the plan is regularly tested for accuracy, currency and suitability.

The PIRMP applies to the shipping of bulk products, other than those handled by GrainCorp, over Berth 104 and includes a range of activities, such as ship loading and unloading, road transport of cargo and refuelling of vessel. The PIRMP applies to material pollution incidents which originate within the licensed premises.

2.2 Existing Surface Water Conditions

2.2.1 General

The majority of the project area is located within the Gurungaty Waterway catchment. In addition, flows from the southern extent of the project area discharge directly into Port Kembla Inner Harbour.

Water quality in Port Kembla Inner harbour is affected by urban runoff from the Gurungaty Waterway catchment as well as industrial runoff from the Port Kembla precinct. Elevated levels of metals, organic pollutants and moderate turbidity have been reported as a result of historic and ongoing industrial operations within the catchment.²

2.2.2 Sites 1 & 3

In existing conditions, Site 1 consists of compacted gravel and drains to the north-west, generally towards an existing sediment basin located adjacent to Tom Thumb Road (refer to **Figure 2-1**). Since there is no pipe drainage or formalised swales within Site 1, sheet flow from the site is likely to discharge onto Tom Thumb Road in the majority of minor and major storms.

The sediment basin on Site 1 is connected to the drainage network on Tom Thumb Road via an overflow orifice. The drainage network on Tom Thumb Road is connected to the larger sediment basin located on Site 3 (refer to **Figure 2-2**) before discharge into Gurungaty Waterway at *Discharge Point 1*.

¹ NSW Ports 2015. Pollution Incident Reduction Management Plan, Environment Protection Licence No. 3577, Berth 104 – Bulk Shipping (non-GrainCorp cargo), Full Version 16 March 2015.

² Sinclair Knight Merz (SKM) 2005. *Proposed Expansion of General Cargo Handling facility Environmental Assessment Report*. Final Report December 2005 (prepared for Port Kembla Port Corporation).

Based on the drainage information provided by NSW Ports, there are intersecting drainage networks on Tom Thumb Road adjacent to the Grain Terminal. Hence, the sediment basin on Site 3 also captures parts of Tom Thumb Road catchment to the west of Gurungaty Waterway, specifically sub-catchments Cat 4-4, Cat 4-5, Cat 4-9, Cat 5-1 and Cat 5-2 (refer to catchment plan provided in **Appendix A**). This part of the catchment has an area of 2.4 ha and is connected to the basin via DN 600mm stormwater under Tom Thumb Road Bridge. This is additional to the 3.1 ha catchment area on the east side of Gurungaty Waterway resulting in a total catchment of 5.5 ha.



Figure 2-1 Existing Sediment Basin on Site 1 Adjacent to Tom Thumb Road (Looking West)



Figure 2-2 Existing Sediment Basin on Site 3 Adjacent to Gurungaty Waterway (Looking South-West)

2.2.3 Site 2

Site 2 is located on the western bank of Gurungaty Waterway and in the existing conditions it consists of compacted gravel surface that grades towards the watercourse. Two existing stormwater lines traverse Site 2, connecting the existing low points on Morton Way to receiving waterbodies (although Site 2 does not connect to these pipes). The northern stormwater line (1200 RCP) discharges into Gurungaty Waterway (*Discharge Point 2*) (refer **Figure 2-3**) and the southern stormwater line (1050 RCP) directly into Inner Harbour (*Discharge Point 3*) (refer **Figure 2-5**). The pipe outlets are equipped with tide gates.

Since there is no stormwater network, swales or stormwater quality treatment measures to cater for Site 2, runoff from the site is conveyed into the adjacent waterbodies as sheet flow across the eastern and southern site boundaries.



Figure 2-3 Site 2 and Discharge Point 2 downstream of Tom Thumb Road (Looking South-West)



Figure 2-4 Site 2 Seen from the Intersection of Morton Way and Tom Thumb Road (Looking South)



Figure 2-5 Southern Extent of Site 2 Near Discharge Point 3 (Looking North)

2.2.4 Berth 104

Berth 104 is located to the south of Site 2 and consists entirely of pavement and other impervious surfaces. In existing conditions drainage has been organised via three longitudinal rows (1 in the middle, 1 on each side) of downpipes that discharge directly into the underlying Inner Harbour waterbody. Hence, there is no stormwater network or treatment devices on the berth. Refer to **Figure 2-6** and **Figure 2-7** for the existing conditions of Berth 104.



Figure 2-6 Berth 104 (Looking North)



Figure 2-7 Existing Drainage on Berth 104 (Looking South)

3 Hydrology

3.1 Sub-catchments

The majority of the project area is located within the Gurungaty Waterway catchment (7.3km²) as defined in the WCFS 2013. Sub-catchments presented in WCFS 2013 were reviewed and used to delineate the main sub-catchments upstream of the project site. Airborne Laser Scanning (ALS) survey data captured in 2013 covers the entire catchment area and was used to refine catchment delineation where required. The ALS data has been captured in 2013 by LPI and has been supplied with a stated vertical accuracy of +/- 0.30m at 95% confidence and horizontal accuracy +/- 0.80m at 95% confidence.

The entire project site discharges into the downstream extent of Gurungaty Waterway, which is separated from Tom Thumb Lagoon by the Gurungaty Waterway causeway. Runoff from the project site does not thereby affect flows in Gurungaty Waterway (upstream of the causeway) and the project site is technically part of Inner Harbour local catchment. As a result, Gurungaty Waterway sub-catchments to the north of Port Kembla railway were excluded from the assessment.

The drainage information provided by NSW Ports indicates that a new stormwater line (825 RCP) has been constructed as part of Tom Thumb Road relocation works (approx. in 2006). The stormwater line runs immediately to the south of Port Kembla railway and drains the northern extent of Tom Thumb Road directly into Gurungaty Waterway bypassing the PK BLT sites, and is therefore excluded from the assessment.

Catchment plan and parameters for the existing conditions are presented in **Appendix A**, whereas the developed scenario sub-catchments within the PK BLT are shown in **Appendix B**. Flooding in Gurungaty Waterway and Inner Harbour are discussed further in **Section 4.2**.

3.2 Hydrological Model Configuration

The computer program XP-RAFTS was used to develop a hydrological model of the subject sites and upstream catchments as indicated in **Section 3.1**. XP-RAFTS estimates the runoff hydrograph based on catchment and rainfall data and is considered to be an appropriate model choice as it provides dynamic estimation of peak flow hydrographs. The XP-RAFTS model was used for estimating peak flows and critical storm durations in the vicinity of the project site in a range of storm events. Peak flows and flooding have been discussed in **Section 4.2**.

The hydrological model was developed for the catchment area presented in **Appendix A**. The sub-catchments were routed based on catchment topography using overland flowpaths because during a major storm the capacity of minor drainage network would be exceeded and grated inlets are likely be blocked by debris resulting in flows bypassing the pipe network. This is a typical assumption for assessing major floods in urban areas and is therefore appropriate for this assessment. Moreover, this results in conservative peak flows on Morton Way since the minor flows that would normally bypass Morton Way are now directed into the existing low point on Morton Way.

3.3 Hydrological Parameters

Each sub-catchment was divided into pervious and impervious sub-areas in the XP-RAFTS model. In the existing scenario these areas were calculated based on aerial imagery captured in January 2015. The post-development sub-areas were sourced from the proposed site design.

The hydrological parameters were compared with that presented in WCFS 2013. It was observed that the land use data presented in WCFS 2013 for the Inner Harbour area does not reflect the existing conditions in 2015. The key differences are:

- > WCFS 2013 assumed that Site 1 is covered with 'medium vegetation' whereas in its current state it is covered with unsealed hardstand (gravel).
- > WCFS 2013 did not include the recent expansion of Grain Terminal located to the north of Tom Thumb Road. WCFS 2013 adopted 'light vegetation', whereas in this assessment the majority of the area has been modelled as impervious surfaces to reflect current site conditions.

It is noted that the above inconsistencies are not considered significant for the high level surface water assessment, since the hydrological model developed for the subject site includes updated catchment parameters to reflect the existing conditions as in 2015. The land use types and the catchment parameters adopted for the hydrological modelling are presented in **Table 3-1** and **Table 3-2**.

Table 3-1 Land Use Types Adopted for Hydrological Modelling

Land Use	Impervious Fraction	Hydraulic Roughness Manning's n
Roof	100%	0.015
Existing paved surface	100%	0.025
Unsealed hardstand (gravel)	90%	0.035
Grass, roadside verge	25%	0.045
Proposed paved surface	100%	0.022
Proposed bunded areas	100%	0.020

Table 3-2 Hydrological Catchment Parameters

Parameter	Pervious Catchment	Impervious Catchment
Initial rainfall loss [mm]	5	0
Continuing rainfall loss [mm/hr]	2.5	0
Vectored Slope [%]	Varies - Estimated from ALS data for each sub-catchment	

The land use sub-areas presented in **Table 3-1** were used to calculate Total Impervious Area (TIA) for each sub-catchment in both existing and post-development scenarios. Breakdown of sub-areas within subject sites are provided in **Table 3-3** and **Table 3-4** in existing and post-development conditions, respectively. Batters from site into the harbour was categorised as 'foreshore' and was excluded from the hydrological model as runoff from these areas is immediately conveyed into the harbour.

Table 3-3 Breakdown of Existing Land Use within Project Site

Allotment	Total (ha)	Roof (%)	Existing Paved (%)	Unsealed Hardstand (%)	Pervious Areas (%)	Foreshore (%)
Site 1	1.80	0.0	0.0	98.5	1.5	0.0
Site 2	4.13	0.0	11.7	64.8	12.5	11.0
Site 3	0.37	0.0	0.0	57.7	42.3	0.0
Berth 104	0.86	33.4	51.6	0.0	0.0	15.0

Table 3-4 Breakdown of Post-Development Land Use within Project Site

Allotment	Total (ha)	Roof / Tanks (%)	Existing Paved (%)	Unsealed Hardstand (%)	Pervious Areas (%)	Proposed paved (%)	Proposed Bunded (%)	Foreshore (%)
Site 1	1.80	28.9	0.0	0.0	0.0	5.4	65.6	0.0
Site 2	4.13	9.9	11.0	0.0	7.2	26.9	33.9	11.0
Site 3	0.37	18.3	0.0	0.0	0.0	81.7	0.0	0.0
Berth 104	0.86	33.4	51.6	0.0	0.0	0.0	0.0	15.0

3.4 Design Storms

3.4.1 Rainfall Data

Design rainfall depths and temporal patterns for various storm durations at Port Kembla were obtained from Australian Rainfall and Runoff 1987 (ARR87), for events up to and including the 100 year Average Recurrence Interval (ARI). This is consistent with the flooding information available for the rest of the catchment as ARR87 data was adopted in WCFS 2013. A summary of design rainfall depths is provided in **Table 3-5**.

Table 3-5 Rainfall Data at Port Kembla

Duration	Total Rainfall (mm)							PMF
	1 yr ARI	2 yr ARI	5 yr ARI	10 yr ARI	20 yr ARI	50 yr ARI	100 yr ARI	
10 min	15	18	23	25	29	33	36	n.a.
20 min	21	27	34	38	43	50	55	n.a.
30 min	26	33	42	47	54	63	69	220
1 hour	36	46	59	66	76	89	99	320
2 hour	46	60	78	89	103	121	136	480
3 hour	53	70	92	105	122	144	161	580
6 hour	68	89	119	137	161	193	217	780
12 hour	87	115	157	182	216	259	294	n.a.
24 hour	113	150	209	245	293	358	406	n.a.
48 hour	144	192	275	327	395	485	557	n.a.
72 hour	160	215	312	375	455	564	652	n.a.

3.4.2 Critical Storm Durations

3.4.2.1 Gurungaty Waterway

Critical storm durations for various parts of the Gurungaty Waterway catchment were determined in the WCFS 2013, through analysis of a range of storm durations from 15 minutes to 12 hours. It was found that the 2-hour and 9-hour storms are critical for a significant majority of the catchment area for the storm events between the 20% AEP and the 1% AEP. The study adopted an embedded design storm for the entire catchment, using the 2-hour design storm burst within the 9-hour design storm. Maximum flows in Gurungaty Waterway adjacent to the project site are likely to occur during prolonged storm events.

The WCFS 2013 adopted an embedded design storm for the PMF by using 30, 60, 120 and 180 minute Probable Maximum Precipitation (PMP).

3.4.2.2 Local Catchments

Based on results of the hydrological modelling, it was identified that the PK BLT site and the local catchment upstream of Site 2 and Site 3 generally have a critical storm duration of 25 minutes (1 to 10 year ARI event) or 90 minutes (20 to 100 year ARI event). This means that the highest peak flows through the sites would occur during a storm of that duration. Since this duration is less than the critical storm duration for the entire Gurungaty Waterway catchment, the peak flows from the project area would not align with the peak flows from the major catchment.

4 Flooding

4.1 Flood Management Policy

4.1.1 State Government Policy

Section 117 of the *Environmental Planning and Assessment Act 1979* requires that development of flood prone land is to be consistent with NSW Government's *Flood Prone Land Policy*, which aims to reduce damage associated with flooding and assist Councils when making land use decisions in flood prone areas. The aim of the policy is to ensure that the provisions of a Local Environmental Plan (LEP) on flood prone land is commensurate with flood hazard, and includes consideration of the potential flood impacts both on and off site. The principles of this policy are set out in the *Floodplain Development Manual (FDM 2005)*.

The FDM 2005 defines flood prone land as all land susceptible to flooding in the PMF event, which is generally characterised by an average recurrence interval in the range of 10,000 – 100,000 years. Although the FDM considers the full range of floods including the PMF event, it recognises that it is generally not economically or physically possible to provide complete protection against this event.

Local Councils have primary responsibility in the management of flood prone land, and are required to do this by developing and implementing Floodplain Risk Management Studies and Plans (FRMS&P). Given that a FRMS&P has been completed for the Gurungaty Waterway catchment by Wollongong City Council (WCC) in 2015, this provides guidance on the flood related development controls applicable to sites within the catchment, including that of the PK BLT sites. Recommendations within the FRMS&P have been reviewed (refer to **Section 2.1.2**).

4.1.2 Council DCP (2009)

WCC's Development Control Plan (DCP 2009) is based on State Government Policies, such as FDM 2005, providing detailed guidelines for appropriate design of new development. Chapter E13 of DCP 2009 specifically addresses floodplain management, and sets out requirements for consideration such as minimum floor levels, parking and evacuation. It further categorises floodplains within the Wollongong Local Government Area (LGA) into three Flood Risk Precincts (FRP's); Low Risk, Medium Risk and High Risk.

Implications of the DCP 2009 are discussed further in **Section 4.3**.

4.2 Susceptibility to Flooding

4.2.1 Height Datum

It was noted in the CZS 2010 that Australian Height Datum (AHD) is approximately 0.87m above Lowest Astronomical Tide (LAT) at Port Kembla. Port Kembla Height Datum (PKHD) is widely used in Port Kembla and is same as LAT. In contrast, the results presented in Council's flood study are in AHD. The differences between the each datum are summarised in **Table 4-1**. PKHD is adopted for this assessment since background information and surveys are typically presented in this format.

Table 4-1 Height Datum

m LAT	m PKHD	m AHD
0.00	0.00	-0.87

4.2.2 Flooding from Gurungaty Waterway

The subject sites have been gradually reclaimed as part of Port Kembla Inner Harbour port reclamation works. There is no recorded flooding within the sites due to these earthworks and the resulting finished ground levels. Flooding in Gurungaty Waterway has been assessed as part of the catchment-wide flood study (WCFS 2013). The peak design flood levels reported in the WCFS 2013 for a range of Annual Exceedance Probability (AEP) storms are summarised in **Table 4-2** while the flood extents in the 1% AEP event are presented in **Figure 4-1**.

These design flood levels reflect the current climate and adopt a tailwater level of 1.5 mAHD (2.37 mPKHD) for 20% to 1% AEP events. A tailwater level of 2.6 mAHD (3.47 mPKHD) is adopted for the PMF event and it includes a 100 year dynamic tide, storm surge and wave setup.

Table 4-2 Peak Design Flood Levels (mAHD) Reported in Gurungaty Waterway (WCFS 2013)

Location	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	PMF
Downstream of Tom Thumb Road, Adjacent to Site 2 (Location S1, WCFS 2013)	1.5 mAHD 2.37 mPKHD	1.5 mAHD 2.37 mPKHD	1.6 mAHD 2.47 mPKHD	1.6 mAHD 2.47 mPKHD	1.8 mAHD 2.67 mPKHD	2.7 mAHD 3.57 mPKHD
Upstream of Tom Thumb Road Adjacent to Site 3 (Location S2, WCFS 2013)	1.6 mAHD 2.47 mPKHD	1.6 mAHD 2.47 mPKHD	1.6 mAHD 2.47 mPKHD	1.7 mAHD 2.57 mPKHD	1.8 mAHD 2.67 mPKHD	2.8 mAHD 3.67 mPKHD

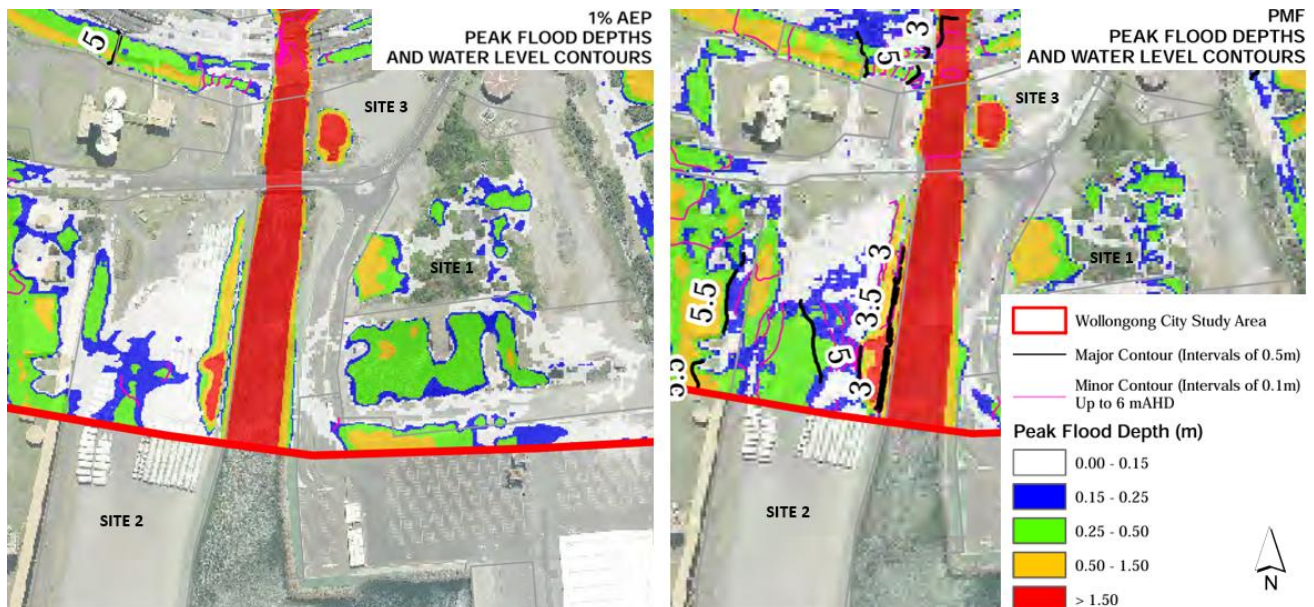


Figure 4-1 Peak Flood Depths and Water Level Contours (mAHD) in the 1% AEP and PMF (WCFS2013)

Existing ground levels on the northern extent of Site 2 are approximately 5.0-5.5 mPKHD. The existing ground levels on Site 1 are between 6-7 mPKHD, whereas Site 3 has an approximate elevation of 5.5 mPKHD. Based on the flood levels reported in the WCFS 2013, all site levels (excluding the existing sediment basin on Site 3) are a minimum of 1.8m above the PMF levels in Gurungaty Waterway. Therefore riverine flooding from Gurungaty Waterway does not impact the proposed PK BLT.

However, the flood maps indicate some flood affectation of the sites, which is due to existing low points and depressions at the time of capturing the adopted ALS survey data (between 2005 and 2007). Since then the sites have been upgraded including resurfacing Site 1 and waterfront works on Site 2, which have levelled the surfaces and thereby is likely to have reduced ponding within the sites. Nevertheless, overland flows from local catchments will occur especially in the vicinity of Morton Way to the west of Site 2, which can be seen in **Figure 4-1**. This results in flows traversing Site 2 and is discussed in **Section 4.2.5**. However, it is noted that this flooding is due to runoff from the local impervious upstream catchment (Grain Terminal and Tom Thumb Road) and therefore is not riverine flooding from Gurungaty Waterway.

4.2.3 Sea Level Rise

The NSW State Government released a Sea Level Rise Policy Statement in October 2009 that included sea level rise planning benchmarks of +0.4m and +0.9m by 2050 and 2100, respectively, which were adopted into the catchment wide flood study (WCFS 2013). These values were established through careful consideration of available sea level rise projections and take into account the uncertainty associated with these projections. Such sea level rise would also impact both on tidal regimes and flood events, potentially reducing the capacity of drainage systems discharging into tidal waterbodies. The projected sea level rise would not, however, pose a risk to PK BLT due to site elevations.

4.2.4 Tidal Planes

Water levels in the Illawarra region are dominated by semi-diurnal astronomical tides. Astronomical tidal planes for Port Kembla are summarised in **Table 4-3**. In addition to astronomical tides, water levels are also influenced by daily, seasonal and inter-annual oceanographic processes which can cause variation to the predicted astronomical tide of up to ± 0.2 m. Tidal planes shall be considered in the detailed design of drainage infrastructure for the PK BLT.

Table 4-3 Tidal Planes for Port Kembla (National Tide Tables 2010)

Tidal Plane	Water Level (m LAT, m PKHD)	Water Level (m AHD)
Highest Astronomical Tide (HAT)	2.00	1.13
Mean High Water Springs (MHWS)	1.50	0.63
Mean High Water Neaps (MHWN)	1.30	0.43
Mean Sea Level (MSL)	0.90	0.03
Mean Low Water Neaps (MLWN)	0.60	-0.27
Mean Low Water Springs (MLWS)	0.30	-0.57
Lowest Astronomical Tide (LAT)	0.00	-0.87

4.2.5 Flooding from Local Catchments

4.2.5.1 Eastern Side of Gurungaty Waterway

Site 1 and Site 3 located on the eastern side of Gurungaty Waterway are part of a small local catchment which consists mainly of the sites themselves, and small portion of Tom Thumb Road which would be the primary overland flowpath in major storms. Since Site 1 has no upstream catchment and Site 3 only a small upstream catchment (0.95ha plus Site 1), significant flooding is not likely to occur due to flows from external catchments.

As discussed in **Section 2.2.2**, part of the Tom Thumb Road catchment to the west of Gurungaty Waterway drains into the existing sediment basin on Site 3 via minor drainage line across the Tom Thumb Road bridge. While this network may be able to convey minor flows from the upstream catchment into Site 3, during a major storm event (100 year ARI) these inter-catchment flows are relatively small. These flows are not considered to have significant impact on flooding on Site 3 due to the high flow bypass weir built into the existing sedimentation basin.

4.2.5.2 Western Side of Gurungaty Waterway

In contrast, Site 2 is located in the downstream end of a larger catchment that includes the majority of the Grain Terminal site as well as the majority of Tom Thumb Road on the western side of Gurungaty Waterway. The primary overland flow path runs along Tom Thumb Road and then diverts to the south through the Grain Terminal site before connecting to Morton Way.

The size of the catchment upstream of Site 2 is 9.9 ha, which applies to major storms when runoff is predominantly conveyed by overland flow paths based on catchment topography. In minor storms runoff from a 2.4 ha extent of the catchment bypasses Site 2 (due to the minor drainage across Tom Thumb Road bridge), and therefore a catchment size of 7.5 ha would apply. However, for a conservative approach the

larger overland flow catchment shall be adopted for conceptual design of drainage infrastructure on Morton Way. A Catchment plan has been provided in **Appendix A**.

The detailed survey indicates that there are two low points on Morton Way adjacent to Site 2. The northern low point has been included in the WCFS 2013, and results indicate flood depths of up to 0.5m at this location in the 1% AEP flood event (Refer to **Figure 4-1**). The southern low point is beyond the study area of the WCFS 2013 and thereby no flooding results from that location are available. However, if full extents of Morton Way and Site 2 were included in the WCFS 2013, the flooding on Morton Way would be likely to spread further to the south reducing flood depths on Morton Way.

Stormwater drainage from the two low points on Morton Way has been provided via two stormwater pipes that traverse Site 2. The northern stormwater line (1200 RCP) discharges into Gurungaty Waterway at *Discharge Point 2* (DP2) and the southern stormwater line (1050 RCP) at *Discharge Point 3* (DP3). A Catchment plan showing the location of these stormwater pipes and discharge points has been provided in **Appendix A**. Should the capacity of these pipes be exceeded or pits be blocked in the existing conditions, overland flows would traverse Site 2 and discharge into Gurungaty Waterway.

4.2.6 Drainage Infrastructure on Morton Way

In the proposed scenario Site 2 would be bounded by a 1.8m bund wall, which would effectively block major flows from the upstream catchment from traversing the site. This would likely result in increased depth and duration of ponding on Morton Way in major storms exceeding the capacity of the existing drainage infrastructure (or in minor storms if pipes should block). In order to mitigate the impacts, runoff from external catchments shall be captured and diverted around the project site via upgraded road drainage and overland flowpaths on Morton Way. Since in the proposed scenario there will be no continuous overland flowpaths traversing Site 2, the stormwater network need to be designed to cater for major flows.

Peak flows on Morton Way at the northern and southern low points were assessed using the hydrological model described in **Section 3** and are summarised in **Table 4-4**. The peak flows were adopted from the scenario where the upstream catchment is based on overland flow paths, which results in larger upstream catchment area and is therefore a conservative approach (refer to **Section 4.2.5.2**). This also includes the sub-catchments on Morton Way to the west of the proposed bund wall on Site 2 (Cat 2-3, Cat 2-4, Cat 2-5 and Cat 2-6). Estimated capacities of the existing stormwater pipes draining the low points on Morton Way are presented in **Table 4-5**.

Table 4-4 Peak Flow Rates at Morton Way in the Developed Scenario

Location	Upstream Catchment Size incl. Morton Way	10 year ARI (25 min)	50 year ARI (90 min)	100 year ARI (90 min)
Northern Low Point (Outflow from Cat 2-5)	6.95 ha	2.76 m ³ /s	3.54 m ³ /s	3.99 m ³ /s
Southern Low Point (Outflow from Cat 2-6)	3.64 ha	1.76 m ³ /s	2.29 m ³ /s	2.57 m ³ /s

Table 4-5 Estimated Capacity of Existing Stormwater Lines (Site 2)

Location	Pipe Size	Slope	Approx. Capacity (free discharge)
Northern Low Point	1200 RCP	1.0 %	4.0 m ³ /s
Southern Low Point	1050 RCP	2.7%	4.5 m ³ /s

By comparing the peak flow rates and the existing capacities of the stormwater pipes, it can be seen that the capacity of the northern pipe is equal to the 100 year ARI peak flow, while the southern pipe has excess capacity.

In order to get better understanding of the capacity of the existing stormwater lines, a conceptual hydraulic DRAINS modelling was undertaken to analyse operation of the pipes under the 1% AEP tailwater conditions as presented in **Table 4-2** (2.67 mPKHD at DP2 and 2.37 mPKHD at DP3). Inflow hydrographs were adopted from the hydrological model discussed in **Section 3**. The DRAINS modelling indicated that both existing stormwater pipes have sufficient capacity to convey the 100 year ARI flows from Morton Way into the harbour. Both pipe outlets are submerged in these conditions, however the installed tide gates would prevent water from backing up into the drainage network.

Hydraulic modelling indicated that the existing pipes have sufficient capacity for conveying major flows under the 1% AEP tailwater conditions. Therefore main reasons for flooding on Morton Way are insufficient pit inlet capacities, unfavourable pit locations and blockage of pits. However, all of these factors can be improved by upgrading drainage on Morton Way and on Site 2 as part of the PK BLT works. There are three main options for upgrading the existing drainage system:

1. **Maintain existing stormwater pipes traversing Site 2.** This requires increasing the number of pits on Morton Way to increase total inlet capacity. Pit inlets are to be designed to reduce likelihood of blockage of grates and pipes.
2. **Realign and upsize stormwater pipes traversing Site 2.** Relocation of the existing stormwater lines is likely to be required as part of the PK BLT works due to construction of the proposed tanks and other structures. Pipes may be required to be upsized to maintain the existing capacity depending on the final pit configuration.
3. **Diversion to the south along Morton Way.** Construct an additional stormwater line from the northern low point along Morton Way to the south and maintain the existing stormwater lines. This stormwater line would be approximately 300m long starting from the northern low point on Morton Way and discharging into the harbour adjacent to the southern entry into Site 2. Due to the length of the diversion, it would be required to begin from a higher elevation than the invert levels of the existing stormwater lines. Therefore, the diversion would be a separate stormwater line and would not be connected to the existing pipe network on Morton Way.

The final capacity of the upgraded drainage system depends on the pit and pipe configuration and therefore shall be determined as part of the detailed design stage. Detailed modelling of the drainage upgrade works will be undertaken during the PK BLT detailed design stage. All of the above options can be designed to achieve the following design objectives:

- > Pipes and pits on Morton Way to be designed to cater for major storms (i.e. the 100 year ARI flows presented in **Table 4-4**) since there is no continuous overland flow paths available for major flows.
- > Design conditions shall include the 1% AEP tailwater conditions in the harbour plus the sea level rise planning benchmark of +0.4m by 2050. Based on the WCFS 2013 this results in tailwater levels of 3.07 mPKHD at DP2 and 2.77 mPKHD at DP3.
- > Existing flood elevations within the adjacent property (Grain Terminal) to be maintained.
- > Pit inlets to be designed so that the likelihood of blockage by debris is reduced. This could include custom inlets with debris screens.
- > Increase number of pits on the low points on Morton Way to increase total inlet capacity.
- > The location and depth of existing services adjacent to Morton Way and under Tom Thumb Road shall be carefully considered.
- > Tide gates to be installed at all pipe outlets.

4.3 Floodplain Management Controls

4.3.1 Provisional Hydraulic Categorisation

The FRMS&P (2015) provides catchment-specific provisional hydraulic categorisation for the 1% AEP and PMF events based on FDM 2005 framework. General definition and catchment specific criteria are summarised in **Table 4-6**. Hydraulic categories in the vicinity of the project site are presented in **Figure 4-2**.

Table 4-6 Provisional Hydraulic Categorisation Adopted in the FRMS&P 2015

Category	Definition
Floodway	Those areas of floodplain where significant discharge of water occurs during floods: <i>Peak value of velocity multiplied by depth ($V \times D$) is greater than $0.25 \text{ m}^2/\text{s}$ plus peak velocity is in excess of 0.25 m/s; OR</i> <i>Peak velocity is in excess of 1.0 m/s and peak depth is in excess of 0.15 m.</i>
Flood Storage	The parts of the floodplain that are important for the temporary storage of floodwaters during the passage of flood: <i>Area outside the Floodway where peak depth is in excess of 0.5 m.</i>
Flood Fringe	The remaining area of flood prone land after floodway and flood storage areas have been defined: <i>Area outside the Floodway where peak depth less than 0.5 m.</i>

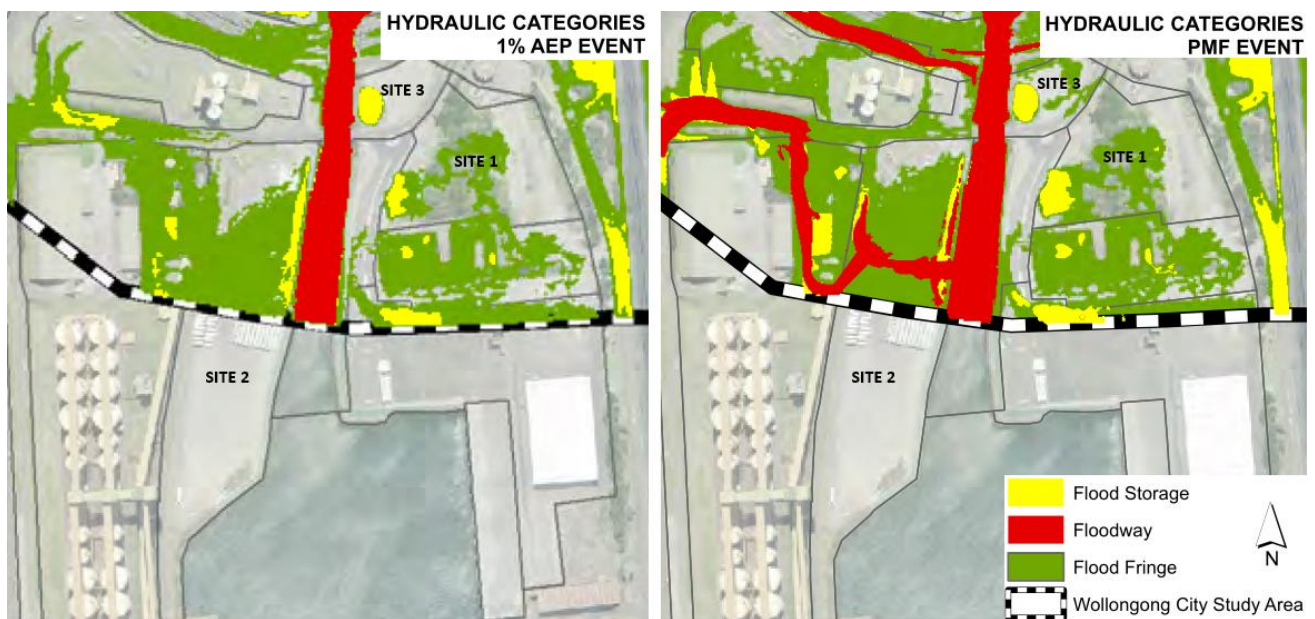


Figure 4-2 Existing Hydraulic Categories based on the FRMS&P 2015

The following can be concluded from **Figure 4-2** regarding the major flood behaviour in the proximity of the project site:

- > **Site 1** is only flooded due to local flows. Flood storage within the site is based on the ALS survey data captured between 2005 and 2007 and has been removed due to site upgrade works undertaken by NSW Ports since then which has included additional filling to create a raised development pad. Thereby the FRMS&P 2015 does not reflect the existing conditions of Site 1.
- > **Site 2** is flooded due to flows from the local upstream catchment (refer to **Section 4.2.5**). The FRMS&P indicates that in the 1% AEP flood event, the site is mainly subject to slow and shallow overland flow traversing the site from west to the east. In the PMF event, the northern low point on Morton Way (refer to **Section 4.2.5**) becomes more apparent and causes flood velocities and depths to increase within the site so that the primary flow path would be categorised as Floodway area. It is noted that the Flood Storage area shown on the eastern site boundary (parallel to Gurungaty Waterway) is based on superseded ALS survey data and does not reflect the current site conditions. The southern extent of Site 2 is beyond the model extent of the WCFS 2013 and the FRMS&P 2015, therefore no results for this area are available.
- > **Site 3** is only flooded due to local flows, similar to Site 1. The flood storage area in the western extent of the site reflects the existing stormwater sediment basin.

In addition to hydraulic categorisation described in **Table 4-6**, Council's DCP 2009 adopts the provisional hydraulic hazard (flood hazard) as presented in the FDM 2005. The method categorises hydraulic hazards to

Low and High based on the velocity and depth of flow as shown in **Figure 4-3**. This method is adopted by WCC for determining FRPs as per DCP 2009 although apparent overlapping with the hydraulic categorisation shown in **Table 4-6**. Determination of FRPs for the project site has been discussed below in **Section 4.3.2**. It is noted that the example values (yellow lines) shown in **Figure 4-3** are from the FDM and are not related to the PK BLT project.

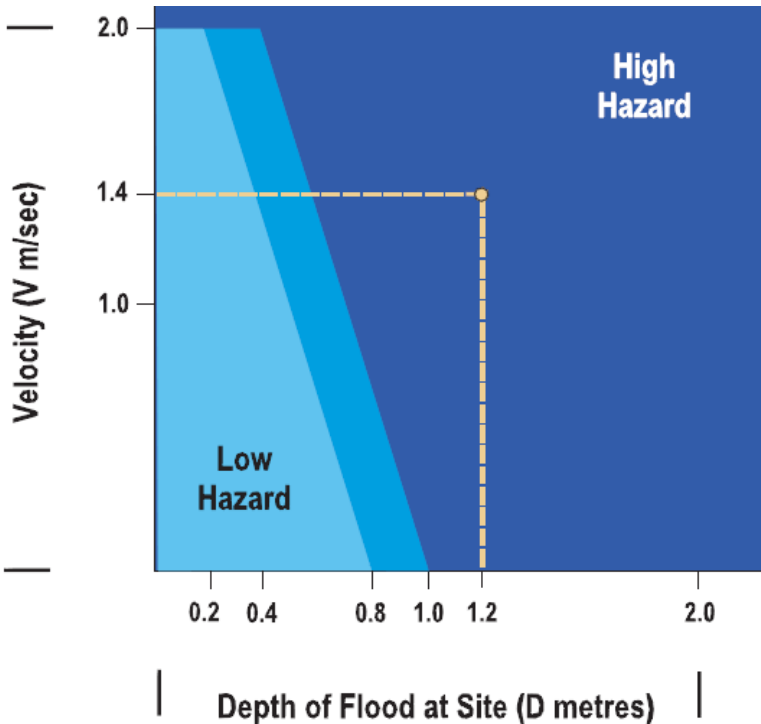


Figure 4-3 Provisional Hydraulic Hazard Assessment (FDM 2005)

4.3.2 Flood Risk Precincts

The DCP 2009 defines FRPs based on the 100 year ARI (approx. 1% AEP) and the PMF flood extents and the provisional hydraulic hazard (flood hazard) as shown in **Figure 4-3**. The definitions of FRPs are provided in **Table 4-7**, while existing FRPs in the vicinity of the project site are illustrated in **Figure 4-4**.

Table 4-7 DCP 2009 Flood Risk Precinct Definitions

FRP	Definition	Acceptable Development Types
Low	All other land within the floodplain (i.e. the extent of the PMF) but not defined within either the High or Medium FRP.	Subdivision, Residential, Commercial & Industrial, Tourist Related Development, Recreational & Non-Urban and Concessional Development. Only Essential Community Facilities are considered unsuitable in a Low FRP.
Medium	Land below the 100 year flood level (plus 500mm freeboard) that is not within the High FRP.	Development types as listed in the low FRP are allowable, with exception to Essential Community Facilities and Critical Utilities. It is noted that the allowable development in a Medium FRP is subject to more stringent prescriptive controls than the Low FRP.
High	The area within the envelope of land subject to a high provisional hydraulic hazard (in accordance with FDM 2005) in a 100 year flood event plus all land within 10m from the top of the creek bank.	Most development is considered to be unsuitable with exception of Recreational, Non-Urban and Concessional Development.

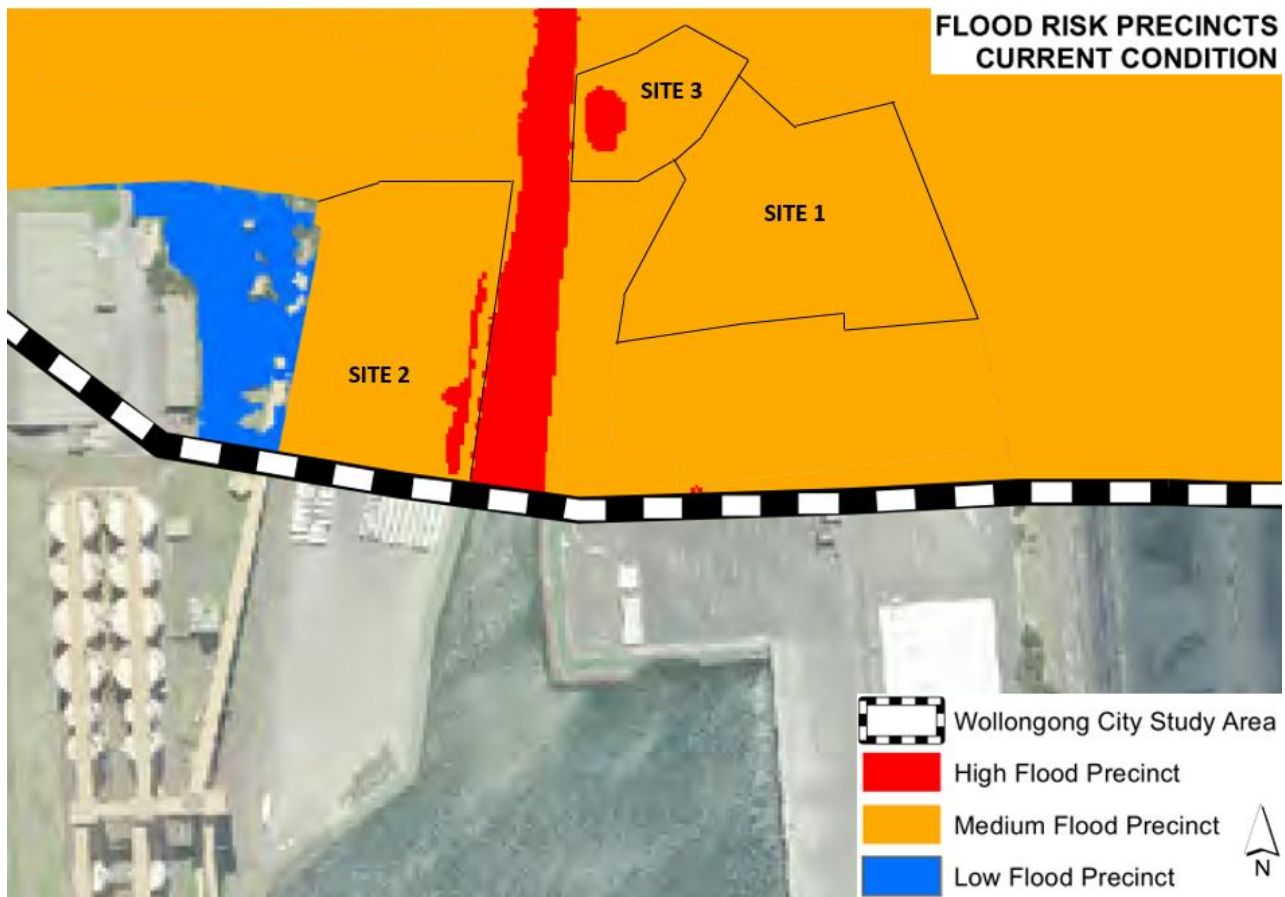


Figure 4-4 Existing Flood Risk Precincts (FRMS&P 2015)

The FRMS&P 2015 indicates that in the existing conditions the project site predominantly lies within the Medium FRP as shown in **Figure 4-4**. Since the project site is not flooded from Gurungaty Waterway (refer to **Section 4.2.2**) the Medium FRP is due to overland flows from local catchments traversing the subject sites.

Based on the FRMS&P 2015, small parts of the existing Site 2 and Site 3 lie within the High FRP, including:

- > Existing depression on the eastern boundary of Site 2 parallel to Gurungaty Waterway. This is likely to be due to the superseded ALS survey data collected between 2005 and 2007. Thereby the data does not include the site upgrade works and Inner Harbour reclamation works undertaken since 2008.
- > Existing dis-used stormwater sediment basin on Site 3 (due to the water depth in the basin in a major storm). It is noted that in the developed scenario, the existing stormwater sediment basin will be filled and replaced with an enclosed water quality treatment device.

It is noted that the existing FRP categorisation within Port Kembla appears to be inaccurate, especially due to utilisation of outdated ALS survey data. Furthermore, the model extent does not cover the southern part of Site 2 and thereby existing categorisation for that area is not available. However, updating the ALS data would be unlikely to change the FRP categories within the project area itself. For planning purposes it can be reasonably assumed that all project sites are within the Medium FRP, which allows commercial and industrial development as per DCP 2009 (refer to **Table 4-7**).

4.3.3 Filling on Flood Liable Land & Flood Affection

The DCP 2009 requires that unless a Floodplain Risk Management Plan for the catchment has been adopted, which allows filling to occur, filling in flood prone areas is not permitted unless a report from a suitably qualified civil engineer is submitted to Council that certifies that the development will not increase flood affection elsewhere.

Filling of individual sites in isolation, without consideration of the cumulative effects is not permitted. The FDM 2005 states that a case by case decision making approach cannot take into account the cumulative impact of flooding behaviour, and associated risks, caused by individual developments. Any proposal to fill a site must therefore be accompanied by an analysis of the effect on flood levels of similar filling of developable sites in the area. This analysis would form part of a flood study prepared in accordance with DCP 2009.

Given that part of the project site is on flood liable land (refer to PMF flood extents shown in **Figure 4-1**), WCC would not generally accept filling of the sites without demonstrating that there are no flooding impacts elsewhere within the catchment. However, based on a desktop analysis of the results from the WCFS 2013 and the FRMS&P 2015 the following can be concluded:

- > The flooding from Gurungaty Waterway does not extend into the project sites, therefore importing fill within the site would not affect flooding within the upstream extents of Gurungaty Waterway.
- > **Site 1** does not have an upstream catchment, therefore fill within the site only affects its internal drainage, which would be accounted for in the site drainage design. Fill within Site 1 would not increase flood affectation elsewhere.
- > Filling within **Site 2**, especially near Morton Way, would impede major flows from the upstream catchment that in existing conditions flow through the site into Gurungaty Waterway. Introducing fill on the flood liable extent of Site 2 is therefore more critical for flow conveyance than it is for loss of floodplain storage. Provided that the existing stormwater pipes traversing Site 2 remain capable of conveying upstream flows from Morton Way, works within Site 2 would not increase flood affectation elsewhere. Alternatively, a diversion around the site may be required.
- > **Site 3** has a small upstream catchment, however the main flow path is Tom Thumb Road. Therefore, filling within Site 3 would not impact on the main flow path and would not increase flood affectation elsewhere.

4.3.4 Prescriptive Floodplain Management Controls

The proposed development shall be compliant with prescriptive floodplain management controls in accordance with the DCP 2009. In absence of catchment specific controls, the generic planning considerations presented in DCP 2009 shall be adopted. A summary of these controls in relation to industrial development on a Medium FRP is provided in **Table 4-8**.

Table 4-8 Prescriptive Floodplain Management Controls (DCP 2009)

Control	Requirement	Comment
Floor Level	<ul style="list-style-type: none"> Habitable floor levels to be equal or greater than the 100 year flood level plus freeboard (500mm); or Floor levels of shops to be as close to the design floor level (DFL) as practical. Where below the design floor level, more than 30% of the floor area to be above the design floor level or premises to be flood proofed below the design floor level. 	The proposed building (office / warehouse) would be located on Site 3 which is not affected by main stream flooding from Gurungaty Waterway. The building would meet the habitable floor level requirements.
Building Components	<ul style="list-style-type: none"> All structures to have flood compatible building components below or at the 100 year flood level plus freeboard. 	To be addressed in detailed design. Nb. The project site is not affected by main stream flooding from Gurungaty Waterway.
Structural Soundness	<ul style="list-style-type: none"> Applicant to demonstrate that any structure can withstand the forces of floodwater, debris and buoyancy up to and including a 100 year flood plus freeboard, or a PMF plus freeboard if required to satisfy evacuation criteria (see below). 	To be addressed in detailed design. Nb. The project site is not affected by main stream flooding from Gurungaty Waterway.
Flood Affection	<ul style="list-style-type: none"> Engineers report required to certify that the development will not increase flood affection elsewhere (loss of floodplain storage, changes in flood levels and velocities) 	Refer to Section 4.3.3 . Further assessment to be undertaken in subsequent design phases.
Evacuation	<ul style="list-style-type: none"> Reliable access for pedestrians required during a 100 year flood. The development is to be consistent with any relevant flood evacuation strategy or similar plan. 	Safe evacuation access for pedestrians from the proposed building on Site 3 can be achieved up to and including the 100 year flood. Flow depths and velocities within Site 2 are anticipated to be safe for vehicles, especially taking into account that the area is primarily used by heavy vehicles.
Management & Design	<ul style="list-style-type: none"> Site Emergency Response Flood plan required where floor levels are below the Design Floor Level (DFL). Applicant to demonstrate that area is available to store goods above the 100 year flood level plus freeboard. No external storage of materials below the design floor level which may cause pollution or be potentially hazardous during any flood. 	The proposed building (office / warehouse) would be located on Site 3 and have floor levels above the DFL. Storage of hazardous materials (liquids) will utilise closed tanks which are risen above ground on raised foundations. Storage tanks are located within closed bunded areas that are immune to flooding from external catchments. Any internal spills would be contained within the bunded area.

4.3.5 Compliance with Floodplain Management Controls

WCC in their letter dated 9 October 2015 identified the requirement for a flood study to be undertaken:

“... in consideration of the NSW Floodplain Development Manual (2005), the stormwater and floodplain management chapters of the Wollongong DCP 2009 and Wollongong City Flood Study (2013) and Floodplain Risk Management Study and Plan (2015)”.

The port of Port Kembla (including the TQ premises) is subject to the controls contained within the Port SEPP, with the Project defined as State Significant Development (SSD) as it meets the requirements of Clause 27 associated with both the site location within the Port Lease Area and the capital cost of works in excess of \$100 million.

Clause 10(1) of the Port SEPP states:

“For the purpose of enabling development on land in any zone to be carried out in accordance with this Policy or with a development consent granted under the Act, any agreement, covenant or other similar instrument that restricts the carrying out of that development does not apply to the extent necessary to serve that purpose”.

Furthermore, Clause 6(1) of the Port SEPP states:

“Subject to section 74 (1) of the Act and this clause, in the event of an inconsistency between this Policy and another environmental planning instrument, whether made before or after the commencement of this Policy, this Policy prevails to the extent of the inconsistency.”

Subject to Clause 10(1) of the Port SEPP any instrument that restricts the carrying out of development identified under the Port SEPP does not apply, with Clause 6(1) identifying that the Port SEPP prevails over other environmental planning instruments where there is an inconsistency.

This Surface Water Assessment has considered all documents required by WCC. The flood assessment discussed in **Section 4** has identified that there is the potential for limited off-site impacts, which is counter to the requirements of *Chapter E13: Floodplain Management* of the Wollongong DCP. These off-site impacts would be limited to the eastern extent of the Grain Terminal site adjacent to PK BLT Site 2. Given the industrial context and limited sensitivity of the use on the adjacent site this impact is not considered significant and can be mitigated during the detailed design phase as part of the proposed stormwater upgrade works discussed in **Section 4.2.6**.

Consequently, while this Surface Water Assessment does not result in strict compliance with the Wollongong DCP, it has considered the impacts and found them to be limited, with these impacts proposed to be addressed during the detailed design phase due to their limited extent.

Furthermore, it is noted that development control plans are planning guidelines with Section 74BA of the EP&A Act identifying their purpose:

74BA Purpose and status of development control plans

(1) The principal purpose of a development control plan is to provide guidance on the following matters to the persons proposing to carry out development to which this Part applies and to the consent authority for any such development:

- a. giving effect to the aims of any environmental planning instrument that applies to the development,*
- b. facilitating development that is permissible under any such instrument,*
- c. achieving the objectives of land zones under any such instrument.*

The provisions of a development control plan made for that purpose are not statutory requirements.

The Surface Water Assessment and associated modelling has sought to comply with the objectives and requirements presented in the various sections of the DCP as far as practicable within the development context.

5 Stormwater Management during Construction

5.1 Potential Impacts during Construction

5.1.1 Hydrology and Flooding

Construction works have the potential to alter runoff generation and flow paths impacting on surface water flow regimes at the project area. Changes to surface water flow regimes may result from a number of factors, including:

- > An increase in impervious surface area due to replacing existing pervious surfaces with paved surfaces or compaction of pervious surfaces due to use of heavy machinery.
- > Re-grading of existing surfaces to suit construction staging.
- > New structures or earthworks impede surface flows.
- > Alteration to existing drainage infrastructure (temporary or permanent).
- > Construction of new drainage infrastructure.
- > Discharge of treated water from construction water treatment systems into the local stormwater system or directly into Gurungaty Waterway or Inner Harbour.

Potential impacts to surface water flow regimes during construction may include:

- > Increased peak flow rates and runoff volumes discharging from sites due to an increase in impervious surface areas within the project area.
- > Increased flooding on Morton Way due to construction of Site 2 earthworks that may impact on the surface flow paths from Morton Way to Gurungaty Waterway.
- > Localised flooding within construction sites during high rainfall events due to discontinuous overland flow paths and temporary stormwater detention measures.

5.1.2 Water Quality

During construction, site runoff may contain pollutants that have the potential to affect water quality of the Port Kembla Inner Harbour. Potential water quality impacts during construction may include:

- > Fuel and oil spills occurring due to use of construction machinery or temporary storage of construction materials, chemicals and equipment on site.
- > Litter originating from use and storage of construction materials.
- > Generation and mobilisation of fine particles and associated heavy metal and organic contaminants from eroding soils.
- > Increased sediment loads due to sediment trapped to vehicles. This concerns specifically Morton Way that has two direct drainage connections to Gurungaty Waterway / Inner Harbour.
- > Direct disturbance of Gurungaty Waterway or Inner Harbour due to installation of new drainage infrastructure at the waterfront areas, especially on Site 3 at the site discharge point.
- > Sedimentation of Gurungaty Waterway or northern extent of Inner Harbour as a result of erosion within construction sites.

5.2 Mitigation Measures

An Erosion and Sediment Control Plan (ESCP) will be prepared as part of the Construction Environmental Management Plan (CEMP) in accordance with the Landcom Managing Urban Stormwater; Soils and Construction Manual 2004 (Blue Book) prior to any works commencing at the site. The ESCP would be maintained for the duration of the construction to prevent any polluted water and sediment entering receiving waterbodies. The priority in the design of mitigation measures is to control erosion before controlling sediment.

As a minimum, the following mitigation measures shall be included:

- > Installation of erosion and sedimentation control devices prior to commencement of any site works. Erosion controls would remain in place until the bare soils and surfaces are stabilised (by revegetation or other means) and removed when redundant. This needs to include the diversion of 'clean' water around the site in order to avoid treating it and also to avoid potential additional erosion from off-site sources.
- > Appropriate erosion and sediment control devices would be placed down-slope of all excavation works, spoil stockpiles or works that would disturb the ground surface, down-slope of access roads that are highly utilised as well as in other areas as appropriate.
- > Sedimentation is likely to be due to sheet flows occurring within the site. This type of sedimentation can be effectively controlled by using vegetated buffers (e.g. turf), sediment barriers and sediment fences.
- > Minimise the extent and duration of disturbance by means of work planning and staging.
- > Disturbed areas would be restored (sealed or covered with pebbles/gravel or vegetated, as appropriate) upon the completion of the works in that area to ensure that the exposure of soils is minimised.
- > Embankments and other areas subject to earthworks and grading would be revegetated with an appropriate cover crop or stabilised with other means as soon as possible following achievement of final levels.
- > Where revegetation is required and where deemed feasible, locally indigenous plant species, including shrubs, grasses and other groundcovers, would be planted in appropriate locations to assist in soil stabilisation following completion of construction. Maintenance of these plantings would include regular watering and appropriate weed control to ensure the plants survive and continue to enhance the site.
- > Regular visual inspections of erosion and sediment control devices to determine the condition and effectiveness of control measures. Immediate action would be taken to repair any control devices that have failed to work adequately.

The ESCP would also include emergency procedures for high rainfall events that could increase soil erosion during construction. Earthworks would be avoided or minimised during wet weather, in order to minimise water induced soil erosion and increased sedimentation to the surrounding environment.

The CEMP will cover the construction phase of the Project and includes details of temporary and permanent spill control measures, treatment requirements and incident response details to ensure effective management measures and procedures are in place. The procedures for Berth 104 are detailed in the existing Pollution Incident Reduction Management Plan¹ (PIRMP) prepared in 2015.

6 Stormwater Management during Operation

6.1 Stormwater Management Concept

6.1.1 Basis of Design

A stormwater management concept has been developed based on a conceptual site layout to address the management of the quantity and quality of stormwater runoff from Sites 1-3, adopting the following principles:

- > All water which has been in contact with potentially hydrocarbon-soiled surfaces is contained and processed to Environmental Protection Agency (EPA) standard by using an Oil Water Separator (OWS) that will be strategically located on Site 3, and called in this assessment OWS-3. Sites 1 and 2 have centralised collection sumps that will include a gravity oil separation and oil recovery system. Before an intermediate bund sump transfers water to the centralised collection sump, the pump must be locally started so that inspection for potential oil spills can take place. If a spill is detected in an intermediate bund sump the spill can be redirected away from the centralised collection sump for recovery.
- > The proposed OWS system utilises advanced hydrocyclone technology that separates out any hydrocarbon droplets, significantly reducing the residual oil content as compared with traditional gravity separation units.
- > Recovered hydrocarbons from OWS-3 are directed to the waste oil decanter tank where they can be collected by a waste collection vehicle.
- > Treated water from OWS-3 would discharge into Gurungaty Waterway immediately upstream of Tom Thumb Road bridge. Stormwater is inspected for contamination prior to pumping into the gravity settling pit on Site 3 feeding OWS-3. This allows for redirection of stormwater from the storage area to improve the quality of the discharged water and minimise the risk of hydrocarbon carry over.
- > Protection against the appearance of hydrocarbons in stormwater discharge is provided in the form of a capacitance probe, mounted in the final weir of the unit. If hydrocarbons are detected, OWS-3 would be stopped, ceasing discharge from site.
- > The existing stormwater sediment basin on Site 3 will be replaced with an underground Gross Pollutant Trap (GPT) for the treatment of stormwater flows from the road drainage network prior to discharging the treated stormwater into Gurungaty Waterway (non-licensed discharge point). In addition to gross pollutants and sediments, the treatment system will be designed to capture oil and grease. The treatment system will be sized for the full road catchment including the western extent of Tom Thumb Road connecting to Site 3 across the bridge. Runoff from the PK BLT sites will bypass the GPT and be directed to OWS-3 instead.
- > Bund walls (1.8m high) will be established around the storage tank areas on Sites 1 and 2. In addition, separate intermediate bunds (0.6m high) will be constructed to contain most tanks individually. All product spillage and stormwater runoff would be contained inside the bunded area. Each intermediate bund has a sump that can be drained individually into a central bund water collection pit for the site.
- > Bund sumps are equipped with a level indicator, a hydrocarbon detector and an air driven pump for transferring water to the appropriate receiving area including either the slops system for product spills or the central bund water collection pit (if stormwater only). Water from the central bund water collection pit on either Site 1 or Site 2 can then be pumped into the two stage gravity settling pit on Site 3, prior to being treated by OWS-3 and then discharged from site in accordance with an EPA license. Sump pumps are started by field start only, to ensure close inspection of waste liquid before pumping commences.
- > The access road on the southern and eastern extent of Site 2 (Cat 2-2) will be used as a truck staging area for empty trucks waiting for loading. Runoff from this area will be discharged into Inner Harbour via stormwater treatment system consisting of a GPT and oil capture system to collect oil and grease from runoff. In case of spill, a clean-up will also be initiated using spill kits.
- > Leakage, spillage and washdown water within the bunded truck loading bays will be collected in grated pits at each bay. The bunded area at each truck bay will be sized to contain the contents of a tanker

compartment as well as normal washdown water. Any waste collected from the truck loading bay will be pumped to the above ground slops tank. All waste piping from each truck loading bay remains above ground to eliminate the possibility of undetected subsurface contamination.

- > Where practical, non-contaminated runoff generated on site will be connected directly into the minor drainage system.
- > Drip trays will be provided on all pipe work proposed over water and on the Marine Loading Arms (MLA).
- > Roofing would be incorporated on high risk areas, such as the Truck Loading Bay to minimise runoff generated from potentially contaminated paved surfaces.
- > Runoff from external catchments will be captured and diverted around the project site via upgraded road drainage on Morton Way (adjacent to Site 2).

An Operational Environmental Management Plan (OEMP) will cover the operational phase of the Project. The OEMP will include details of temporary and permanent spill control measures, procedures to contain and treat polluted waters and incident response details. The PIRMP¹ details the spill control measures and procedures for Berth 104.

6.1.2 Bund Volumes

Storage available within the bunded areas on Site 1 and Site 2 were estimated based on preliminary concept drawings. The volume lost due to the form and height of bund walls is accounted for in the total volume. The total volume was then converted to an effective rainfall depth on the bunded area in order to estimate the total rainfall depth required to fill the storage within the intermediate bunds (0.6m high) as well as the main bunds (1.8m high). Results have been summarised in **Table 6-1**.

Due to the absence of explicit guidelines for the containment of runoff from a bulk liquid terminal facility, the Blue Book³ was used for determining an appropriate long duration storm event for identifying the minimum volume required within the bunded areas. Assumptions used in the definition of the design criteria are summarised in **Table 6-2**.

Table 6-1 Bund Calculations

	Site 1	Site 2
Surface area within the bunded area	15,840 m ²	16,180 m ²
Total volume within intermediate bund walls (0.6m high)	7,960 m ³	7,410 m ³
Total volume within the main bund wall (1.8m high)	27,570 m ³	27,490 m ³
Total rainfall required to fill intermediate bunds (no discharge)	500 mm	460 mm
Total rainfall required to fill the main bund wall area (no discharge)	1,740 mm	1,700 mm

Table 6-2 Minimum Design Criteria for Bunded Areas (Blue Book 2008)

Criteria	Parameter
Basin Type	'Type F' – Fine sediments (Minimum 33% of the particles are finer than 0.02 mm and less than 10 % of soil materials are dispersible)
Duration of disturbance	More than 3 years (i.e. operation of PK BLT)
Sensitivity of receiving environment	Sensitive
Minimum design storm	5-day duration 95 th percentile annual storm event (i.e. 95% of annual 5-day storm events are included in the design storm), 5-day rainfall depth 95.6 mm
Bunds structurally sound	100 year ARI design storm

³ Department of Environment & Climate Change NSW, Blue Book – Managing Urban Stormwater, Edition 2008. Volume 2E – Mines and Quarries, Section 6 Erosion and Sediment Control Techniques)

From **Table 6-1** it can be seen that the rainfall required to fill the intermediate bunds is 460-500mm which is approximately five times larger than the minimum design criteria shown in **Table 6-2** (i.e. the 5-day 95th percentile rainfall depth of 95.6 mm). Moreover, it is noted that the total volume within the intermediate bunds is in excess of the total rainfall of 24-hour 100 year ARI event (406mm), and the total volume within the main bund is more than twice as large as a 72 hour 100 year ARI storm (652mm) or the 6 hour PMP (780mm). The bunded area therefore provides sufficient capacity for storing any major storm event, while still providing capacity for containing major product spills within the bunded area.

6.1.3 **Berth 104**

Berth 104 includes three Marine Loading Arms (MLA) on existing rails. The MLA's trolley design incorporates an integral bund around the MLA loading platform to contain any hydrocarbon spills and leaks from operation as well as contaminated stormwater. The bund drains via a flame trap under gravity to a storage tank which can be collected by waste removal truck for treatment. The tank would be capable of containing the largest credible fuel spill. The details of spill control measures and procedures for Berth 104 are detailed in the existing RIRMP¹.

6.1.4 **Water Quality Performance Criteria**

6.1.4.1 ***ANZECC (2000) Guidelines for Fresh and Marine Water Quality***

The Australian and New Zealand Environment and Conservation Council (ANZECC) 2000 guidelines provides policies, a process and national guidelines for water quality treatment. These guidelines provide an agreed framework to assess water quality in terms of whether the water is suitable for a range of environmental values (including human uses). The guidelines also provide a method for assigning a level of protection based on a hierarchy of ecosystem conditions, and recommends threshold levels of change that are acceptable for each.

The ecosystem conditions in the proximity of the PK BLT site fall into '*Highly disturbed systems*' category due to the site location within Port Kembla Inner Harbour. This means that the ecosystem is measurably degraded and of lower ecological value. However, this recognises that degraded aquatic ecosystems still retain some ecological or conservation values, but for practical reasons it may not be feasible to return them to a '*Slightly to moderately disturbed conditions*'.

The ANZECC guidelines present the water quality guidelines based on three different recreational categories of waterbody: 1) *primary contact*, 2) *secondary contact* and 3) *visual recreational use*. It was established that Port Kembla Inner Harbour falls into the third category because only passive recreational use (no-contact activity) is available. Furthermore, it is noted that passive recreational use would be very limited due to restricted public access in the vicinity of Inner Harbour. Water quality characteristics relevant to visual recreational use are summarised in **Table 6-3**.

Table 6-3 Relevant Water Quality Characteristics for Visual Recreational Use (ANZECC 2000)

Characteristics	Threshold Level
Nuisance organisms (e.g. algae)	Not specified – Ensure aesthetic quality of the waterbody is maintained.
Aesthetics	Maintain clarity and colour of the waterbody.
Clarity	The natural visual clarity should not be reduced by more than 20%.
Color	The natural hue of the water should not be changed by more than 10 point on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.
Oil	Oil and petrochemicals should not be noticeable as a visible film on the water nor should they be detectable by odor.
Debris	Maintain aesthetic quality of the waterbody.

6.1.4.2 Typical Pollutant Loads and Concentration Limits

When operational, the land use of the proposed PK BLT is considered to be similar to the adjacent paved industrial areas. Typical pollutant loads from the proposed PK BLT site would therefore be generally consistent with the mean pollutant concentrations adopted for industrial areas in New South Wales. The mean pollutant concentrations were sourced from the NSW MUSIC modelling guideline prepared by Sydney Catchment Authority (SCA)⁴, and are summarised in **Table 6-4**.

Table 6-4 Typical Pollutant Loads for Industrial Area (SCA)

Pollutant	Typical Storm Flow Mean Concentration	
	(mg/L $-\log_{10}$)	(mg/L)
Total Suspended Solids (TSS)	2.15	141.25
Total Phosphorous (TP)	-0.60	0.25
Total Nitrogen (TN)	0.30	2.00

In absence of specific water quality guidelines for port facilities, typical concentration limits were estimated based on a reference site⁵ (Port Botany, NSW). These concentration limits are considered to represent generally acceptable limits of discharge in a similar environment and are provided in **Table 6-5** for reference only. The future Environmental Protection License (EPL) for PK BLT will define the requirements and detailed concentration limits for the site based on liaison with Environmental Protection Agency (EPA). The proposed water quality treatment system will be designed to meet the EPL criteria.

Table 6-5 Typical Concentration Limits (Industrial Site, Port Botany)

Pollutant	Unit of Measure	100% Concentration Limit
Hydrocarbons (Oil and Grease)	mg/L	10
Total Suspended Solids (TSS)	mg/L	30
pH	pH	6.5-8.5

6.1.5 Water Sensitive Urban Design

The proposed PK BLT incorporates Water Sensitive Urban Design (WSUD) principles where possible. The overarching objective of the WSUD measures is to satisfy the general water quality guidelines (ANZECC 2000) discussed in **Section 6.1.4.1**. The proposed WSUD measures include the OWS and GPT systems for the PK BLT site, a GPT for the existing road catchment as well as rainwater reuse on Site 3.

6.1.5.1 Oil Water Separation

The OWS system on Site 3 will be designed to process the water from site bunds within a reasonable timeframe. In case of large rainfall, runoff will be temporarily stored within the bunded area and gradually released into the water quality treatment system. It is noted that the bunded areas provide a large temporary storage for stormwater, which effectively enables treatment of flows in most storm events. This is in excess of the minimum (hydrological) design criteria outlined in the Blue Book (refer to **Section 6.1.2**) as well as the general water quality treatment objective within the Wollongong LGA that requires treatment of runoff up to and including the 3 month ARI design storm.

The proposed gravity / coalescing separator on Site 2 will be designed to cater for the 3 month ARI peak flows. The peak flow rates in a critical duration storm (25 minute) are presented in **Table 6-6** and were established as 50% of the 1 year ARI peak flow rates. It is noted that the design flow rates can be reduced by providing temporary storage of stormwater prior to directing flows into the water quality treatment system.

⁴ Sydney Catchment Authority (SCA), 2012. Using MUSIC in Sydney's Drinking Water Catchment. A Sydney Catchment Authority Standard.

⁵ Patrick Autocare, Port Botany Terminal Operational Environmental Management Plan. Version #0.3. August 2014.

Table 6-6 3 Month ARI Peak Flow Rates from Paved Areas (excl. Bunded Areas)

Location	Local Sub-Catchment ID	Catchment Area	3 Month ARI Peak Flow (l/s)
Site 2 Paved Area (North)	Cat 2-0	0.767 ha	95
Site 2 Paved Area (South)	Cat 2-2	0.333 ha	41
Site 3	Cat 3	0.367 ha	43

6.1.5.2 Gross Pollutant Trap

The existing stormwater sediment basin on Site 3 will be replaced with an underground GPT for the treatment of stormwater flows from the road drainage network with the following treatment priorities:

1. Sediment
2. Gross pollutants
3. Hydrocarbons

A GPT equipped with a device to capture hydrocarbons, would provide sufficient treatment of runoff from the existing Tom Thumb Road catchment. The GPT will be sized for the full catchment including the Tom Thumb Road catchment connecting to Site 3 across the Tom Thumb Road bridge. The total catchment area draining into the GPT is therefore approximately 3.3 ha.

It is noted that runoff from the PK BLT sites will bypass the GPT and will be directed to OWS-3 instead. Although the GPT would be located on Site 3, the discharge point from the GPT is not a licenced discharge point as it cater for the road catchment only.

A GPT system will also be provided on the access road on Site 2 (Cat 2-2) to capture sediment, oil and grease prior to discharge into Inner Harbour.

6.1.5.3 Rainwater Reuse

The PK BLT site has a minimal usage of water due to the nature of operations, and therefore extensive rainwater harvesting is not proposed. However, harvested rainwater from the roof of the office building will be used on Site 3, which reduces the total water demand of the PK BLT.

6.1.6 Minor & Major Drainage

Effectively all rainwater falling on bunded areas on Sites 1 and 2 will generate runoff, be contained within the bunds and directed into the stormwater treatment system described in **Section 6.1.1**. Therefore, there is no separation between minor and major drainage systems within the bunded areas. Furthermore, it was noted in **Section 6.1.2** that the bunded areas have large storage capacity and they will be able to temporarily store runoff in major storm events and slowly release it into the stormwater treatment system.

The proposed impervious surfaces outside the bunded areas will be connected to new minor drainage networks on each site or on adjacent road reserve and connected to the proposed stormwater treatment systems described in **Section 6.1.1**. Specifically:

- > The paved area at the entry into Site 1 (Sub-catchment Cat 1-2 shown in **Appendix B**) will be connected directly into the road drainage system on Tom Thumb Road and the proposed GPT on Site 3. In major storms surface flows will be directed onto Tom Thumb Road.
- > The paved access road on the south-eastern extent of Site 2 (Cat 2-2) will drain into Inner Harbour via drainage system including a GPT system capable of capturing oil and grease. A designated overland flow path will be provided at the low point for flows in excess of the drainage system.
- > Truck loading bays on Site 2 are roofed to minimise runoff generated from potentially contaminated paved surfaces. The loading bays are connected into the stormwater treatment system. In major storms, surface flows from the surrounding paved surfaces will not enter truck loading bays.
- > Roofs and the surrounding paved areas on the northern extent of Site 2 (Cat 2-0) that have low risk of contamination are connected to a minor drainage system that discharges into Inner Harbour. Major flows

from this area are discharged into Inner Harbour via a designated overland flow path located at the low point.

- > Site 3 (Cat 3) will have a minor drainage system consisting of pits and pipes that is connected to the proposed oil water separator (OWS-3). The OWS system will therefore be used for the treatment of entire Site 3 including 'clean' runoff from paved surfaces as well as 'dirty runoff' from areas such as the proposed workshop. An overland flowpath will be provided for major storms to bypass the OWS system and discharge directly into Gurungaty Waterway (near DP1).

6.1.7 Management of External Flows

A concept for management of major flows from external catchments, specifically on Morton Way (Site 2), has been provided in **Section 4.2.6**. The recommendations include options for drainage upgrade works on Morton Way and key design criteria to be adopted. Sites 1 and 3 are not affected by external major flows as any external overland flows would be conveyed into Gurungaty Waterway along Tom Thumb Road.

6.2 Potential Operational Impacts

6.2.1 Hydrology and Flooding

Runoff from the project site is contained within the site and conveyed through internal drainage and stormwater treatment system, which would significantly attenuate peak flows discharging from the project site in both minor and major storms. Furthermore, the project site location at the downstream end of the catchment means that any changes in flow regimes would not affect any downstream catchment area or have any impact on the flows in Inner Harbour. This is supported by Council's DCP 2009, which shows the sites located within On-site Stormwater Detention (OSD) Concession Zones for this reason.

In order to assess peak flow rates from the bunded areas on Site 1 and Site 2, the proposed oil water separator (OWS-3) is assumed to have a constant design flow of approximately 100 m³/h (i.e. 28 l/s) in all storm events. Any additional flows would be contained within the bunded areas and directed to OWS-3 within a reasonable time after the storm. Peak flows from other sub-catchments were estimated using the hydrological model discussed in **Section 3**. The critical duration of 25 minutes was adopted for the 1 to 10 year ARI storms and 90 minutes for larger storm events. The existing and developed scenario peak flow rates at each discharge points DP1, DP2 and DP3 have been summarised in **Table 6-7**, **Table 6-8** and **Table 6-9**.

Table 6-7 Peak Flow Rates at DP1 (m³/s)

Scenario	1 Year ARI	5 Year ARI	10 Year ARI	20 Year ARI	50 Year ARI	100 Year ARI
Existing	0.721	1.227	1.381	1.617	1.782	1.985
Developed	0.351	0.551	0.615	0.71	0.788	0.87
Impact	-0.37	-0.676	-0.766	-0.907	-0.994	-1.115

Table 6-8 Peak Flow Rates at DP2 (m³/s)

Scenario	1 Year ARI	5 Year ARI	10 Year ARI	20 Year ARI	50 Year ARI	100 Year ARI
Existing	1.828	3.134	3.536	4.063	4.533	5.108
Developed	1.653	2.833	3.195	3.664	4.087	4.603
Impact	-0.175	-0.301	-0.341	-0.399	-0.446	-0.505

Table 6-9 Peak Flow Rates at DP3 (m³/s)

Scenario	1 Year ARI	5 Year ARI	10 Year ARI	20 Year ARI	50 Year ARI	100 Year ARI
Existing	1.278	2.032	2.352	2.756	3.041	3.409
Developed	1.059	1.669	1.943	2.292	2.523	2.828
Impact	-0.219	-0.363	-0.409	-0.464	-0.518	-0.581

The peak flow assessment indicates that the peak flows and hydraulic loads at the existing discharge points will be reduced from the existing conditions in all modelled critical duration storm events. This is due to temporary storage of stormwater within the bunded areas of PK BLT and slow release of runoff through the stormwater quality treatment systems. This attenuation of flows compensates for any increase in the amount of impervious surfaces runoff elsewhere within the site.

6.2.2 Water Quality

As noted in **Section 2.2.1**, the existing water quality in Port Kembla Inner harbour is characterised by elevated levels of metals, organic pollutants and moderate turbidity as result of historic and ongoing industrial operations within the catchment. The proposed PK BLT does not differ from the adjacent paved industrial areas and thus does not cause particular risk to water quality provided that the proposed stormwater management and treatment systems are fully operational.

Potential water quality impacts from the proposed PK BLT would primarily be related to product spills (hydrocarbons) in case of a malfunction in the system and sediment-laden runoff from paved areas. The proposed PK BLT includes multi-staged containment and treatment to prevent any spill of products, slops or contaminated stormwater into the receiving waterbody. Hydrocarbon and waste collection piping will be designed to run above ground so that any potential leaks are visible and can be detected and repaired, rather than underground where a leak poses a potential ground contamination issue.

The PK BLT would only consist of impervious surfaces, which effectively prevents infiltration of hydrocarbon contaminated runoff into ground. Furthermore, any underground stormwater pipes that may potentially be exposed to hydrocarbon contaminated water will be equipped with hydrocarbon compatible sealed joints to prevent infiltration into ground. Therefore the overall risk to surface water and ground water quality and the potential for contamination of soil are considered low.

Environmental impacts of fire-fighting foams will be considered. A detailed Fire Safety Study and fire system design will be undertaken to determine optimal type and methods for collection and dewatering of foams within bunded areas. Consideration for foam selection will include water quality and contamination impacts of the foam solution. Spill kits, such as booms, would be utilised on non-bunded areas in the unlikely event of spill.

In addition, potential hazards to the environment associated with Berth 104 activities are identified in the PIRMP. Potential impacts include water pollution, specifically sediment / turbidity and hydrocarbons occurring due to a product spill or release of polluted ballast water during loading operation. However, the PIRMP indicates that the likelihood of these pollution events is low.

6.3 Site Water Balance

Due to the minimal water usage within the PK BLT detailed site water balance calculations (as noted in SEARs) are not considered relevant for the Proposal. However, different components of water cycle have been discussed in this Assessment as far as practicable within the development context, including:

- > Existing surface water conditions (**Section 2.2**);
- > Hydrology (**Section 3**);
- > Flooding (**Section 4**);
- > Stormwater Management (**Section 6**);
- > Water supply and wastewater management (**Section 7**);

7 Water Supply and Wastewater

7.1 Water Supply

The PK BLT requires only minimal potable water supply during operation and therefore does not generate large quantities of process water. Reuse of process water is hence not proposed for the site. However, the office building on Site 3 will use harvested stormwater from the roof of the building.

The PK BLT would connect to the existing water main located on Tom Thumb Road. Connections into the PK BLT facility would be required at following locations:

- > Control room and office building (Site 3).
- > Safety showers and washdown connections at the loading gantry, product pump and inlet areas (Site 1, Site 2 and Berth 104).
- > Fire water tanks (2 x 1ML) on Site 2.

The fire tanks are designed to cater for the worst case fire scenario i.e. fire in the central tank of Site 2. Total estimated worst case water demand for the entire facility is 25,000 l/min, which would be achieved by using two 12,500 l/min diesel powered pumps simultaneously. An additional third pump would be installed to allow for maintenance of a single pump at the time. Fire pumps would be located in the pump house adjacent to the fire water tanks.

A cooling water system shall be designed for the bulk storage areas (Site 1 & 2) in accordance with Australian Standard (AS) 1940. The system would include a single circular header and nozzles at the tank top height for applying water to the tank shell and roof. The worst case cooling demand of 22,000 l/min is associated with the worst case fire scenario.

In addition to the cooling water system, all tanks above 6m in diameter shall be fitted with foam pourers, since combustible tanks are located in the same compound as flammable tank on Site 1 and Site 2. However, the foam reticulation system will utilise separate lines and is not connected to the water supply.

7.2 Wastewater Management

Wastewater from amenities on Site 3 will be discharged into the existing 100mm rising main located on Tom Thumb Road on the western side of Gurungaty Waterway.

Wastewater may be generated within Site 1 and Site 2 due to product spills or utilisation of fire water or foam solution. Wastewater would be managed as part of the stormwater management concept discussed in **Section 6**. Generally wastewater would be collected into oily water tanks and transported for further processing.

During operation, extensive water management systems are in place at the PK BLT. Therefore the overall risk of wastewater discharge from bulk storage or loading areas into Inner Harbour is considered low. The existing rising main would provide appropriate connection from Site 3 into the sewer system.

8 Conclusions & Recommendations

8.1 Conclusions

The following can be concluded from the surface water assessment:

Hydrology, Flooding & Water Quality

- > The project site is not impacted by flooding from Gurungaty Waterway as the site levels are a minimum of 1.8m above the PMF levels in the watercourse.
- > Site 1 and Site 3 are not likely to be affected by external flows due to small upstream catchments.
- > In existing conditions an overland flow path originating from a 9.9 ha upstream catchment traverses Site 2. The flowpath is required to be diverted around the site by upgrading drainage on Morton Way.
- > The FRMS&P 2015 indicates that the existing basin on Site 3 as well as a depression adjacent to Gurungaty Waterway on Site 2 are within High RFP as per DCP 2009. However, it is noted that the basin on Site 3 will be removed in the proposed scenario and the depression on Site 2 is based on superseded ground elevation data. Therefore, in the proposed scenario the entire project site would lie within a Medium FRP and is suitable for the proposed land use.
- > Runoff from the project site would be contained within the site and conveyed through an internal drainage and stormwater treatment system including multi-staged containment and water quality treatment using oil water separation.
- > The bunded areas on Site 1 and Site 2 would provide capacity to temporarily store the 24 hour 100 year ARI rainfall plus a simultaneous major product spill, which is in excess of minimum design requirements.
- > Once operational, the Project would not affect any downstream catchment area or have any detrimental impact on the flows regimes in Inner Harbour due the site location at the downstream extent of the catchment.
- > Peak flows and hydraulic loads at the existing discharge points will be reduced from the existing conditions due temporary storage of stormwater within the bunded areas and slow release of runoff through the stormwater quality treatment systems. This attenuation of flows compensates for any increase in the amount of impervious surfaces runoff elsewhere within the site.
- > Potential water quality impacts from the proposed PK BLT would primarily be related to product spills (hydrocarbons) in case of a malfunction in the system and sediment-laden runoff from paved areas. The proposed PK BLT includes multi-staged containment and treatment to prevent any spill of products, slops or contaminated stormwater into the receiving waterbody. Therefore the overall risk to water quality during operation is considered low.
- > Replacing the existing sediment pond on Site 3 with a GPT will improve stormwater quality treatment of the existing Tom Thumb Road catchment and facilitate easier maintenance. The GPT will capture sediments, gross pollutants as well as hydrocarbons.
- > Appropriate erosion and sedimentation control devices as well as clean water diversions would be installed prior to commencement of any site works. Erosion controls would remain in place until exposed soils and surfaces are stabilised.

Water Supply & Wastewater

The following can be concluded from the surface water assessment:

- > The PK BLT requires only minimal potable water supply during operation and therefore does not generate large quantities of process water or warrant reuse of water on site.
- > The PK BLT would connect to the existing water main located on Tom Thumb Road. Connections would be required for amenities on Site 3 as well as for safety showers and washdown connections at the loading gantry, product pump and inlet areas on Site 1, Site 2 and Berth 104.

- > Fire tanks, fire pumps and cooling water system would be incorporated into Sites 1 and 2.
- > Wastewater from amenities on Site 3 will be discharged into the existing rising main located on Tom Thumb Road on the western side of Gurungaty Waterway.

The proposed mitigation measures have been designed to minimise the likelihood and severity of environmental impacts discussed in this assessment. The proposed PK BLT facility is not anticipated to have significant residual impacts on surface water quantity or quality.

8.2 Recommendations

- > Develop detailed designs of the stormwater management systems by adopting the proposed construction phase and operational phase mitigation measures outlined in this report.
- > Issue this report to support the Environmental Impact Statement.

Proposed Port Kembla Bulk Liquids
Terminal

APPENDIX

A

CATCHMENT PLAN

Existing Catchment	Total Catchment Area (ha)	Total Impervious Area (ha)	Impervious Area as % of Total Catchment (%)
Site 1	1.802	1.604	89
Cat 1-3	0.600	0.345	58
Cat 1-4	0.192	0.134	70
Cat 1-5	0.153	0.153	100
Site 3	0.367	0.229	63
Site 2	4.135	2.890	70
Cat 4-4	0.207	0.156	75
Cat 4-5	0.485	0.386	80
Cat 4-6	0.912	0.682	75
Cat 4-7	0.791	0.617	78
Cat 4-8	0.367	0.197	54
Cat 4-9	0.078	0.078	100
Cat 5-1	0.751	0.590	78
Cat 5-2	0.844	0.550	65
Cat 5-3	1.748	1.547	88
Cat 5-4	0.500	0.343	69
Cat 5-5	0.036	0.030	82
Cat 5-6	3.200	2.809	88
Berth 104	0.861	0.444	52



Legend

- Project Site
- Existing Discharge Points
- Existing Stormwater
- Watercourses (LPI)
- Existing Catchments
- Cadastre (LPI, 2015)



1:4,000 Scale at A3

Metres

0 25 50 75 100

Existing Catchment Plan

PORT KEMBLA



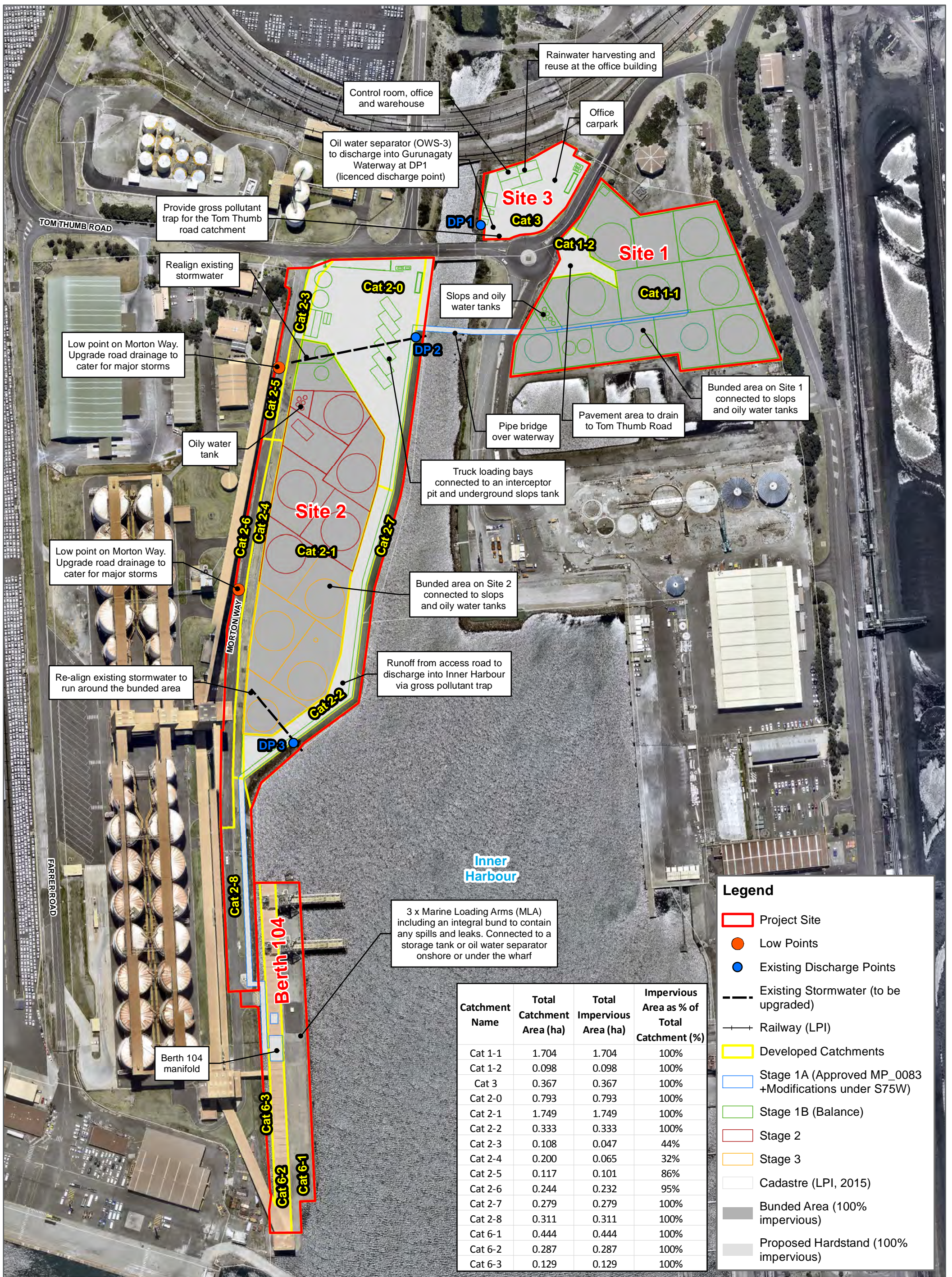
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
 Date: 2015-11-13
 Coordinate System: GDA 1994 MGA Zone 56
 Project: 82015103-01
 Map: 82015103-GS-016-ExistingCatchmentPlan.mxd 04
 Aerial imagery supplied by nearmap (January, 2015)

Proposed Port Kembla Bulk Liquids
Terminal

APPENDIX

B

STORMWATER MANAGEMENT PLAN



Catchment Name	Total Catchment Area (ha)	Total Impervious Area (ha)	Impervious Area as % of Total Catchment (%)
Cat 1-1	1.704	1.704	100%
Cat 1-2	0.098	0.098	100%
Cat 3	0.367	0.367	100%
Cat 2-0	0.793	0.793	100%
Cat 2-1	1.749	1.749	100%
Cat 2-2	0.333	0.333	100%
Cat 2-3	0.108	0.047	44%
Cat 2-4	0.200	0.065	32%
Cat 2-5	0.117	0.101	86%
Cat 2-6	0.244	0.232	95%
Cat 2-7	0.279	0.279	100%
Cat 2-8	0.311	0.311	100%
Cat 6-1	0.444	0.444	100%
Cat 6-2	0.287	0.287	100%
Cat 6-3	0.129	0.129	100%

Legend

- Project Site
- Low Points
- Existing Discharge Points
- Existing Stormwater (to be upgraded)
- Railway (LPI)
- Developed Catchments
- Stage 1A (Approved MP_0083 + Modifications under S75W)
- Stage 1B (Balance)
- Stage 2
- Stage 3
- Cadastre (LPI, 2015)
- Bunded Area (100% impervious)
- Proposed Hardstand (100% impervious)



1:2,500 Scale at A3
Metres
0 25 50 75 100

Stormwater Management Plan

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