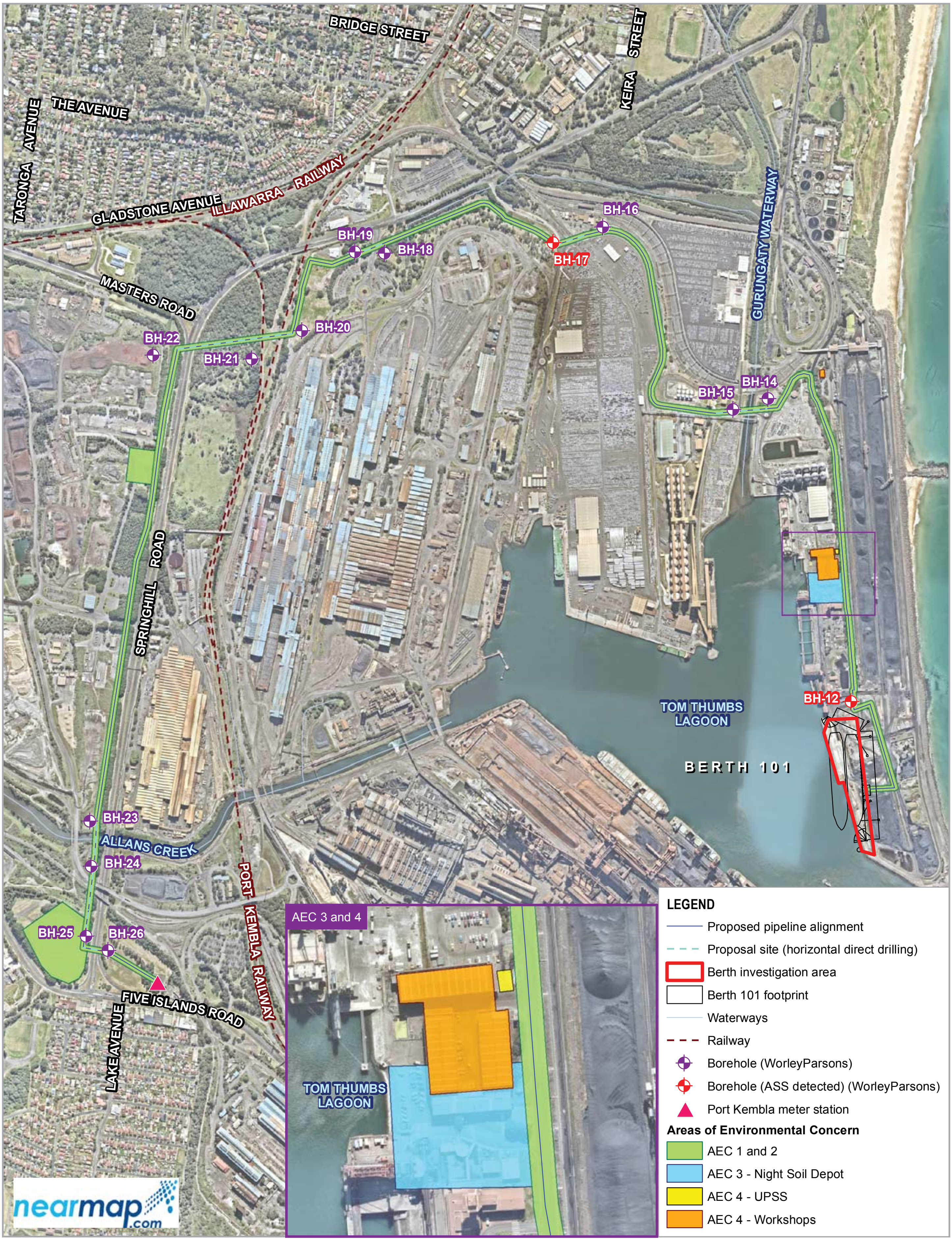


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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

**Australian Industrial Energy**
**Port Kembla Gas Terminal**
**Pipeline PSI**
**Berth 101, Port Kembla, NSW, 2505**

Project No. 21-27477
Revision No. -
Date 05/11/2018

# AECs and Site Features

# FIGURE 11-1

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Data source: Aerial imagery - nearmap 2018 (image date 16/04/2018, date extracted 01/08/2018); General topo - NSW LPI DTDB 2017, 2015 & 2015; Berth footprint - Australian Industrial Energy. Created by: afoddy

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### Site history

Available site history information indicates that the proposed pipeline alignment was generally unoccupied until between 1951 and 1961. Development along the pipeline alignment commenced between 1951 and 1961 and included the upgrade of transport infrastructure to the current standard, the reclamation of land within Tom Thumb Lagoon and the construction of the steelworks and port facilities. The site usage has remained heavy industrial since this period and site activities appear to have been relatively unchanged since 1994.

Relevant site features identified in the site history searches and locations of previous investigations are shown on Figure 11-1.

### Site observations

Key site observations (19 August and 25 September 2018) are as follows:

- **PKCT Boundary** - The walkover was conducted along the main access road within PKCT site boundary and immediately north of the boom gates along Port Kembla Rd. The pipeline route exits the Berth 101 area and heads north running adjacent to the main road of PKCT. Buildings, including administration and project buildings are located to the west of the pipeline route, while coal stockpiles and loaders are present to the east. The route follows Port Kembla Rd, heading north past the boom gates until the intersection of Tom Thumb Rd and Port Kembla Rd. Drainage in these areas is likely to get captured by internal drainage systems or existing road drainage as most of the landscapes are paved surfaces.
- **Bluescope visitor carpark area** - The walkover was conducted in the area around the Bluescope visitor car park which was in the general vicinity of WorleyParsons geotechnical borehole BH-19 (refer to Figure 11-1 for location). The area immediate area around BH-19 was mainly lightly vegetated with grasses and light tree cover, the vegetation did not appear to be distressed. The area to the south-west of BH-19 was a visitor carpark for BlueScope, south south-east are the boom gates and entrance into BlueScope. There was a building west of BH-19 and paved car parking area located behind it. Drainage in this area is likely to infiltrate into the soil in unpaved areas, with runoff expected to get captured in existing stormwater drains.
- **Cnr Five Islands Rd & Springhill Rd** - The walkover was conducted on the grassed reserve on the corner of Five Islands Rd and Springhill Rd The immediate area south, east and north of BH-26 was a grassed reserve (refer to Figure 11-1 for location); existing gas infrastructure was present in this area and the location where the proposed pipeline is expected to cross Springhill Road. Drainage in this area is likely to infiltrate into the soil in unpaved areas, with runoff expected to get captured in existing stormwater drains located on Springhill Rd.

There was no direct evidence of stockpiling or surface contamination (e.g. asbestos) in the areas directly observed. It is likely that fill does exist in all areas given the location is a built environment and the proximity to roads and major services is seen in all areas.

## 11.3.3 Dredging area and the proposed Outer Harbour disposal area

### Site observations

The site for investigation of marine sediment contamination consists of two areas. One comprising the waters off Berth 101 and the other area in the Outer Harbour, where the dredge sediment will be disposed of as part of harbour reclamation works. These are shown in Figure 11-2 and Figure 11-3.

The wharf of Berth 101 extends into the water and is supported by timber piles. Revetments consisting of angular boulders protect the shoreline to the south of Berth 101, comprising half of the length of the study area. The water off Berth 101 is a high traffic area for cargo ships accessing the eastern and western basins of the Inner Harbour. The water off Berth 101 was turbid with a high suspended sediment load, water based dust suppression systems were observed on Berth 101 and a coal/coke stockpile was located at the northern end of Berth 101, these are assumed to be contributing runoff to the marine area.

The disposal area encompasses a portion of the waters of the Outer Harbour, and has a wharf at its eastern end approximately 150 metres from the Outer Harbour wall. The wharf is armoured on its western side with angular boulders, and the remainder of the shoreline on the southern side is comprised of a sand beach at water level. The area is low traffic for shipping with smaller vessels using the wharf. Water of the reclamation area was of lower turbidity, with a reduced suspended sediment load.

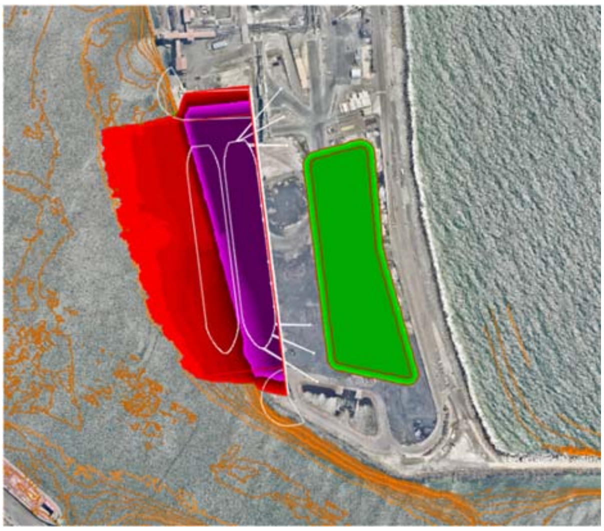

**Figure 11-2 Excavation of Berth 101**

Purple area is the current Berth 101 and the red is the proposed dredging area.  Green is the proposed stockpiling area.

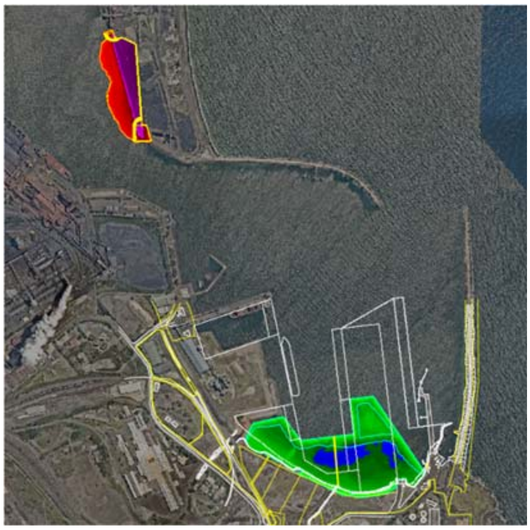

**Figure 11-3 Proposed disposal area**

The blue-green area southeast of the Berth 101 is the proposed disposal area.

### *Historical investigations*

Previous investigations have been undertaken to assess the contamination of the marine sediments in Port Kembla Harbour including detailed analysis of sediments adjacent to Berth 101 by Worley Parsons in 2012 and in the Outer Harbour by AECOM in 2010 as part of the Outer Harbour Development project. For detail on the samples taken, the exceedances/non-exceedances reported and the recommendations and conclusions made, refer to Appendix E3.

From the previous investigations, the following points are noted:

- Commonly two main sedimentary units were identified with a soft silty clay layer overlying a stiffer clay layer.
- The upper soft silty clays were contaminated throughout all sampling areas.

- Heavy metals commonly exceeded the screening levels for cadmium, chromium, copper, lead, nickel, mercury and zinc.
- Tributyltin, dioxins and PAHs were reported above the nominated guidelines in several studies.

The investigations identified a number of activities that would have likely contributed to the possible contamination of marine sediments including:

- Industrial discharges associated with licensed activities
- Spill events within the harbour
- Overflows from Port Kembla Sewage Treatment Plant during storms
- Catchment road and industrial runoff
- Particulate matter, e.g. coal dust, through atmospheric deposition
- Redistribution of previously contaminated sediments through tug manoeuvring, passage of deep draft vessels and currents action , e.g. during floods
- Redistribution of sediments during dredging and sweeping operations
- Leaching from reclaimed and waste filled areas of the harbour foreshores
- Antifoulant coatings leaching and flaking, e.g. TBT

## 11.4 Assessment criteria

The criteria applied in the contamination assessments (Section 11.5) are detailed in Appendix E1, E2, and E3. The sources of these criteria are provided below.

### 11.4.1 Soil contamination

The soil assessment criteria was sourced from the following:

- NEPC (1999) National Environment Protection (Assessment of Site Contamination) Amendment Measure (No. 1) 2013 (NEPM)
- Friebel and Nadebaum (2011) CRC Care Technical Report No. 10 – Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater

Exceedances of the soils and groundwater contamination criteria do not necessarily mean that remediation is required, however they should be regarded as triggers for further assessment, (e.g. a site specific risk assessment), and/or management.

### 11.4.2 Groundwater contamination

Laboratory results for groundwater samples will be compared to guidelines which afford protection to the identified receptors (human direct contact and marine water) and are contained within the following references:

- ANZECC/ARMCANZ (2000) [1]Australian Water Quality Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and

[1] ANZG (2018) criteria were endorsed by NSW EPA under S105 of the CLM Act on 4 September 2018. At the same time the ANZECC (2000) water quality guidelines were revoked. While the ANZG (2018) have been endorsed, AZNG (2018) authors have stated that there were not intended to be any new criteria to ANZECC 2000 at the time of publishing. However, a preliminary review of the AZNG guidelines by GHD and others has identified a number of discrepancies with ANZECC (2000)

Agriculture and Resource Management Council of Australia and New Zealand, Canberra, October 2000. For a working harbour, 80% species protection level criteria are considered to be applicable for this highly modified environment and have been adopted.

- National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended in 2013), (NEPC 2013), National Environment Protection Council, Canberra (this document references ANZECC 2000)Verbruggen, E.M.J. (2004) Environmental Risk Limits for Mineral Oil (Total Petroleum Hydrocarbons) for the National Institute for Public Health and the Environment, Netherlands, Report Ref: RIVM report 601501021/2004.
- Friebel and Nadebaum (2011) CRC Care Technical Report No. 10 – Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater, listed in Table 1A(4).

#### 11.4.3 Waste classification

Waste classification of site soils is undertaken in general accordance with the six step procedure for classifying waste as detailed in the Waste Classification Guidelines - Part 1: Classifying Waste (NSW EPA, 2014). Because excavated material may contain potential or actual ASS, the waste classification has also been carried out in accordance with Waste Classification Guidelines - Part 4: Acid Sulfate Soils.

#### 11.4.4 Acid sulphate soils

ASS criteria applied to the assessment has been sourced from Queensland guidance:

- QLD (2014) Acid Sulfate Soils Technical Manual – Soil management Guidelines V4.0 based on greater than 1,000 tonnes of fine texture soils to be disturbed. Which is based on the guidelines of the Acid Sulphate Soils Management Advisory Committee (ASSMAC 1998).

#### 11.4.5 Sediment contamination

The sediment assessment criteria was sourced from the following guidelines:

- National Assessment Guidelines for Dredging (NAGD 2009).
- ANZECC/ ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality (as recommended in the NAGD (2009)).

### 11.5 Potential impacts

#### 11.5.1 Berth 101

As discussed in Section 11.4.1, the site is a highly disturbed area with evidence of historical contamination. As a result, the investigations and sampling focused on soil and groundwater contamination and identification of ASS.

An analysis of the results from the previous investigations and sampling and a comparison with adopted criteria (Section 11.4) are provided below. Management measures recommended to reduce/ eliminate the impacts of contamination are provided in Section 13.5.

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which have yet to be clarified. As such, ANZECC (2000) criteria have still been adopted for the purposes of this report until the issues with ANZG (2018) have been resolved.

### *Soil contamination*

Fill was encountered at all locations up to 5.5 metres depth, typically comprising gravelly sand and sandy gravel overlying sand (probable reclaimed sand). Results show that contamination in the fill material within the area to be excavated at Berth 101 is relatively minor, and generally consistent.

As shown in Figure 11-4, the laboratory analytical results for soil samples taken from boreholes were below adopted criteria with the exception of two soil samples which exceeded the adopted criteria. These were at GHB09 and GBH26 and were for BaP (TEQ) (health criterion) and for heavy end petroleum hydrocarbons (Management Limits) near the inferred base of fill material between 4 metre to 5 metres below ground level.

A summary of the laboratory analytical results are as follow:

- Samples GBH09/4.2-4.4 and GBH26/4.75-4.90 m had benzo(a)pyrene (TEQ) concentrations of 150 mg/kg and 110 mg/kg, respectively, which exceed the HIL-D assessment criterion of 40 mg/kg.
- Samples GBH09/4.2-4.4 and GBH26/4.75-4.90 m had TRH F3 (>$C_{16}$-$C_{34}$) concentrations of 5,400 mg/kg and 4,100 mg/kg, respectively, which exceeds the Management Limit for this fraction of 3,500 mg/kg.
- Fibre cement samples PACM 1 and PACM 2 collected from the ground surface east of the substation were identified to contain chrysotile, amosite and/or crocidolite. Asbestos was also tested in selected soils samples. No asbestos was detected in soil samples.

Remaining contaminants of potential concern (COPC) tested were below the reporting limit of adopted assessment criteria where available.

Source-pathway-linkages identified for contamination at Berth 101 indicates that it is unlikely to pose any significant constraints to the project, subject to further assessment of the extent of BaP TEQ hotspots and mitigation measures developed to manage potential health impacts during construction works. Potential risks to marine environmental receptors from relocation of the berth material are considered low and acceptable based on measured concentrations of contaminants.

Asbestos was identified on site in the form of fragments of asbestos containing material (ACM) on the ground surface (refer to the Site Observations subsection in Section 11.3.1). These are assumed to be associated with historical demolition on site. No asbestos was identified in samples below the ground surface, and it is therefore unlikely that asbestos containing materials are present in the fill, although this cannot be precluded.

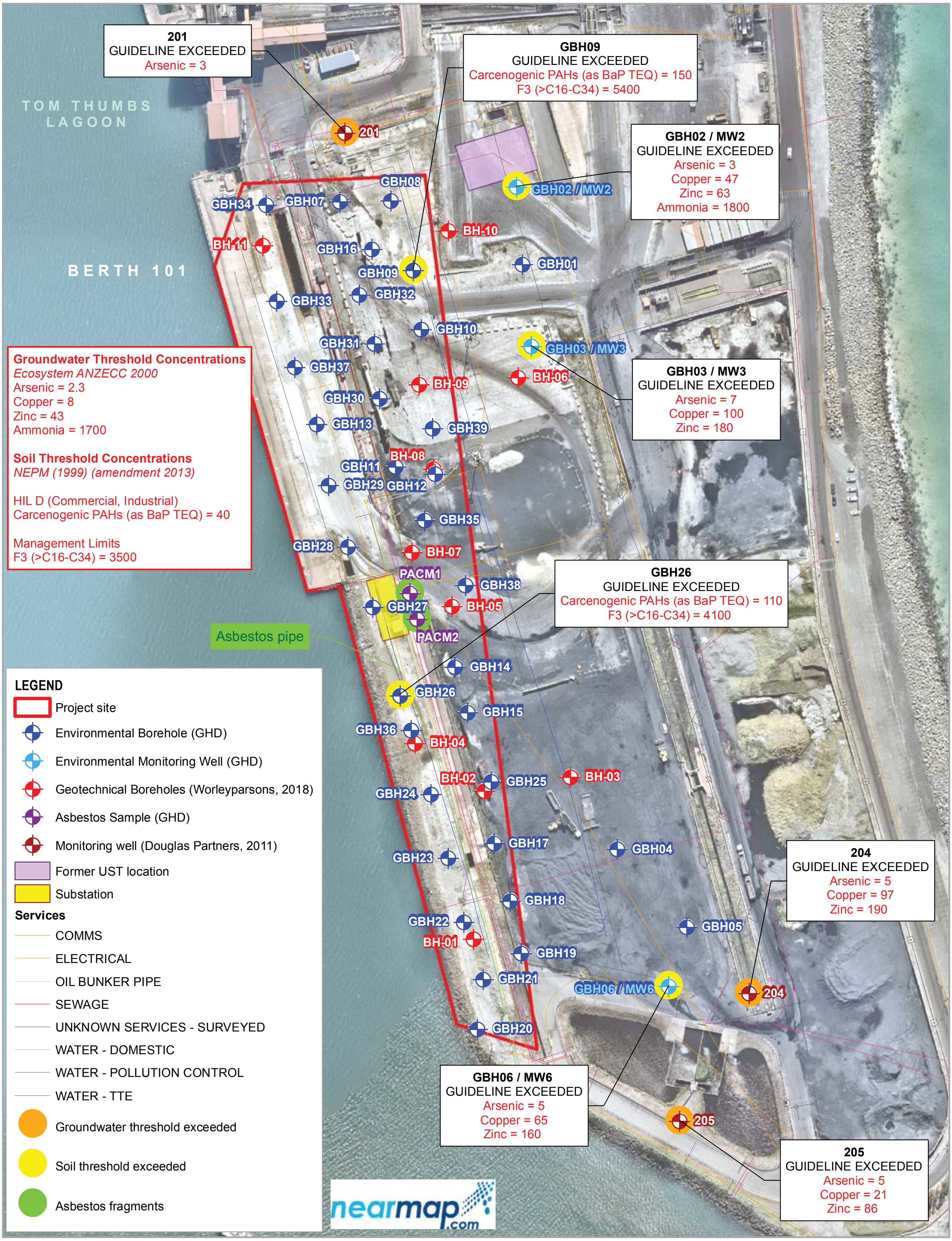
### *Groundwater contamination*

Groundwater inflows were typically encountered in at depths between about 3.7 metres and 5.0 metres. No hydrocarbon odours were noted in groundwater during drilling or sampling at any of the wells. No evidence of non-aqueous phase liquids (NAPL) was observed during groundwater sampling. No odours or sheens were noted on the surface of the groundwater from monitoring wells during purging and sampling for the remaining locations.

As shown in Figure 11-4, three GHD environmental monitoring wells exceeded the adopted criteria for arsenic, copper, zinc and ammonia.

Concentrations of TRH, BTEX, PAH and remaining heavy metals were either close to or below the laboratory limit, which was also below adopted assessment criteria.

Overall, some relatively minor impacts from heavy metals and ammonia were identified in a perched fresh to brackish groundwater lens within Berth 101. The size of the lens is not well understood, however, the proposed piling and excavation works will limit the amount of perched water discharging into the marine environment, which will in any event significantly attenuate the concentrations of contaminants observed in this investigation.

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Australian Industrial Energy
Port Kembla Gas Terminal
Preliminary Contamination Assessment
Berth 101, Port Kembla, NSW, 2505

**Soil and Groundwater Exceedances at Berth 101**

Project No. 21-27477
Revision No. -
Date 05/11/2018

**FIGURE 11-4**

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Data source: Aerial imagery - nearmap 2018 (image date 16/04/2018, date extracted 01/08/2018); General topo - NSW LPI DTDB 2017, 2015 & 2015; Berth footprint - Australian Industrial Energy. Created by: afoddy

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### *Acid sulphate soils*

Field screening and laboratory results of 170 samples show that ASS occurs in natural sediments below the fill (variable and to depths between 2.5 metres and 5.5 metres below ground level) to at least 14 metres depth and probably beyond, particularly where dark grey and green clays exist.

Disturbance as a result of construction activities, primarily excavation and dewatering, of these natural sediments have the potential to impact the surrounding marine environment. The activities will need to be carefully managed and it is recommended that an Acid Sulphate Soil Management Plan (ASMP) is prepared by a consultant experienced in the identification and management of ASS (refer to Section 11.6).

### *Preliminary waste classification*

The preliminary waste classification assessment of fill and underlying natural materials in the event that off-site disposal to land is required, is General Solid Waste (non-putrescible) based on the available data. This classification was undertaken in accordance with NSW EPA (2014) Waste Classification Guidelines, Part 1 – Classifying Waste.  This preliminary classification needs to be confirmed during excavation works, and is not applicable to any material types, which differ in nature from those sampled.

Results show that proposed excavated material contains ASS. Therefore, handling, treatment and disposal of ASS will be carried out in accordance with Part 4 of the waste classification guidelines (EPA 2014).

### *Erosion and sediment control*

Construction activities at Berth 101 have the potential to cause erosion of sediment and mobilisation of contaminants into the nearby marine environment.  The erosion risk is considered relatively low as the site is flat and implementation of appropriate controls with reference to the *Managing Urban Stormwater: Soils and Construction Volume 1* (The ‘Blue Book’; Landcom, 2004) together with management of controls for the dredge area (described below) will limit the potential for impacts upon receiving waters in the Inner Harbour.

### *Conceptual site model*

A conceptual site model (CSM) is a representation of site-related information regarding contamination sources, receptors and exposure pathways between those sources and receptors.  The CSM is developed using information obtained from previous investigations, site history, site observations, proposed land use and expected ground conditions. Once the contamination status is understood through the sampling and analysis process, the CSM then allows the assessor to evaluate the risk posed by the contamination to the identified receptor, and whether remediation is required to manage that risk.

The potential Source-Pathway-Receptor (SPR) contaminant linkages identified at the Berth 101 site is provided in Table 11-3.

### Table 11-3 Source-Pathway-Receptor linkages for Berth 101

| Sources (Primary and secondary) | Pathway | Receptor | Potentially Complete? |
|---|---|---|---|
| Contaminated fill impacted by volatile /semi-volatile compounds (impacted by either historic or current leaks or spills from former underground infrastructure) | Volatilisation and lateral migration to outdoor air and subsequent inhalation. | Construction workers / Intrusive Maintenance Workers | No – no volatile contaminants were detected above adopted criteria. |
| | Direct contact (during material handling) | Construction workers / Intrusive Maintenance Workers | No – no volatile contaminants were detected above adopted criteria. |
| | Direct contact/ leaching | Marine environment (disposal area) | Unlikely, volatile contaminant concentrations were low in soil, and below detection in groundwater. |
| Contaminated fill impacted by non-volatile compounds | Direct contact (during material handling) | Construction workers / Intrusive Maintenance Workers | **Possible** – concentrations of BaP TEQ exceeded HIL-D at two locations within the fill between 4 – 5 bgl. However, material handling is likely to be short duration, and further assessment / mitigation should address this risk. |
| | Direct contact/ leaching | Marine environment (disposal area) | Unlikely, contaminant concentrations in soil were generally low. While two locations indicated concentrations of BaP and PAH well above background, leachability testing of BaP was < LOR as were groundwater results. |
| Asbestos | Dust inhalation | Construction workers / Intrusive Maintenance Workers | Unlikely – while two fragments of asbestos were confirmed at ground surface, this is likely from historical above ground demolition. No asbestos was detected in the fill, however its potential presence cannot be discounted. |

| Sources (Primary and secondary) | Pathway | Receptor | Potentially Complete? |
|---|---|---|---|
| Dissolved phase volatile contaminants in groundwater | Volatilisation and lateral migration to outdoor air and subsequent inhalation. | Construction workers / Intrusive Maintenance Workers | No – no volatile contaminants were detected above adopted criteria. |
| Dissolved phase volatile and non-volatile contaminants in groundwater | Direct contact / incidental ingestion | Construction workers / Intrusive Maintenance Workers | Unlikely – contact with groundwater is unlikely in the deep excavation, and would be expected to be controlled by mitigation measures in a construction and environmental management plan. |
| | Lateral migration in groundwater. | Ecological receptor (marine environment) | Unlikely – while concentrations of some contaminants are above adopted criteria in the lens of groundwater sampled, the volume of impacted perched fresh water is likely to be small, and any discharges would be rapidly attenuated within the marine environment. |

Based on review of the potential SPR linkages, it is considered that the only potentially complete linkage for the project is exposure to carcinogenic PAHs in fill material by construction workers as a result of direct contact during excavation and material handling. This should be further assessed to confirm whether management will be required during redevelopment.

### 11.5.2 Proposed pipeline alignment

Four potential areas of environmental concern (AEC) were identified as part of the desktop investigations as shown on Figure 11-1 and outlined below :

- AEC 1 - Fill materials along the entire pipeline alignment including dredged materials, coal and coal by-product, steel production by-product (slag) and possible building demolition materials
- AEC 2 - Spills and surface application of fuels along the entire pipeline alignment, oils and other chemicals associated with current and former industrial land uses
- AEC 3 - Historical impacts associated with former nightsoil depot within PKCT
- AEC 4 - Current and historical impacts associated with use of land adjacent to the alignment as workshops and fuel depots.

The site shows evidence of historical contamination (AEC3 and AEC4) and potentially contaminating activities have been occurring in the area since the 1950s. The pipeline alignment potentially intersects with the former Night Soil Depot, which is located in the poorly defined area within PKCT. Due to the age of the depot and the time since active use the likelihood of residual contamination from this source is considered low. Later site activities including reclamation and land filling are likely to have further reduced the contamination potential.

The land adjacent to the alignment as workshops and fuel depots is considered to have a moderate likelihood of contamination. Previous investigations did not identify any contamination likely to be associated with the UPSS infrastructure at the PKCT refuelling depot. Impacts from current or historical sources along the alignment have not been specifically identified by this investigation but are considered possible in a localised context along the alignment.

Based upon the findings from the desktop study, soil sampling for waste classification and identification of ASS was undertaken. An analysis of the results from the sampling and comparison with adopted criteria (Section 11.4) are provided below.

#### *Subsurface conditions*

The investigation was concurrent with a geotechnical investigation of the pipeline route being conducted by WorleyParsons. Fill materials have been identified along the entire pipeline alignment and have been found to include dredged materials, coal and coal by-product, steel production by-product (slag) and possible building demolition materials, and potentially contaminating activities have been occurring in the area since the 1950's.

#### *Soil contamination*

With regards to human health and management limits, the laboratory analytical results for soil showed that no exceedances of adopted human health assessment criteria were reported in soil samples. Laboratory results were consistent with field observations.

Limited soil sampling and analysis conducted opportunistically as part of the concurrent WorleyParsons geotechnical investigation did not identify any widespread, gross contamination; however it is insufficient to provide a detailed understanding of the contamination status of soils along the alignment. Fill materials are considered to have a moderate likelihood of contamination based upon current and previous land use.

#### *Groundwater contamination*

The groundwater along the western boundary of the site is inferred to be between 4.5 metres and 8.2 metres. Trench excavation is expected to be between about 1 and 1.5 metres deep with deeper excavation required during directional drilling, particularly to traverse roads and railway lines and waterways.

Any groundwater encountered during construction has potential to be contaminated and will need to be appropriately managed.

#### *Acid sulphate soils*

Preliminary assessment of site soils for ASS identified actual ASS at two borehole location at depth of (>12.25 metres and 7.5 metres) and are from buried lagoon sediments. This is consistent with the findings of the investigation within the Berth 101 investigation area and is considered to be representative of the overall pipeline alignment.

The majority of trenching will be undertaken within fill material and is unlikely to disturb the deeper natural sediments more likely to contain ASS.

Construction activities will need to be carefully managed and it is recommended that an ASSMP is prepared by a consultant experienced in the identification and management of ASS (refer to Section 11.6).

### *Preliminary waste classification*

Preliminary waste classification of collected samples indicates that the soils sampled as part of this investigation would be classified as General Solid Waste should off-site disposal be required. This does not constitute a full waste classification of material within the pipeline alignment and additional sampling and assessment will be required in order to confirm classification of specific materials to be disposed of off-site.

Assessment and classification of all material to be disposed of offsite as per NSW EPA (2014) *Waste Classification Guidelines, Part 1: Classifying Waste* and *Part 4: Acid Sulfate Soils* prior to off-site disposal.

### *Erosion and sediment control*

Trenching and directional drilling has potential to cause erosion of sediment and mobilisation of contaminants into the nearby marine environment. The erosion risk is considered relatively low as the site is predominantly flat and implementation of appropriate controls with reference to the *Managing Urban Stormwater: Soils and Construction Volume 1* (The 'Blue Book'; Landcom, 2004 will limit the potential for impacts upon nearby receiving waters.

### *Conceptual site model*

The potential SPR contaminant linkages identified for the proposed pipeline alignment site is provided in Table 11-4.

**Table 11-4 Source-Pathway-Receptor linkages for the proposed pipeline alignment**

| AEC | Source | Pathway | Receptor |
|---|---|---|---|
| 1 | Fill material along alignment | Dermal contact with contaminated soil or groundwater.<br>Inhalation of dust from contaminated soils.<br>Inhalation of vapours/gases generated by soil and groundwater contaminated by volatiles and semi-volatiles (if present) | Future workers<br>Future site users<br>Intrusive maintenance workers |
| 2 | Surface spills associated with current and former land use | | |
| 4 | Adjacent workshops and refuelling depot | | |
| 3 | Historical night soil depot | Dermal contact with contaminated soils<br>Inhalation of dust from contaminated soils | Future workers<br>Future site users<br>Intrusive maintenance workers |

While no potentially complete linkages have been identified through the sampling undertaken in this assessment, it should be noted that the sampling has been limited in nature, and the pipeline crosses over six kilometres of filled industrial land. Therefore, contamination has the potential to be encountered and should be anticipated when developing construction environmental management plans for the project.

### 11.5.3 Dredging area and the proposed Outer Harbour disposal area

Sediments within the proposed dredging and disposal areas are known to be contaminated as a result of historical use of the port. A review of previous investigations found:

- The upper soft silty clays were contaminated throughout all sampling areas.
- Heavy metals commonly exceeded the screening levels for cadmium, chromium, copper, lead, nickel, mercury and zinc.
- Tributyltin (TBT), dioxins and polycyclic aromatic hydrocarbons (PAHs) were reported above the nominated guidelines in several studies

During construction, dredging activities and transportation of material to the Outer Harbour will result in the suspension of sediments into the water column with associated impacts to the marine environment. This has been considered further as part of chapter 12 and 13.

Based upon the findings from the desktop study, additional sediment sampling within the dredge footprint off Berth 101 and at two locations within the disposal area was undertaken. An analysis of the results from the sampling and comparison with adopted criteria are provided below.

#### *Subsurface conditions*

Two main sedimentary units were identified in the dredge footprint at Berth 101 comprising a soft silty clay layer overlying a stiffer clay layer. Sediments encountered at the disposal area were stratigraphically different to Berth 101, predominantly comprising black-brown clayey silt.

Anthropogenic inclusions were noted in sediments at the disposal area including coal waste material, wood and concrete fragments interpreted as fill including a 10 centimetre layer of coarse coal waste.

Elevated metal concentrations were reported above the nominated screening levels in the dredge footprint at both Berth 101 and the disposal area. Other contaminants of potential concern, including PAH, TBT and hydrocarbons reported 95% UCL average concentrations below the nominated screening levels in the dredge area at Berth 101.

With the exception of one sampling location at the disposal area (REA01-1-1.5), concentrations of heavy metals were generally consistent between the Berth 101 dredging area and disposal area. Some metals, notably lead, mercury and zinc, were recorded in concentrations an order of magnitude higher within the disposal area than in samples taken outside of it. With the exception of one sample (REA01_1-1.5), Similarly concentrations of PAH, TBT and TPH in the disposal area were largely consistent with data reported for the dredge area, with the exception of one sample in the disposal area.

Dioxin levels were largely consistent across the two sampling areas with the sediments from the Berth 101 dredge footprint and disposal area reporting WHO $TEQ_{(0.5\ LOR)}$ of 9.4 ppt and 12.2 ppt respectively. Whilst Australian guidelines for dioxins are not currently available, these levels are within the range of background concentrations reported for Australian sediments (Muller et al., 2004) and consistent with the mean WHO $TEQ_{(0.5\ LOR)}$ reported by Worley Parsons (2012) of 15.4 ppt.

Analytical results were generally consistent with those reported previously by others including for the Outer Harbour Project and Worley Parsons (2012) for a previously proposed development of Berth 101. No new contaminants of potential concern were identified at levels exceeding screening criteria during the current investigation. Elutriate testing was not completed during the current investigation. However, based on the comparison of data with previous sampling events, the results of elutriate testing reported by AECOM (2010), Worley Parsons (2012) and Geochemical Assessments (2013) are considered relevant to these works and likely indicative of current conditions.

Overall, the findings of the investigation indicate the presence of contaminated sediments within the proposed dredging and disposal areas. Concentrations of contaminants of concern were largely consistent across the two areas, with the primary contaminants of concern including heavy metals, PAH and dioxins at concentrations above the nominated screening levels.

A dredging management plan should be prepared prior to the dredging of Berth 101, outlining the contamination management and mitigation measures, including surface water monitoring, which will be implemented during the course of the works to minimise potential impacts to the receiving waters (refer to Section 11.6).

### *Acid sulphate soils*

Samples for potential acid sulphate soil (PASS) were initially submitted to the lab for a pH field screen. The results for $pH_F$ range from 8.2 to 8.9. $pH_{Fox}$ ranged from 5.1 to 8 with one sample with a value of 2.3. All samples showed a strong or extreme reaction with a decrease in pH for all samples ranging from 0.4 to 6.1. While a final pH of less than 3.5 is considered an indicator of PASS, they cannot be excluded here as pH is often higher when samples are from a marine source.

Consistent with the findings of previous investigations including AECOM (2010), Worley Parsons (2012) and Geochemical Assessments (2013), the results indicate the presence of PASS and potential acid generating capacity of the sediments.

Given the presence of acid sulphate soils in all measured samples an acid sulphate soil management plan should be devised if there is a likelihood that dredged material could become oxidised during the removal and disposal process (refer to Section 11.6).

## 11.6 Management measures

Table 11-5 outlines the management measures, including recommendation for further investigation, that are proposed to address the contaminations issues associated with project. All management measures would be collated in management plans prepared for construction and operation of the project.

**Table 11-5 Management measures for contamination**

| ID | Issue | Measure | Timing |
|---|---|---|---|
| C01 | Contamination at Berth 101 | One or more of the following is proposed for assessing the potential risk to human health the two BaP (TEQ) hotspots identified at GHB09 and GBH26:<br>• Development of a human health risk assessment for BaP (TEQ), to further refine the potential risk posed by these contaminants to future construction workers. Given the short duration of the works relative to the standard exposure assumptions in a commercial/industrial scenario, it is likely that derived site specific target levels for BaP (TEQ) would be higher than adopted for this assessment.<br>• Additional investigation to delineate the vertical and lateral extent of BaP (TEQ). The investigation would involve step out borehole locations which will target materials at depths between 4 m and 5 m, to assess if the contamination is isolated or widespread.<br>• The source of BaP (TEQ) at GHB09 and GBH26 was not identified nor was there apparent evidence of this contamination present at the time of sampling. The contamination may be a characteristic of the fill material, meaning it could be randomly distributed throughout the fill matrix. Therefore, in addition to further investigation, bioavailability testing is also recommended so that the risk to human health is better understood and appropriate safety control measures can be adopted during construction. The laboratory is presently maintaining these samples pending further analysis. | Pre-construction |
| C02 | Contamination at Berth 101 | Removal of any remnant ACM fragments from the ground surface. The removal should be undertaken by a licenced removalist in accordance with relevant SafeWork NSW codes of practice. Following removal, a licenced asbestos | Construction |

| ID | Issue | Measure | Timing |
|---|---|---|---|
| | | assessor should inspect the site and provide a clearance certificate confirming removal of asbestos. | |
| C03 | Contamination at Berth 101 | Inclusion of an unexpected finds protocol for contamination in the Construction Environmental Management Plan (CEMP) for the work associated with construction activities. | Construction |
| C04 | Berth 101; Proposed pipeline alignment; Dredging area and disposal area | Preparation of an ASSMP by a consultant experienced in the identification and management of ASS. This will also include appropriate treatment and / of management of ASS. The ASSMP will be developed in line with the requirements of the Acid Sulphate Soils Management Advisory Committee Guidelines (ASSMAC, August 1998 and as updated). The ASSMP will be prepared to identify, manage and treat the ASS encountered during excavation and dredging to minimise the production of acid leachate. | Construction |
| C05 | Proposed pipeline alignment | Preparation and implementation of a construction environmental management plan (CEMP) to include an unexpected finds protocol (UFP) to effectively manage the potential contamination issues identified from both a human health and environmental perspective. This would include the assessment of materials to be disturbed across the site to inform appropriate management strategies | Construction |
| C06 | Proposed pipeline alignment | Assessment and classification of all material to be disposed of offsite as per NSW EPA (2014) Waste Classification Guidelines, Part 1: Classifying Waste and Part 4: Acid Sulfate Soils prior to off-site disposal. | Pre-construction |
| C07 | Proposed pipeline alignment | If the proposed pipeline alignment is likely to intersect groundwater, assessment of groundwater quality in those sections should also be carried out to inform construction management of potential contamination issues. | Construction |

| ID | Issue | Measure | Timing |
|---|---|---|---|
| C08 | Dredging area and disposal area in the Outer Harbour | A dredge management plan will be prepared prior to the dredging of Berth 101, outlining the contamination management measures, including:<br>• surface water monitoring, which will be implemented during the course of the works to minimise potential impacts to the receiving waters<br>• use of a turbidity curtain to restrict the generation of turbidity plumes and localise any water quality issues | Construction |

# 12. Water resources

## 12.1 Introduction

This chapter provides an assessment of the project's impacts to water quality, hydrodynamics and hydrology during construction and operation. The existing setting, including historical ambient water quality within the port is described and assessed in the context of development of the proposed LNG import terminal. Management measures to reduce the impact of the project on water quality, hydrodynamics and hydrology have been developed with reference to industry best practice.

Water quality, hydrodynamic and hydrology impacts have been considered through studies and assessments undertaken as part of the project's development and guidelines set by the industry, including:

- Guidelines set by Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000).
- Guidelines set by the NSW Marine Water Quality Objectives in NSW (DEC, 2006).
- Guidelines set by National Assessment Guidelines for Dredging (Commonwealth of Australia, 2009)
- Port Kembla Outer Harbour Development Environmental Assessment Report (Aecom, 2010)
- Long Waves, Sediment & Thermal Plume Modelling Report (Cardno, 2018) included as Appendix F in Volume 2.

The above studies, assessments and guidelines have been used to form the basis of this chapter.

## 12.2 Existing environment

### 12.2.1 Marine Water Quality Objectives

The National Water Quality Management Strategy (NWQMS) provides a national framework for improving water quality in Australia's waterways. The main policy objective of the NWQMS is to achieve sustainable use of the nation's water resources, protecting and enhancing their quality, while maintaining economic and social development.

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) is a benchmark document of the NWQMS which provides a guide for assessing and managing ambient water quality in a wide range of water resource types and according to specified environmental values. The guidelines provide a framework for determining appropriate values or performance criteria to evaluate the results of water quality monitoring programs against defined objectives or values for the receiving waters. For each environmental value, the guidelines identify particular water quality characteristics or 'indicators' that are used to assess whether the condition of the water supports that value.

The Marine Water Quality Objectives (WQOs) were adopted by the NSW Government in 2005 and are intended as a guideline tool for strategic planning and development assessment (DEC 2006). The WQOs are consistent with the national framework for assessing water quality set out in the ANZECC 2000 Guidelines and include five objectives which describe the water quality needed to protect the following marine water quality values:

- Aquatic ecosystems i.e. aquatic ecosystem health
- Primary contact recreation i.e. swimming, surfing
- Secondary contact recreation i.e. boating, wading
- Visual amenity i.e. aesthetic qualities of waters
- Aquatic foods i.e. water suitable for growing seafood

In the case of Port Kembla Harbour, the relevant values relate only to Aquatic Ecosystems and Visual Amenity, for which the relevant guideline levels for ambient water quality are presented in Figure 12-1.

| **Marine Water Quality Objectives** | **Aquatic ecosystem health**<br><br>**To maintain or improve the ecological condition of ocean waters.** | **Visual amenity**<br><br>**To maintain or improve ocean water quality so that it looks clean and is free of surface films and debris.** |
|---|---|---|
| **Examples of indicative guideline levels for environmental (ambient) water quality**<br><br>The indicative guideline levels (indicators and numerical criteria) listed are examples only of some of the relevant water quality guideline levels recommended in the ANZECC & ARMCANZ Guidelines 2000. For a full list, refer to the appropriate tables as referenced in the ANZECC & ARMCANZ Guidelines 2000. These are available at [www.deh.gov.au/water/quality/nwqms/index.html](www.deh.gov.au/water/quality/nwqms/index.html) | Biological<br>• Frequency of algal blooms – no change from natural conditions<br>• Bioaccumulation of contaminants – no change from natural conditions.<br><br>Physico-chemical<br>• **Nutrients**<br>Total Nitrogen < 120 µg/L<br>Total Phosphorous < 25 µg/L<br>• **Turbidity** 0.5–10 NTU*<br><br>Toxicants in coastal waters<br>• **Metals**<br>Copper < 1.3 µg/L<br>Lead < 4.4 µg/L<br>Zinc < 15 µg/L<br>• **Pesticides**<br>Chlorpyrifos < 0.009 µg/L<br><br>Toxicants in bottom sediments<br>• **Metals**<br>Copper < 65 mg/kg dry weight<br>Lead < 50 mg/kg dry weight<br>Zinc <200 mg/kg dry weight<br>Mercury < 0.15 mg/kg dry weight<br>• **Organochlorines**<br>Chlordane < 0.5 µg/kg dry weight<br>Total PCBs < 23 µg /kg dry weight | Indicators to ensure water looks clean and free from pollutants<br>• **Surface films and debris**<br>Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter.<br>• **Nuisance organisms**<br>Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, and sewage fungus should not be present in unsightly amounts. |

**Figure 12-1 Relevant guideline levels for ambient water quality (DEC 2006)**

The ANZECC Guidelines provide the technical guidance to assess the water quality needed to protect identified environmental values. This guidance includes indicators (specific monitoring parameters) and numerical criteria (guideline limits for each parameter) for ambient water quality which must be considered in light of the individual development location.

It should also be noted that the environmental values and respective numerical indicator values apply to ambient background water quality and are not intended to be applied to point source discharges or mixing zones.

The guidelines have formed the basis of previously complete water quality assessment and would form the basis of further water quality monitoring proposed to be undertaken as outlined in Section 12.4.

### 12.2.2 Water quality within the port

Water quality within the Inner Harbour and Outer Harbour of Port Kembla has been historically impacted by urban and industrial discharges as well as port activities. In particular, these past activities led to contamination of marine sediments, groundwater and harbour waters. Further discussion of historical and current contaminant levels in the vicinity of the project site are described in Chapter 11 and Appendix E.

Water quality monitoring studies have been previously undertaken in order to define ambient water quality within the port and to monitor water quality parameters during previous dredging campaigns. Key water quality monitoring programs undertaken within the Inner Harbour and Outer Harbour of Port Kembla include the following:

- Port Kembla Water Quality Monitoring Program undertaken by BHP between 1990 and 1999.
- Port Kembla Harbour Water Quality Monitoring Program undertaken by the Port Kembla Environment Group between 2002 and 2005.
- Blue Scope Steel Water Quality Monitoring Program undertaken by the Port Kembla Environment Group between 2007 and 2008.
- MPB3 / Berth 107 Dredging Water Quality Monitoring Program undertaken by Cleary Bros on behalf of Port Kembla Port Corporation between 2006 and 2008.
- Outer Harbour Tug Berth Dredging Water Quality Monitoring Program undertaken on behalf of Port Kembla Port Corporation in 2011.
- Outer Harbour Stage 1A Reclamation Water Quality Monitoring Program (including baseline and impact monitoring) undertaken on behalf of Port Kembla Port Corporation between 2011 and 2012.
- Maintenance Dredging Water Quality Monitoring Program undertaken by ENRS on behalf of NSW Ports in late 2014.

The 2002-2005 monitoring program undertaken by the Port Kembla Environment Group is considered to be the most comprehensive study of ambient water quality conditions within the Port. The program aimed to establish benchmarks to determine trends and future improvements in water quality and assess whether contaminant concentrations exceed the ANZECC / ARMCANZ Guidelines (2000). The program identified monitoring locations within the Inner and Outer Harbours which have been subsequently adopted by a number of programs and are presented below in Figure 12-2.

Analysis of the following parameters was undertaken and the results compared to relevant trigger values derived from the ANZECC / ARMCANZ water quality guidelines (2000):

- Metals (Al, Cr, Mn, Fe, Ni, Cu, Zn, Sn, Pb, Cd, As, Se);
- Total Suspended Solids (TSS)

- Cyanide
- Ammonia
- Phenols

More recent monitoring programs associated with the 2014 Maintenance Dredging Program also considered the following parameters:

- Temperature
- Salinity
- Dissolved Oxygen (DO)
- pH
- Oxygen Reduction Potential (ORP)
- Turbidity


**Figure 12-2 Port Kembla monitoring locations**

It is important to note that in many instances the historical laboratory Limits of Reporting (LOR) adopted during previous studies are greater than the assessment criteria, meaning that the laboratory was not able to confirm whether contaminant concentrations were above or below the relevant criteria. Consequently, the results of detailed analysis of the full data set would be misleading and would be considered of relatively little value. Nevertheless, it is possible to summarise the key issues relating to existing water quality within the port through review of these previous investigations. Further observations of the historical water quality data set are summarised in Table 12-1.

**Table 12-1 Historical water quality**

| Parameter | Summary of historical results |
|---|---|
| Contaminants | Water samples collected under ambient conditions during the 2002-2005 monitoring program undertaken by the Port Kembla Environment Group identified concentrations of aluminium, cadmium, copper, lead, zinc, tin and arsenic in excess of the ANZECC (2000) 95% trigger values for protection of marine waters. Concentrations of all other analytes were below the adopted trigger values.<br>Elevated levels of adverse water quality parameters were generally found in the vicinity of creeks and waterways that drain industrial and stockpile areas such as the entrance to Allans Creek (Site 1), Gurangaty Waterway (Site 5), near No. 1 Products Berth (Site 3), the Cut (Site 7) and Darcy Road Drain (Site 15). |
| Suspended Solids / Turbidity | TSS concentrations are known to be influenced by shipping movements and freshwater flood events. Long term data collected during the 2002-2005 monitoring program undertaken by the Port Kembla Environment Group measured average TSS concentrations of 5.9mg/L and 3.2mg/L within the Inner and Outer Harbours respectively. TSS concentrations within the Inner Harbour were shown to vary between 1.0mg/L and 17.9mg/L.<br>TSS concentrations within the Outer Harbour were shown to vary between 0.5mg/L and 11.8mg/L.<br>Previous dredging campaigns (Berth 103) established a relationship between Nephelometric Turbidity Units (NTU) and Total Suspended Solids (TSS) of 1 NTU = 2mg/L TSS. It is critical to note that the relationship between NTU and TSS is highly dependent on the material properties of the sediments in suspension. |
| pH | Previous monitoring campaigns have recorded pH levels within the Inner and Outer Harbour ranging between 7.6 and 8.1 and in some instances below the recommended ANZECC criteria for harbour waters (8.0-8.5). Previous investigations concluded that pH levels are lower in the Inner Harbour than the Outer Harbour, indicating pH levels within the Inner Harbour are likely influenced by freshwater discharges from existing waterways. |
| Temperature | Water temperatures within Port Kembla are generally higher than those measured offshore due to tidal flushing patterns and existing industrial discharges to the Inner Harbour. As a result, water temperatures within the Inner Harbour are generally one to two degrees warmer than sea temperatures beyond the entrance to the harbour. The Outer Harbour benefits from greater tidal flushing and is generally less than 0.25 degrees warmer than sea temperatures beyond the entrance to the harbour. |

| Parameter | Summary of historical results |
|---|---|
| Salinity | Total Dissolved Solids (TDS) concentrations assessed during 2014 maintenance dredging campaign ranged from 31.15g/L to 35.38g/L. Concentrations have been shown to vary with depth indicating density stratification within the water column. Concentrations are also known to be influenced by freshwater flood events. |

### 12.2.3 Hydrodynamics

Port Kembla's Inner Harbour is considered a relatively low energy environment with relatively low discharges from creeks and drains and relatively little wave energy propagation into the Inner Harbour. Tidal planes and percentage exceedance tables for offshore wave heights are provided in Table 12-2 and Figure 12-3 respectively.

The Outer Harbour is known to be impacted by long wave events, which are typically multi-directional, with long waves from multiple directions occurring at the same time. The predominant directions are from the east, the north, and also from the west, which is likely to be due to waves reflecting off the beach. Further information is provided in Appendix F.

**Table 12-2 Tidal Planes for Port Kembla**

| Tidal Plane | Tidal Level (m PKHD) |
|---|---|
| Highest Astronomical Tide (HAT) | 2.0 m |
| Mean High Water Springs | 1.5 m |
| Mean High Water Neaps | 1.3 m |
| Mean Sea Level | 0.9 m |
| Mean Low Water Neaps | 0.6 m |
| Mean Low Water Springs | 0.3 m |
| Lowest Astronomical Tide (LAT) | 0.0 m |

PERCENTAGE EXCEEDANCE FOR Significant Wave Height(m)

| Hsig | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTAL | Hsig |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.000 | 0.00 |
| 0.50 | 100.00 | 99.94 | 99.99 | 99.86 | 99.47 | 99.37 | 99.36 | 99.62 | 99.94 | 99.91 | 99.98 | 99.89 | 99.775 | 0.50 |
| 1.00 | 90.51 | 91.36 | 89.89 | 82.46 | 78.61 | 75.27 | 77.58 | 74.43 | 80.62 | 83.91 | 85.66 | 85.93 | 82.897 | 1.00 |
| 1.50 | 45.82 | 49.47 | 48.14 | 46.18 | 45.71 | 47.09 | 45.25 | 39.41 | 42.32 | 44.08 | 44.13 | 44.05 | 45.059 | 1.50 |
| 2.00 | 16.09 | 23.31 | 21.49 | 21.88 | 23.24 | 25.05 | 24.54 | 20.33 | 19.49 | 19.66 | 18.55 | 17.92 | 20.957 | 2.00 |
| 2.50 | 5.40 | 9.97 | 9.25 | 9.68 | 11.01 | 13.13 | 13.01 | 10.93 | 9.15 | 9.34 | 8.11 | 6.41 | 9.631 | 2.50 |
| 3.00 | 1.65 | 3.69 | 3.69 | 4.40 | 5.18 | 6.73 | 6.47 | 5.46 | 4.27 | 4.32 | 3.62 | 2.37 | 4.338 | 3.00 |
| 3.50 | 0.44 | 1.44 | 1.64 | 1.83 | 2.18 | 3.43 | 3.47 | 3.00 | 1.73 | 1.92 | 1.53 | 0.82 | 1.966 | 3.50 |
| 4.00 | 0.12 | 0.42 | 0.86 | 0.84 | 0.83 | 1.62 | 1.64 | 1.73 | 0.65 | 0.97 | 0.67 | 0.23 | 0.890 | 4.00 |
| 4.50 | 0.03 | 0.17 | 0.57 | 0.43 | 0.46 | 0.66 | 0.75 | 1.06 | 0.22 | 0.37 | 0.26 | 0.05 | 0.425 | 4.50 |
| 5.00 | 0.01 | 0.03 | 0.26 | 0.15 | 0.28 | 0.28 | 0.36 | 0.69 | 0.08 | 0.19 | 0.12 | 0.02 | 0.209 | 5.00 |
| 5.50 | 0.00 | 0.00 | 0.06 | 0.03 | 0.15 | 0.09 | 0.14 | 0.41 | 0.06 | 0.12 | 0.04 | 0.00 | 0.094 | 5.50 |
| 6.00 | 0.00 | 0.00 | 0.04 | 0.01 | 0.10 | 0.02 | 0.04 | 0.19 | 0.02 | 0.05 | 0.01 | 0.00 | 0.040 | 6.00 |
| 6.50 | 0.00 | 0.00 | 0.02 | 0.00 | 0.07 | 0.01 | 0.00 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.013 | 6.50 |
| 7.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.006 | 7.00 |
| 7.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.002 | 7.50 |
| 8.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.002 | 8.00 |
| 8.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.000 | 8.50 |
| Average : | 1.53 | 1.62 | 1.61 | 1.58 | 1.56 | 1.64 | 1.56 | 1.52 | 1.48 | 1.56 | 1.55 | 1.52 | 1.58 | |
| Maximum : | 5.01 | 5.39 | 6.88 | 6.14 | 8.43 | 6.74 | 6.30 | 7.41 | 6.65 | 6.47 | 6.09 | 5.62 | 8.43 | |
| Minimum : | 0.56 | 0.41 | 0.50 | 0.29 | 0.29 | 0.29 | 0.29 | 0.34 | 0.38 | 0.43 | 0.29 | 0.29 | 0.29 | |

**Figure 12-3 Port Kembla percentage exceedance for significant wave height (MHL, 2018)**

### 12.2.4 Hydrology

The proposed berth will be located at the existing Berth 101, which is characterised as a relatively flat area of reclaimed foreshore, where stormwater is currently managed via a series of detention basins (associated with the site's current use as a coal terminal).

The pipeline would cross Gurungaty Waterway in the north-east and Allans Creek in the south. Both waterways flow through highly disturbed land and have been modified through previous industrial development at Port Kembla, with modified banks and are crossed by numerous man-made structures including pipelines and bridges. Gurungaty Waterway does contain small areas of mangrove and saltmarsh upstream from the pipeline crossing and Allans Creek drains natural catchment areas of the Illawarra Escarpment.

The proposed Outer Harbour disposal area lies immediately seaward of Salty Creek and the Darcy Road Drain. These waterways drain heavily developed industrial catchments to the south and serve important functions with respect to conveying flood flows and wastewater effluent.

Both waterways have been heavily modified in order to facilitate industrial development of the adjacent lands.

It is also important to note that the approved Port Kembla Outer Harbour Development proposes to redirect and extend Salty Creek and the Darcy Road Drain through the proposed reclamation area. Further information regarding the existing catchments and approved future modifications are contained within the 2010 Environmental Assessment (Aecom, 2010).

## 12.3 Potential impacts

### 12.3.1 Construction

Potential construction phase impacts are primarily associated with water quality impacts generated during the removal, handling and placement of dredged sediments. In particular, dredging and reclamation activities may generate turbid plumes, mobilise contaminants, disturb dinoflagellate cysts within the Outer Harbour and increase rates of sedimentation.

Construction is proposed to commence in 2019 and for a duration of around 10 to 12 months. During construction the total amount of material that will be dredged and excavated at the new berth is around 600,000 cubic metres. Allowing for typical bulking factors, this volume would equate to around 720,000 cubic metres.

Excavation and dredging would be carried out by long reach excavator and backhoe dredger. The long reach excavator would be situated on land and would primarily be used to excavate the existing berth and revetment with road haulage to the Outer Harbour for disposal.

The backhoe dredger would be situated in the Inner Harbour adjacent to Berth 101 and would primarily be used to excavate the deeper sediments at Berth 101. The volume of material to be excavated or dredged may vary depending on the preference and capacity of the construction contractor.

The backhoe dredger will be used to remove material and load split hopper barges for transport to the disposal area in the Outer Harbour. Prior to placement of the dredged material within the Outer Harbour, it will be necessary to first construct a perimeter bund to ensure the stability of the disposal site. Construction of the bund will require removal of an existing layer of soft sediments that have been previously placed within the reclamation footprint. This activity will be undertaken using a backhoe dredger and hopper barge to relocate the material from within the footprint of the bund to the central portion of the reclamation area.

It is expected that two split hopper barges will be used with the capacity of around 1,200 cubic metres each. Removal of material at the berth will take place on a continuous basis whilst disposal barges will place material within the Outer Harbour every 4 to 6 hours.

A numerical modelling report has been prepared by Cardno (2018) which outlines the investigations undertaken in order to define the potential impacts associated with hydrodynamics, wave energy and sediment and thermal plume dispersion. The existing, calibrated 3-Dimensional hydrodynamic model of Port Kembla has been extended and applied as shown in Figure 12-4. The model utilises the Deltares modelling software, Delft3D, which has been previously used to assess similar projects within Port Kembla such as the Outer Harbour Development.

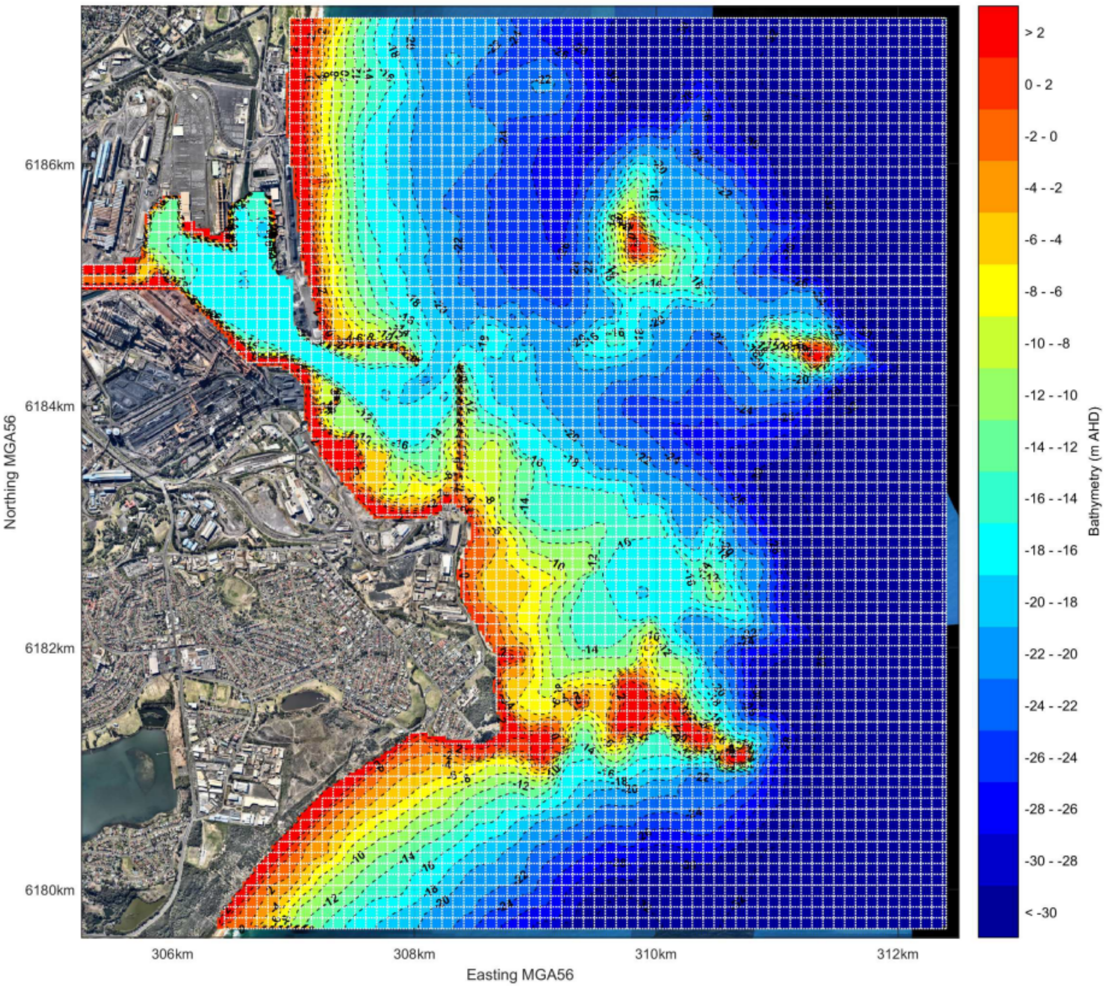


**Figure 12-4 Delft 3D Model extent and bathymetry (Cardno, 2018)**

A copy of the report is provided in Appendix F and a summary of the key results and conclusions relating to potential construction impacts is provided below. Results relating to the potential impacts associated with the operation of the facility are summarised in Section 12.3.2.

### *Dredge plume dispersion*

Based on review of the proposed work methodology and available geotechnical information, the removal and placement of the harbour muds from the berth area was identified as the activity with the greatest potential to impact water quality. Model scenarios were developed in order to assess impacts to Total Suspended Solids (TSS) and sediment deposition associated with the dredging and disposal of harbour muds within the Inner and Outer Harbours respectively.

Consideration was also given to associated activities such as piling operations and the removal of sediments with poor engineering properties from beneath the proposed Outer Harbour perimeter bund however it was concluded that the turbid plumes associated with these activities would be less significant than those considered in the modelled scenarios.

Figure 12-5 presents the 95$^{th}$ percentile TSS concentrations for the surface, mid-depth and bottom layers of the model.

Further percentile plots are presented in Appendix F, including the minimum TSS concentration, 5th, 10th, 15th, 20th, 50th (median), 80th, 85th, 90th, 95th and the maximum. These plots provide a statistical representation of the plume extent and concentration over the duration of the project.

From examination of the plots, it is apparent that the predicted extent of the dredge plume will be confined to the port with significant TSS concentrations confined to the vicinity of the dredging and disposal areas.

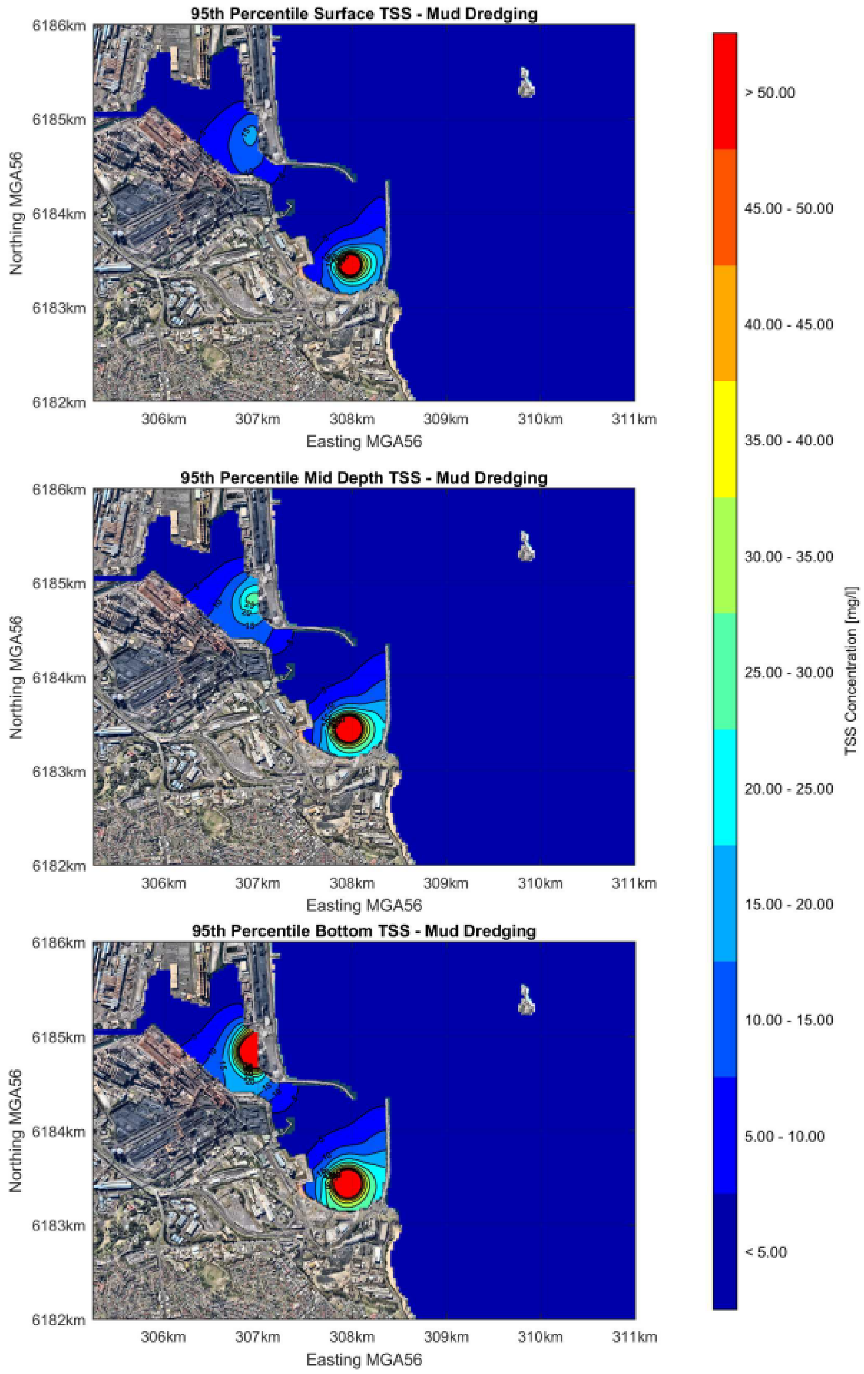


**Figure 12-5 Suspended Solids concentration 95th percentile (Cardno, 2018)**

Figure 12-6 presents the predicted sediment deposition thickness following the dredging and disposal of the mud layer. Sedimentation is predicted to occur in the vicinity of the dredging and disposal activities with no noticeable impacts to sedimentation rates outside of the port. Information regarding the potential impacts associated with the removal and placement of contaminated sediments is provided in Chapter 11.

It should be noted that the sedimentation expected to occur within the dredge area would be re-dredged where necessary to achieve the nominated design levels and tolerances. Similarly, the bulk of the predicted sedimentation within the Outer Harbour would occur within the footprint of the approved Outer Harbour Development and would ultimately be covered by the reclaimed material.


**Figure 12-6 Predicted sedimentation of fines post dredging and disposal (Cardno, 2018)**

In addition to the construction impacts outlined above, the proposed works include a number of activities which have the potential to impact water quality. These include:

- Demolition of the existing Berth 101, including pile extraction, has the potential to disturb sediments leading to localised plumes in the immediate vicinity of the works.
- Movement and anchoring of construction vessels such as spudded dredging equipment, hopper barges, tugs, crew transfer vessels and survey vessels, which may lead to hydrocarbon spills, disturb bottom sediments and contribute to dispersal of suspended sediments.
- Onshore earthworks undertaken in the vicinity of the harbour foreshore, which have the potential to result in the release of hydrocarbons and turbid stormwater into the harbour.

These potential impacts are expected to be minor in comparison to the proposed dredging and disposal works. Such activities would be undertaken in accordance with emergency spill plans and the objectives and development criteria outlined in the Port Kembla Development Code (NSW Ports 2016). Potential impacts to turbidity levels and sedimentation rates associated with these activities would also be mitigated through the use of silt curtains surrounding equipment and activities where there is a potential for impacts to water quality as shown in Figure 12-7 and discussed in Section 12.4.

**Figure 12-7 Example of a silt curtain surrounding a dredging operation**

It is worth noting Port Kembla Harbour has been subject to several capital dredging campaigns, which have been undertaken to facilitate the development of shipping berths. Maintenance dredging activities are undertaken less frequently, with management of declared depths primarily managed through annual sweep dredging (i.e. bed levelling using a sweep bar). These operations result in repeated mobilisation of sediments from within the channel and berth areas. Potential impacts during dredging activities will be managed in accordance with established practices at the port and potential impacts will be commensurate with previous dredging campaigns.

### 12.3.2 Operation

During operation, potential impacts to water quality and hydrology within and around Port Kembla Harbour include:

- Cold water discharge plume associated with the regasification process
- Hydrodynamic impacts associated with the expansion of the existing Berth 101 and changes to the previously approved Outer Harbour reclamation footprint.
- Hydrological and flooding impacts associated with reductions in available flood flow areas due to the presence of pipelines and reclamation areas
- Use of chemicals such as antifouling paints applied to LNG tankers and the FSRU to minimise marine growth
- Residual levels of sodium hypochlorite within the FSRU discharge to the harbour
- Stormwater and spill management

#### *Thermal plume modelling*

The regasification process on board the FSRU relies on the use of seawater extracted from the Inner Harbour to heat the LNG to convert it to gas. The seawater used in the regasification process will then be released back into the Inner Harbour via a horizontal discharge outlet on the side of the FSRU at a rate of approximately 10,000m$^3$/hr. When discharged, this water will be up to 7$^o$ Celsius cooler than the ambient sea water temperature at the immediate point of discharge, falling rapidly to only 1 degree cooler at each end of the proposed berth. Given the overall artificially heightened temperature of the Inner Harbour due to warm water discharges from other facilities, the contribution of cooler water should assist with the overall temperature management of the Inner Harbour.

Near field and far field assessment has been undertaken using the Mixzon Inc. CORMIX and Delft3D software packages. The aim of the modelling was to assess the behaviour and extent of the thermal discharge plume in light of the existing intakes and outlets operated by BlueScope Steel which currently discharge warm water into the Inner Harbour.

A copy of the numerical modelling report is provided in Appendix F and a summary of the key results and conclusions relating to potential impacts during operations is provided below.

The modelling indicates that the release of cold water from the FSRU will only have minor impacts on seawater temperatures. These impacts are expected to be confined to within the port limits.

From examination of the 50$^{th}$ percentile summer seawater temperature plot shown in Figure 12-8, it is apparent that existing warm water discharges have a significant influence on water temperatures within the Inner Harbour during summer months. The model results indicate that the extent of the existing warm water plumes will be reduced by the proposed release of cold water within the Inner Harbour.

Predicted 5$^{th}$ percentile (low temperatures) summer and winter plots are shown in Figure 12-9 and differential plots of predicted seawater temperatures presented in Figure 12-10. The model results show that predicted reductions in temperature are greatest during winter when BlueScope warm water discharges are reduced. The model predicts that initial near field mixing will reduce the 5$^{th}$ percentile temperature differential to one degree at each end of the proposed berth. On average, temperatures within the port are generally expected to decrease by 0.1 to 0.2 degrees.

Further percentile plots are presented in Appendix F, including the minimum seawater temperature, 5th, 10th, 15th, 20th, 50th (median), 80th, 85th, 90th, 95$^{th}$, the maximum and differential plots.

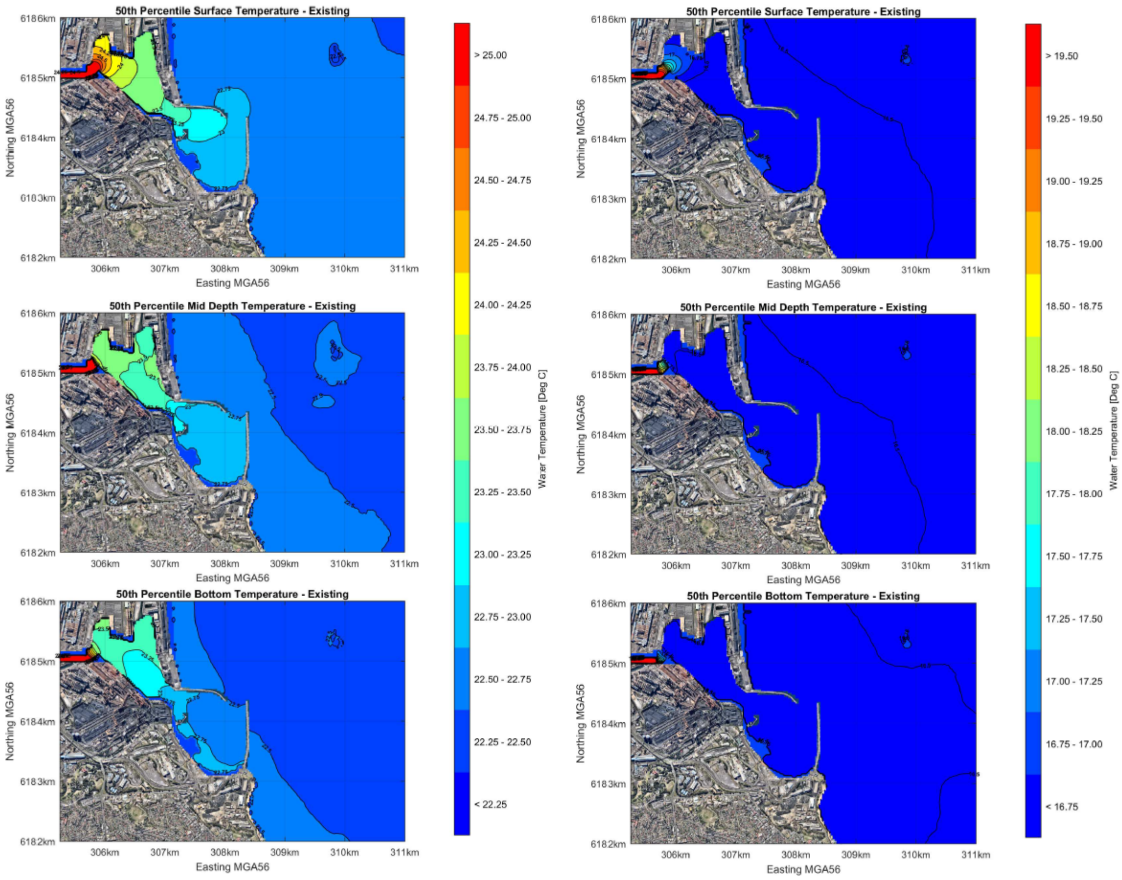


**Figure 12-8 Existing 50th percentile summer and winter seawater temperatures (Cardno, 2018)**

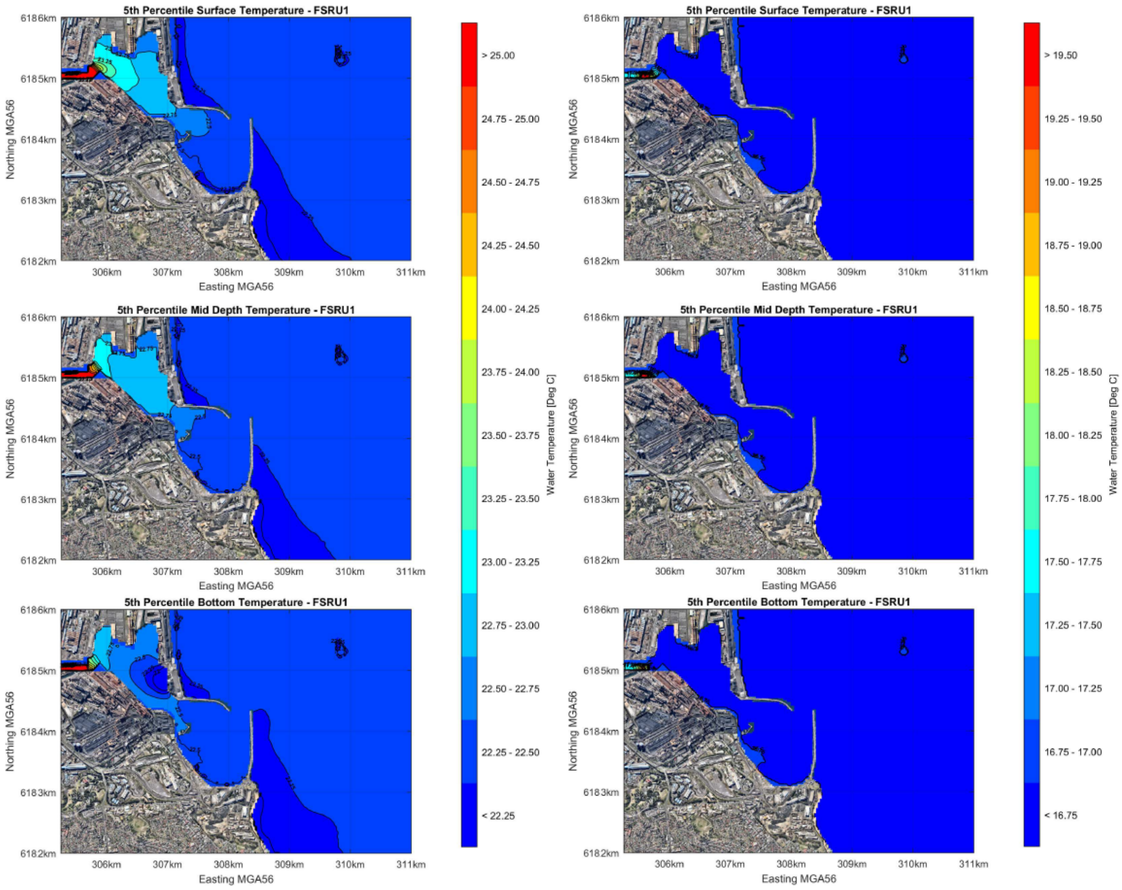


**Figure 12-9 Predicted 5th percentile summer and winter seawater temperatures (Cardno, 2018)**

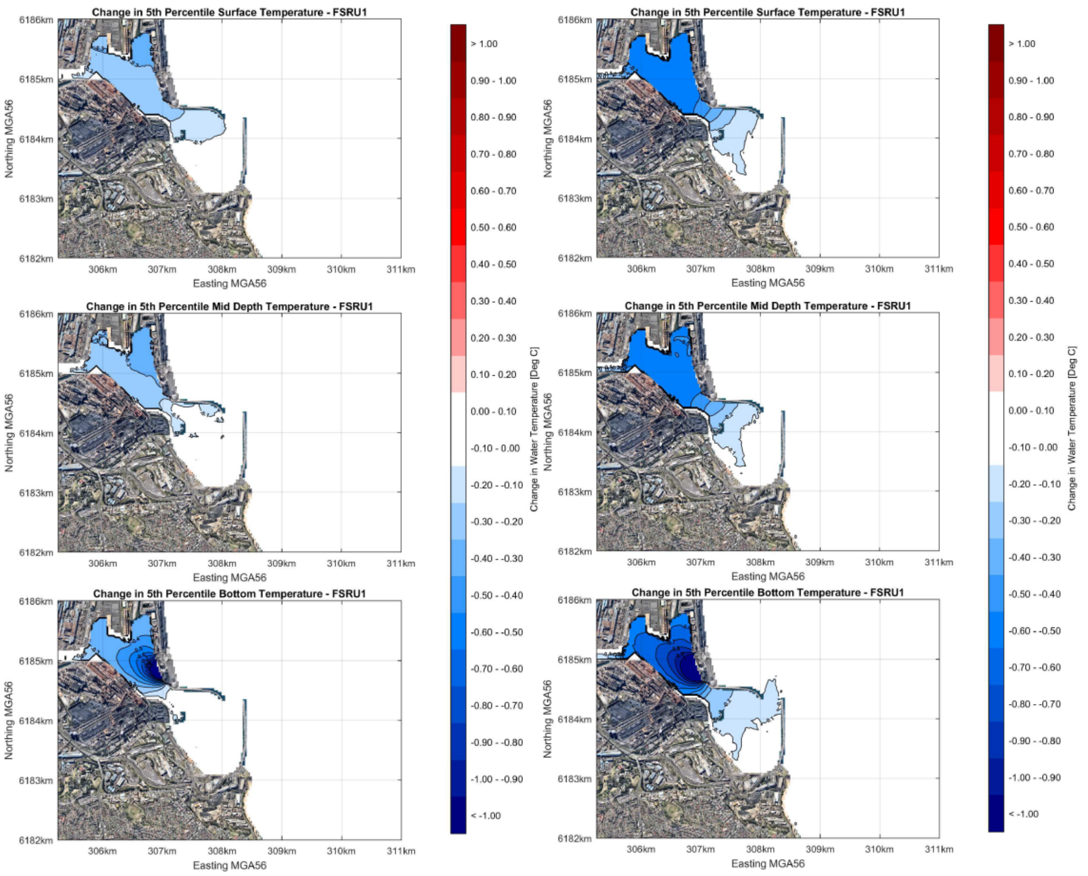


**Figure 12-10 Predicted 5th percentile summer and winter seawater temperature differential plots (Cardno, 2018)**

### *Use of Chemicals*

Consideration has been given to the pollutants and contaminants to be used over the life of the project which have the potential to be released into the marine environment. Whilst the bulk of chemicals will be stored and processed at appropriate onshore facilities, consideration has been given antifouling hull treatments and seawater discharges.

#### Antifouling Treatments

Traditional antifouling treatments utilised harmful substances in paints and hull treatments to prevent the growth of marine organisms on vessels. These compounds slowly leached into the marine environment, killing marine life and potentially entering the food chain.

In accordance with the International Convention on the Control of Harmful Anti-fouling Systems on Ships of the International Maritime Organization, the FSRU has been issued with a certificate to confirm that an antifouling systems controlled under Annex 1 to the Convention has not been applied during the construction of the ship and that the antifouling system on the ship complies with the applicable requirements of Annex 1 to the Convention.

#### Seawater discharges

An FSRU uses seawater for a number of functions. Some functions like the use of seawater for ballast or for fire-fighting, are the same as any ocean-going vessel visiting the Port. Other functions like the use of seawater to warm up the liquid natural gas (LNG) in order to return it to its gaseous state, are unique to the FSRU.

Seawater used for these purposes is usually re-released into the ocean. However, before releasing water back into the ocean, vessels must comply with both international and national regulations on the treatment of seawater. The aims of these requirements are to ensure no foreign or malevolent marine life, no excessive particulates or sediments and no unacceptable concentrations of biocides or other chemicals are released into the surrounding waters.

Because both Hoegh vessels available for use by AIE are state-of-the-art, each is fitted with a Marine Growth Prevention System (MGPS) which helps to ensure no marine growth in the various pipes and other processes which use seawater on the FSRU.

The MGPS takes seawater from the surrounding area, uses its natural salts to produce a solution of sodium hypochlorite, which acts as a natural biocide, that is used on-board to ensure all the systems remain free of marine growths.

Sodium hypochlorite degrades naturally and so most of the created solution will be used within the vessel well before the water is ready for re-release. However, some excess sodium hypochlorite is expected to remain prior to discharge within the Inner Harbour.

The ANZECC guidelines provide a 95% species protection default guideline value (previously known as trigger value) for total residual chlorine within freshwater aquatic environments of 3 µg Cl/L. No equivalent values are provided for the marine environment however the guidelines note that the freshwater value "was adopted as a marine low reliability trigger value, to be used only as an indicative interim working level".

It is important to note that chlorine is very reactive in seawater, reacting with bromine to form chloride ions and hypobromous acid (HOBr). Therefore consideration should be given to concentration values of total residual oxidants measured as µg Cl per L or ppm.

Such values are provided in the IFC World Bank Group Environmental, Health, and Safety (EHS) Guidelines for Liquefied Natural Gas (LNG) Facilities, which include specific information relating to discharges associated with floating storage regasification units. These guidelines stipulate the following in relation to residual sodium hypochlorite in seawater,

*"Free chlorine (total residual oxidant in estuarine/marine water) concentration in cooling/cold water discharges (to be sampled at point of discharge) should be maintained below 0.2 parts per million (ppm)." (IFC, 2017).*

Prior to re-releasing the seawater back into the surrounding area, the operators of the vessel will aim to match the profile of the discharged water, as close as possible, to the pre-discharge profile and will ensure that free chlorine (total residual oxidant in estuarine/marine water) concentrations remain below 0.2 ppm. Changing the profile of the discharge water can be done by modifying the frequency of production and the concentration of sodium hypochlorite produced on-board from the intake of sea water.

Consideration has also been given to the dilution of the discharge stream within the mixing zone of the Inner Harbour based on the results of the near field mixing models. The discharge plume is predicted to have been diluted by a factor of four by the time the plume reaches the floor of the Inner Harbour and a dilution factor of 30 at a distance of 400m from the discharge point. Slightly elevated levels in receiving waters are expected to be primarily restricted to the Inner Harbour and are not expected to extend beyond the Outer Harbour.

### *Hydrodynamic assessment*

Detailed numerical modelling of the previously approved Outer Harbour Development was undertaken as part of the 2010 Environmental Assessment undertaken on behalf of PKPC (Aecom 2010, Cardno Lawson Treloar 2009). The previous assessment included consideration of the following hydrodynamic and metocean processes:

- Infragravity (long) waves and seiching
- Gravity (ocean swell) waves
- Tidal hydraulics
- Water levels

During recent discussions between AIE and NSW Ports, a disposal footprint has been agreed as shown in red in Figure 12-11. The previously approved reclamation footprint for the Outer Harbour Development included a longer western berth area as shown in yellow in Figure 12-11.

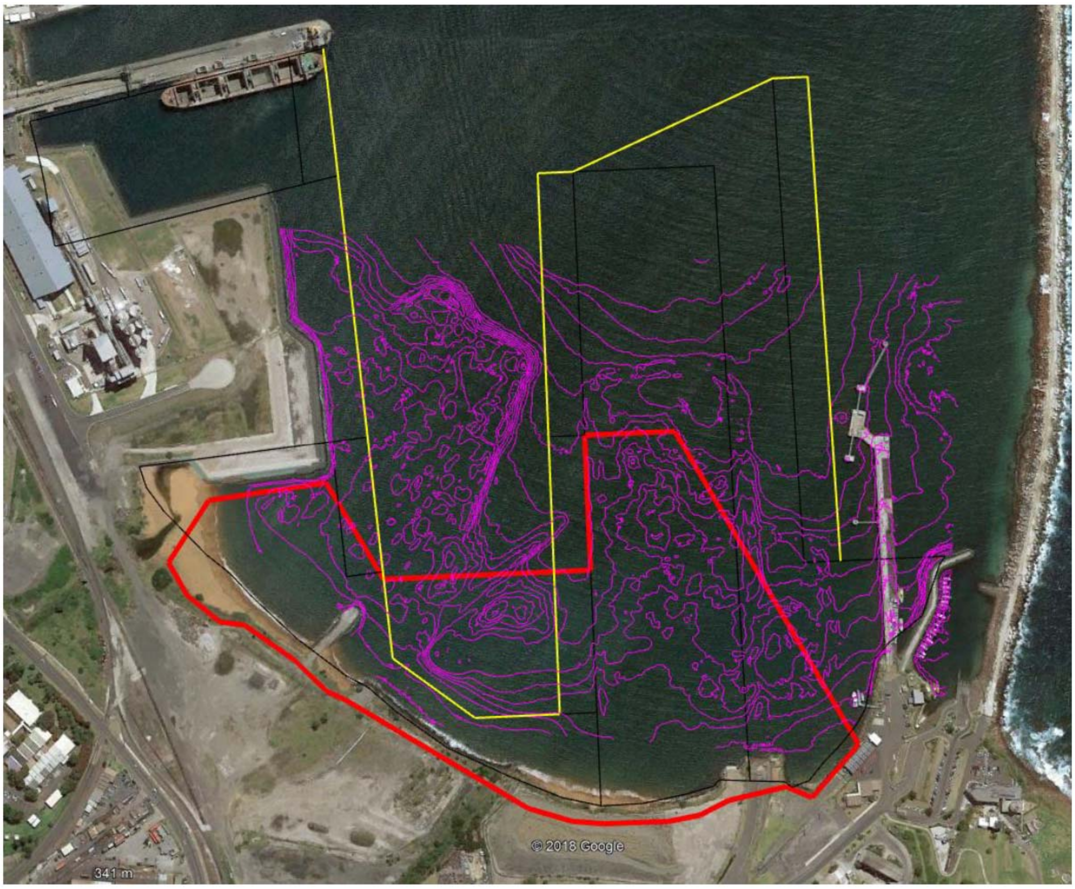


**Figure 12-11 Proposed Outer Harbour disposal footprint (Advisian, 2018)**

Given the departure from the previously approved footprint, additional numerical modelling investigations have been undertaken using the Mike21 BW software in order to characterise any potential changes to the previously assessed impacts. A copy of the numerical modelling report is provided in Appendix F and a summary of the key results and conclusions relating to potential impacts during operations is provided below.

Figure 12-12 demonstrates that the revised disposal footprint is expected to increase long wave heights at select locations within the Outer Harbour. The model predicts that long wave heights could increase by up to 13cm (wave disturbance coefficient of 0.37) at the southern end of the proposed Outer Harbour western berths. The model also predicts that long wave heights will increase in the vicinity of the existing Berth 201, adjacent to the Northern Breakwater by up to 5cm (wave disturbance coefficient of 0.15).

These predicted impacts will require consideration by NSW Ports during the design development of the berthing and mooring infrastructure associated with the proposed Outer Harbour Development. Consideration of the impact upon the existing mooring infrastructure and operations at Berth 201 will also be required by NSW Ports. No impacts to long waves are predicted within the Inner Harbour.

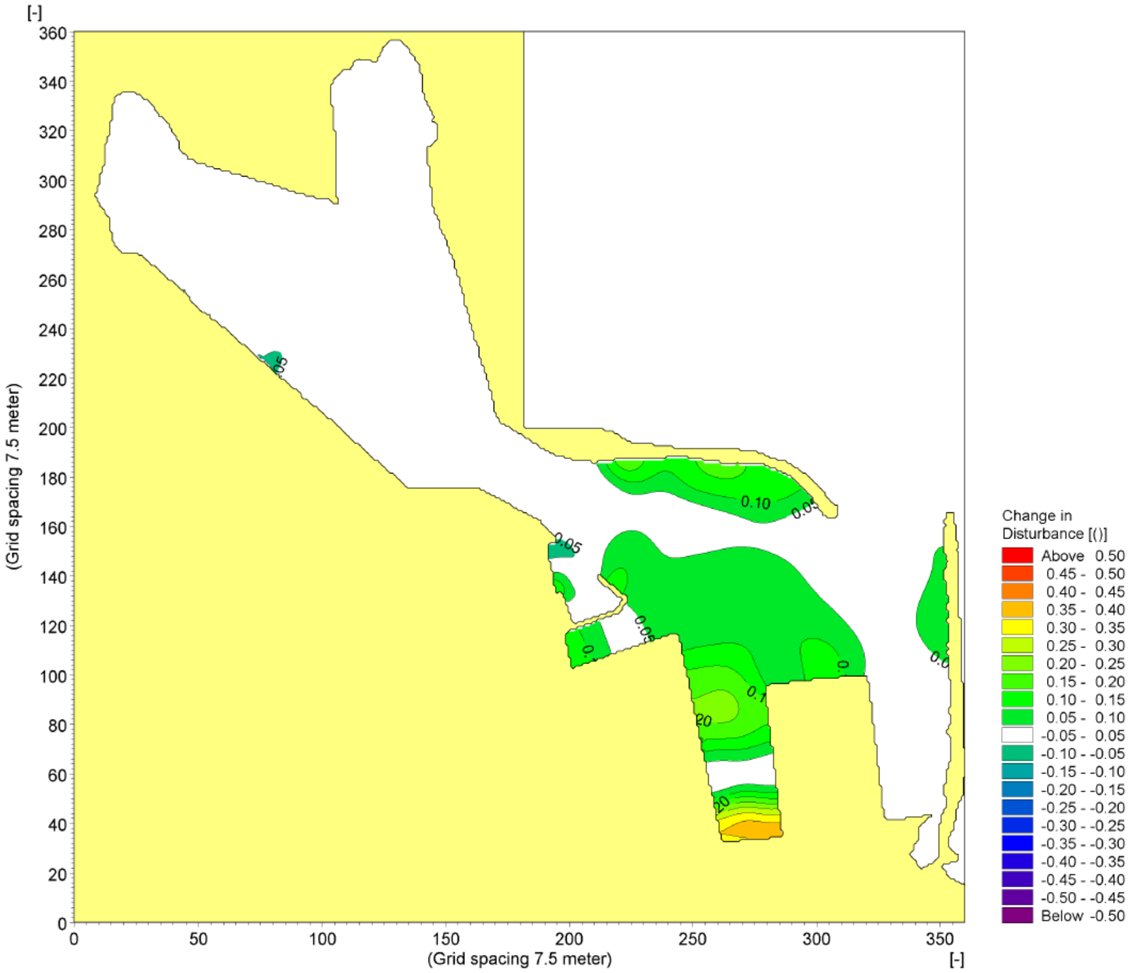


**Figure 12-12 Modelled change in long wave disturbance coefficients (Cardno, 2018)**

In addition to the assessment of long wave impacts, the hydrodynamic assessment report (Appendix F) describes the potential impacts to hydrodynamic processes associated with the proposed dredging and disposal activities. In particular, the report concludes that given the very small scale of the FSRU berth dredging, no substantial impacts are envisaged to the overall tidal flushing of the port.

The previous assessment of the proposed Outer Harbour Development concluded that the proposed reclamation was expected to reduce the tidal prism of the Outer Harbour which would generate improved flushing characteristics within the port as a whole. Given that the revised footprint further reduces the tidal prism of the Outer Harbour, the current project proposed is expected to offer further improvements to tidal flushing within the port.

### *Flooding hydrology assessment*

Potential impacts to hydrology are primarily associated with the alteration of local creeks and drains due to the reclamation of land within the Outer Harbour as assessed in the 2010 Environmental Assessment undertaken on behalf of PKPC (Aecom 2010).

The previously approved Outer Harbour Development proposed that Salty Creek and the Darcy Road Drain would be redirected and extended as required to convey current and future flood flows through the reclamation area. The 2010 EA identified that this approach was expected to change the current Salty Creek Estuary from an Intermittently Closed or Open Lake or Lagoon (ICOLL) to a system permanently open to the Outer Harbour. This was expected to provide benefits with respect to upstream flooding, tidal flushing and water quality however it was also noted that the stabilisation of salinity and water levels within the estuary could lead to potential impacts on aquatic flora and fauna, including impacts to fish passage between the estuary and the Outer Harbour. The assessment concluded that the proposed works were not likely to have significant impacts on the aquatic ecology of the Outer Harbour.

Previously proposed mitigations measures included the introduction of light to the Salty Creek drainage tunnel, however these are not relevant to the currently proposed reclamation activities since the extension of Salty Creek will remain open to natural light.

The gas pipeline will be installed below ground and will be installed by directional drilling beneath both Gurungaty Waterway and Allans Creek.  There will be no changes to flow paths or flood storage due to the installation of the pipeline and no alteration in the potential for flooding of the waterways during flood events.

### *Stormwater and spill management*

Given the relatively small onshore footprint and nature of the proposed operations, the risk of stormwater related issues during operations is relatively low. Nevertheless, foreshore industrial operations have the potential to release litter, sediment, fuel, oil, grease, wash water, debris, detergent, paint, etc. into the harbour.

Where possible, surfaces would remain unsealed and be landscaped to assist in control of stormwater related issues. Design would be undertaken in accordance with emergency spill plans and the objectives and development criteria outlined in the Port Kembla Development Code (NSW Ports 2016).

Operational management plans and emergency response plans would be prepared in order to ensure the facility is operated in an environmentally sensitive manner and in accordance with all relevant approvals, licences and industry guidelines.

## 12.4 Management measures

### Table 12-3 Management measures for water resources

| ID | Issue | Measure | Timing |
|---|---|---|---|
| W1 | Water quality and hydrodynamics | The location of the proposed terminal berth has been refined through navigation simulations to be located as close possible to the existing turning basin. This approach minimises hydrodynamic impacts and reduces dredging and disposal volumes as far as possible. | Design |
| W2 | Flooding | The proposed pipeline between the terminal and the existing east coast gas transmission network at Cringila has been designed such that the pipeline will be below existing ground levels. | Design |
| W3 | Hydrology | The western extent of the reclamation footprint has been limited to ensure Salty Creek remains open to the Outer Harbour without the need for enclosed culverts, thereby minimising the impacts to fish passage. | Design |
| W4 | Water quality and hydrodynamics | The footprint of the Outer Harbour placement area has been minimised by raising the proposed fill height to include emergent reclamation. This approach minimises the quantity of material to be bottom dumped and thereby reduces the potential for generation of turbid plumes and mobilisation of sediments. | Design |
| W5 | Water Quality | Preparation of a Construction Environmental Management Plan (CEMP) including specific dredge management plan to provide a framework for the environmental management of construction activities to minimise the environmental risks to a level that is as low as practically possible for this project. | Construction |
| W6 | Water Quality | Design and implementation of a Water Quality Monitoring Program to ensure construction works do not cause exceedance of the marine water quality criterion of background plus 50 mg/L of suspended sediment, in accordance with recent Environmental Protection Licences (EPL) for similar activities within Port Kembla such as the Berth 103 Stage 2 Dredging & Spoil Disposal EPL20563).<br>Continuous turbidity monitoring would be undertaken using a series of monitoring buoys to provide impact and background data (turbidity (NTU), pH, temperature). Prior to | Construction |

| ID | Issue | Measure | Timing |
|---|---|---|---|
| | | commencement of the dredging works, buoys would be deployed for an agreed period of time to confirm background conditions in the vicinity of the monitoring points. Data would be logged and transmitted to an onshore recording station where it would be processed to allow automated comparison of median turbidity levels to a series of green, amber and red trigger levels. When exceeded, an alarm would be triggered, automated email and SMS alerts sent and agreed the procedures implemented. Such procedures may include hand held monitoring to verify readings, reduction in the rate of dredging, relocation of dredging activities or cessation of turbidity generating works until turbidity readings reach acceptable levels.<br>Daily visual observations would be undertaken during dredging operations to monitor the potential release of oil or grease.<br>Collection of water samples and laboratory analysis for an agreed set of contaminants would be undertaken on a weekly basis during dredging operations.<br>The WQMP would include regular reporting, evaluation and revision where required to ensure the project objectives and approval conditions are achieved. | |
| W7 | Water Quality | Silt curtains would be installed prior to commencement of the works in order to minimise the spread of any sediments entrained within the water column during dredging and disposal operations.<br>Silt curtains are available in a range of designs and would be provided by the successful Contractor. It is envisaged that the silt curtain would comprise a geocomposite material consisting of a non-woven geotextile sewn to a woven geotextile, which would provide the required filtering capacity and rigidity respectively. Vessel access would be via gated or overlapped curtains or through installation of a bubble curtain. The top of the curtain would be supported by a floating boom, whilst the lower portion of the curtain would be weighted with appropriate ballasting (eg. bars or chains) to ensure that the full length if the curtain is maintained at all times. The curtain would be | Construction |

| ID | Issue | Measure | Timing |
|---|---|---|---|
| | | anchored or fixed to existing structures as necessary. | |
| W8 | Water Quality | Subaqueous sediment removal would be undertaken using a backhoe dredge. The use of mechanical dredging (rather than hydraulic dredging) ensures that sediments are removed, transported and placed as close to their insitu density as possible. Thereby minimising the suspension and mobilisation of sediments at the dredge and disposal sites. Method statements would be prepared by the contractor to ensure that loading of dredged materials into the hopper barges is undertaken in a manner that reduces spillage and avoids overfilling barges. | Construction |
| W9 | Water Quality | A perimeter bund would be constructed within the Outer Harbour placement area to ensure long term stability of dredged materials and to minimise sediment migration during placement. | Construction |
| W10 | Water Quality | A site specific erosion and sediment control plan (ESCP) will be prepared as part of the CEMP to provide control of all land based excavation and stockpiling requirements. All erosion and sediment control measures shall be designed, implemented and maintained in accordance with 'Managing Urban Stormwater: Soil and Construction Volume 1' (Landcom 2004) ('the Blue Book). | Construction |
| W11 | Water quality, chemical and fuel impacts on flora and fauna | A site specific emergency spill plan will be developed, and will include spill management measures in accordance relevant EPA guidelines. The plan will address measures to be implemented in the event of a spill, including initial response and containment, notification of emergency services and relevant authorities (including Roads and Maritime and EPA officers) | Construction |
| W12 | Water quality, chemical and fuel impacts on flora and fauna | An emergency spill kit will be kept on site at all times. All staff will be made aware of the location of the spill kit and trained in its use. | Construction |
| W13 | Water quality, chemical and fuel impacts on flora and fauna | Machinery will be checked daily to ensure there is no oil, fuel or other liquids leaking from the machinery. All staff will be appropriately trained through toolbox talks for the minimisation and management of accidental spills. | Construction |

| ID | Issue | Measure | Timing |
|---|---|---|---|
| W14 | Water Quality | Prior to re-releasing the seawater back into the surrounding area, the operators of the vessel will aim to match the profile of the discharged water, as close as possible, to the pre-discharge profile and well below agreed thresholds for residual concentrations of sodium hypochlorite. Changing the profile of the discharge water will be done by modifying the frequency of production and the concentration of sodium hypochlorite produced on-board from the intake of sea water. | Operations |
| W15 | Water Quality | A stormwater management system would be designed and constructed to control discharges from the import terminal site, including traps and filters where required.<br>Design would be undertaken in accordance with emergency spill plans and the objectives and development criteria outlined in the Port Kembla Development Code (NSW Ports 2016). | Operations |
| W16 | Water Quality | A site specific emergency spill plan will be developed, and will include spill management measures in accordance relevant EPA guidelines. The plan will address measures to be implemented in the event of a spill, including initial response and containment, notification of emergency services and relevant authorities (including Roads and Maritime and EPA officers).<br>An emergency spill kit will be kept on site at all times. All staff will be made aware of the location of the spill kit and trained in its use | Operations |

# 13. Marine ecology

## 13.1 Overview

This chapter describes marine ecology matters relevant to the construction and operation of the project. It summarises the more detailed Marine Ecology Impact Assessment (MEIA) in Appendix G.

The assessment has been prepared with reference to and in accordance with the Secretary's Environmental Assessment Requirements (SEARs).

The scope broadly includes:

- A description of the existing marine environment within the project study area and the likelihood of any threatened biota and their habitats occurring in the project area. This assessment included database searches, review of existing studies and review of other Environmental Impact Statements (EISs). Matters of National Environmental Significance (MNES) under the Environment Protection Biodiversity Conservation Act 1999 (EPBC Act), and threatened marine fauna species listed under the NSW Fisheries Management Act (FM Act), and the NSW Biodiversity Conservation Act 2016 (BC Act), known or predicted to occur within the project site were also described.
- A field validation exercise to confirm that marine ecology within the Inner Harbour (inclusive of Berth 101) and Outer Harbour is consistent with observations historically made within these areas. Use of both field and historical data to describe the extant conditions.
- Assessment of potential construction and operational impacts on marine ecology (directly and indirectly) from project activities.
- Provision of mitigation and management measures, to avoid and minimise impacts to the marine ecology values, where relevant.

Refer to Appendix G for detail on the assessment methodology and assumptions. The terrestrial biodiversity report is provided in Appendix H and Chapter 14 of this EIS, which assesses terrestrial biodiversity issues under the BC Act, the FM Act and EPBC Act. No referrals was required under the EPBC Act for biodiversity matters.

## 13.2 The project and marine environment

The project has potential to impact upon the marine environment during both construction and operation.

Construction activities have the potential to directly disturb biofouling and benthic communities through activities such as:

- Removal of the existing Berth 101 infrastructure (including removal of the piles and quay wall)
- Pile driving
- Dredging of the seabed
- Development of the perimeter bund
- Placement of the dredged material within the disposal area

- Placement / anchoring of construction vessels
- Construction activities will also have the potential to impact marine ecology as a result of:
- Deterioration of water quality through increased turbidity and mobilisation of contaminated sediments
- Noise generation through activities such as pile driving and rock armouring
- Artificial lighting from construction vessel and site lighting

Operational activities with the potential to impact upon the marine environment include:

- Impacts to water quality from discharges to the Inner Harbour including cold water and residual sodium hypochlorite
- The movement of LNG carriers between port environments
- Lights installed as part of the new berth and LNG carrier infrastructure

Refer to Section 13.4 for the assessment of construction and operational activities upon marine ecology at Port Kembla.

## 13.3 Existing environment

### 13.3.1 Marine habitat

A description of the existing marine habitat at Port Kembla, including biofouling community, benthic communities and fish habitats, is provided in the section below.

#### *Biofouling community*

Hard substrate habitat within Port Kembla consists of infrastructure such as breakwalls, piles and quay walls around the perimeter of the port. Such hard substrate presents ideal habitat for biofouling communities within the sheltered environment. Assemblages around the Inner Harbour have been described by previous studies as sparse with community structures reflective of the highly disturbed environment; species noted within these communities are polychaete worms, bryozoans, barnacles and ascidians (Worsley Parsons, 2012). Comparatively, a higher diversity and abundance of sessile invertebrates has previously been reported in the Outer Harbour (Worsley Parsons, 2012).

Surveys of the berth piles undertaken in 2012 identified the Sydney rock oyster (*Saccostrea glomerata*) dominating the intertidal zone while oyster limpets (*Patelloida mimula*) were common and sea squirts (*Cunjevoi pyura*) were occasionally present (Worley Parsons, 2012). The subtidal zone (down to 2 metre depth) consisted of a mixture of encrusting bryozoan (*Watersipora subtorquata*), polychaete tubeworms (predominantly *Hydroides elegans*), compound ascidians (*Botrylloides leachii*), solitary ascidians (*Styela plicata*) and blue mussels (*Mytilus galloprovincialis*) (Worley Parsons, 2012). Large hydroids, arborescent bryozoans (*Bugula flabellata* and *Bugula stolonifera*), small sponges and barnacles were also common in this zone. Beyond 2 metres depth, encrusting communities were smothered by silt inhibiting identification of taxa (Worley Parsons, 2012). Introduced species accounted for 50 % of the coverage of the hard substrate assemblages within Port Kembla (Johnston, 2006).

Biofouling communities identified during the 2018 field investigation were generally consistent with those recorded during the 2012 survey, refer to Figure 13-1. Oysters and gastropods dominated the intertidal zone with compound ascidians, tubeworms and bryozoans present in the subtidal zone. A differentiator with the previous survey was the presence of the brown algae

*Dictyota dichotoma* at the shallow sub-tidal zone. This difference is potentially a result of seasonal variation.


**Figure 13-1 Biofouling communities on Berth 101 piles**

### *Benthic communities*

The seabed within the Inner Harbour has previously been described as consisting of fine, unconsolidated silt expanses with large decapod burrows (Worley Parsons, 2012). This was also confirmed during the 2018 field investigation via the underwater video footage, refer to Figure 13-2.

Historically the seagrass species *Halophila ovalis* has been recorded within the Inner Harbour benthos (Pollard and Pethebridge, 2002; EcoLogical Australia, 2003). More recently this species has not been detected. Surveys in 2012 and 2018 confirm the persistent absence of any seagrasses from the Inner Harbour dredge footprint (Worley Parsons, 2012; current survey results). Furthermore, no seagrass was recorded in the Outer Harbour reclamation area during the conduct of the geochemical assessment in 2018. There are no known mapped seagrass communities adjacent to the project.

Macroalgae has been known to occur in sparse distributions across soft sediments habitats within both the Inner Harbour and Outer Harbour. The diversity and abundance has been considered to be higher in the Outer Harbour compared to the Inner Harbour, with 26 and 15 species recorded, respectively (Pollard and Pethebridge, 2002). The dominant forms of macroalgae were encrusting and turfing algae present across areas surveyed in the Outer Harbour at depths greater than 10 metres (AECOM, 2010). Although macroalgae have been previously observed in the Inner Harbour, 2018 investigations identified none are present within the proposed dredge footprint, other than those described along the berth piles (refer to biofouling community section above).


**Figure 13-2 Benthic communities within the proposed dredging footprint**

***Fish communities***

The different habitats within the Inner Harbour and Outer Harbour have been found to support varying diversities in fish assemblages and compositions. The higher diversity within the Outer Harbour as observed during the 1999, 2002 and 2009 surveys may have reflected the use of the area, including macroalgal habitat and breakwater, as nursery for juvenile species (AWT, 1999; AECOM, 2010). The eastern breakwater environments also provided niche habitat for species including mado (*Atypichthys strigatus*), yellowtail (*Trachurus novaezelandiae*) and moon-wrasse (*Thalassoma lunare*) (AECOM, 2010). Whereas other species such as the red morwong (*Cheilodactylus fuscus*) was the only species observed in deeper soft sediment habitat (AECOM, 2010). In contrast the highly utilised and developed Inner Harbour is not known to support as many species. Those that occur are typical of inshore habitats being glass perchlet (*Ambassis jacksoniensis*) and Japanese striped goby (*Tridentiger trigonocephalus*) AWT, 1999; Pollard & Pethebridge, 2002; UNSW, 2009). Fish assemblages identified as part of these studies are common across the region and did not include any threatened species.

### 13.3.2 Marine fauna

A search was undertaken to identify MNES under the EPBC Act 1999, and threatened marine fauna listed under the FM Act and the BC Act. Under the EPBC Act 1999, the MNES were identified using a point taken between the Inner and Outer Harbour (including a 5 kilometre buffer area) in the protected matters search tool (PMST). The following relevant matters were identified:

- No Wetlands of International Significance
- No Commonwealth Marine Areas
- 69 Listed Threatened Species (marine species excluding marine birds)
- 56 Listed Migratory Species (marine species excluding marine birds)
- 83 Listed Marine Species
- 12 Whales and other Cetaceans

- Habitat requirements and species distributions of the species identified from searches were reviewed in order to determine the likelihood of occurrence in the project area. A full list of the listed species and their likelihood of occurrence are provided in Appendix G. Those species which may occur and are likely to occur in the project area are provided in Table 13-1,Table 13-2, Table 13-3, and Table 13-4 below.

**Table 13-1 Potential for species listed under the EPBC Act 1999 to occur at the project site**

| Species | Scientific name | EPBC Act status | Likelihood of occurrence |
|---|---|---|---|
| **Listed threatened species** | | | |
| Black rockcod, Black cod, Saddled rockcod | *Epinephelus daemelii* | Vulnerable | **May occur** - Species likely to use habitat within Port as shelter. |
| Southern right whale | *Eubalaena australis* | Endangered, Migratory<br>Listed marine species<br>Whales and Cetaceans | **Likely to occur** - Records of sightings within Outer Harbour. |
| Humpback whale | *Megaptera novaeangliae* | Vulnerable, Migratory<br>Listed marine species<br>Whales and Cetaceans | **Likely to occur** - Records of sightings within Outer Harbour. |
| Grey nurse shark (east coast population) | *Charcharias taurus* | Critically Endangered | **May occur** - Individuals may transit the area during migrations between aggregation areas. |
| **Listed marine species (not previously listed)** | | | |
| Long-nosed fur seal, New Zealand fur seal | *Arctocephalus forsteri* | Listed marine species | **Likely to occur** - Potential haul-out site at Five Islands. |
| Australian fur seal, Australo-african fur-seal | *Arctocephalus pusillus* | Listed marine species | **Likely to occur** - Known haul-out site at Five Islands. |
| Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphi | *Tursiops aduncus* | Listed marine species<br>Whales and Cetaceans | **Likely to occur** - Species known throughout NSW and habitat occurs in Port area. |
| Bottlenose dolphin | *Tursiops truncates s. str.* | Listed marine species<br>Whales and Cetaceans | **Likely to occur** - Species known throughout NSW and habitat occurs in Port area. |

| Species | Scientific name | EPBC Act status | Likelihood of occurrence |
|---|---|---|---|
| Syngnathids<br>21 species<br>(i.e. seahorses, seadragons, pipefish and pipehorses) | | Listed marine species | **May occur** - Habitat may be suitable for species. |
| **Listed bird species** | | | |
| Bar-tailed godwit (bauera), western Alaskan bar-tailed godwit | Limosa lapponica baueri | Vulnerable | **May occur** - The project area is highly modified and is not considered to support foraging and roosting for this species. This species may fly over the region during annual migrations. |
| Curlew sandpiper | Calidris ferruginea | Critically Endangered, Migratory | **May occur** - The project area is highly modified and is not considered to support foraging and roosting for this species.<br>This species may overfly the region during annual migrations. |
| Eastern curlew, far eastern curlew | Numenius madagascariensis | Critically Endangered, Migratory | **May occur** - The project area is highly modified and is not considered to support foraging and roosting for this species.<br>This species may overfly the region during annual migrations. |
| Gould's petrel, Australian Gould's petrel | Pterodroma leucoptera leucoptera | Endangered | **May occur** - No critical habitat for this species known to occur within the project area. This species may fly over or forage in the surrounding area. |
| Northern giant-petrel | Macronectes halli | Vulnerable, Migratory | **May occur** - The project area is highly modified and is not considered to support foraging and roosting for this species.<br>This species may overfly the region during annual migrations. |

| Species | Scientific name | EPBC Act status | Likelihood of occurrence |
|---|---|---|---|
| Orange-bellied parrot | Neophema chrysogaster | Critically Endangered | **May occur** - This species may overfly the region during annual migrations. |
| Red knot, knot | Calidris canutus | Endangered, Migratory | **May occur** - The project area is highly modified and is not considered to support foraging and roosting for this species.<br>This species may overfly the region during annual migrations. |
| Southern giant-petrel | Macronectes giganteus | Endangered, Migratory | **May occur** - The project area is highly modified and is not considered to support foraging and roosting for this species.<br>This species may overfly the region during annual migrations. |
| Swift parrot | Lathamus discolor | Critically Endangered | **May occur** - This species may fly over the area during migration. |
| Wandering albatross | Diomedea exulans | Vulnerable, Migratory | **May occur** - This species may fly over the area during migration. |

**Table 13-2 Potential for migratory bird species listed under the EPBC Act 1999 to occur at the project site**

| Name | Scientific name | Description | Likelihood of occurrence |
|---|---|---|---|
| Bar-tailed godwit | *Limosa lapponica* | A wading bird that occurs in coastal habitats and brackish wetlands. Forages in sheltered intertidal areas, including beaches. Roosts on sandy beaches, sandbars and spits (Marchant and Higgins, 1990). | **May occur** - Core habitat for this species not known within the project area. This species may overfly the region during annual migrations. |
| Fork-tailed swift | *Apus pacificus* | Non-breeding visitor to all states and territories of Australia (Higgins, 1999) and is almost exclusively aerial and mainly occur over foothills an in coastal areas in Australia. Widespread across most areas of Australia, they have been recorded in NSW (DoEE, 2018). | **May occur** - Core habitat for this species not known within the project area. This species may overfly the region during annual migrations. |

| Name | Scientific name | Description | Likelihood of occurrence |
| --- | --- | --- | --- |
| Little tern | *Sternula albifrons* | A small, slight tern with gregarious behaviour. Australian population consists of several sub-populations, with the eastern population's distribution covering the east coast of Australia. This species generally occurs along sandy coastlines and mangrove mudflats (DoEE, 2018). | **May occur** - Core habitat for this species not known within the project area. This species may overfly the region during annual migrations. |
| Wedge-tailed Shearwater | *Ardenna pacifica* | A marine, pelagic shearwater. This species breeds on the east and west coasts of Australia and on off-shore islands. The species is common in the Indian Ocean, the Coral Sea and the Tasman Sea (Lindsey 1986). In tropical zones the species may feed over cool nutrient-rich waters. The species has been recorded in offshore waters of eastern Victoria and southern NSW, mostly over continental slope. | **May occur** - Core habitat for this species not known within the project area. This species may overfly the region during annual migrations. |

**Table 13-3 Potential for species listed under the FM Act 1994 to occur at the project site**

| Species | Scientific name | FM Act status | Likelihood of occurrence |
| --- | --- | --- | --- |
| Grey nurse shark | *Carcharias taurus* | Critically Endangered | **May occur -** Species may transit the area during migrations. |
| Black rockcod | *Epinephelus daemelii* | Vulnerable | **May occur -** Species may use habitat within Port as shelter. |

**Table 13-4 Potential for species listed under the BC Act 2016 to occur at the project site**

| Species | Scientific name | BC Act status | Likelihood of occurrence |
| --- | --- | --- | --- |
| Southern right whale | *Eubalaena australis* | Endangered | **Likely to occur -** Records of sightings for the Outer Harbour. |
| Long-nosed fur seal, New Zealand fur seal | *Arctocephalus forsteri* | Vulnerable | **Likely to occur -** Known haul-out site near Port Kembla. |
| Australian fur seal, Australo-african fur-seal | *Arctocephalus pusillus* | Vulnerable | **Likely to occur -** Known haul-out site near Port Kembla. |

### 13.3.3 Introduced marine species

A comprehensive survey of pest species in Port Kembla was conducted in May 2000. This identified 35 introduced species and 14 cryptogenic species (Pollard & Pethebridge, 2002), including:

- Two dinoflagellates (*Alexandrium sp*. (catenella type) and *Alexandrium ostenfeldii / peruvianum)*
- One hydrozoan (*Halecium delicatulum*)
- Four species of polychaetes (*Boccardia chilensis, Boccardia proboscidea, Hydroides dirampha, and Hydroidesezoensis*)
- Eight species of crustaceans (*Megabalanus rosa, Cirolana harfordi, Paracerceis sculpta, Sphaeroma walkeri, Corophium acutum, Paradexamine pacifica, Liljeborgia c.f. dellavallei* and *Elasmopus rapax*)
- 15 species of broyzoa (A*mathia sp., Bowerbankia sp., Bugula dentata, Bugula flabellata, Bugula neritina, Bugula stolonifera, Cryptosula pallasiana, Schizoporella errata, Schizoporella sp. A, Schizoporella sp. B, Schizoporella sp. C, Schizoporella unicornis, Tricellaria occidentalis, Watersipora arcuata* and *Watersipora subtorquata*)
- Three species of ascidian (*Botryllus schlosseri, Ciona intestinalis* and *Styela plicata).*
- A number of smaller surveys conducted in 1991, 2000 and 2006 also identified additional introduced species (Pollard & Pethebridge, 2002; Johnston, 2006), including:
- Two fish species (*Acanthogobius flavimanus* and *Tridentiger trigonocephalus)*
- Three invertebrate species (the bivalve *Theora lubrica*, and the colonial ascidians *Botrylloides leachii* and *Perophora japonica)*
- Seven additional unidentified cryptogenic species

As evidenced by the extensive list of species recorded during previous surveys, introduced marine species accounted for 50 % of the coverage of the hard substrate assemblages within Port Kembla with more pest species and higher abundances of pest species present in the Outer Harbour compared to the Inner Harbour (Johnston, 2006).

Of the species recorded within Port Kembla, *Alexandrium spp*. dinoflagellates are listed as High National Priority Pests while the ascidians *Ciona intestinalis* and *Styela clava* and bryozoan *Schizoporella errata* are classified as Medium National Priority Pests (Hayes *et al.*, 2005).

Some toxic dinoflagellate species such as *Alexandrium spp.* can form dormant sedentary cysts that accumulate in bottom sediments. Under favourable conditions, these cysts can germinate, triggering blooms which deplete dissolved oxygen and produce toxins, causing environmental damage including fish kills. The toxins produced by *Alexandrium catenella* are known to bioaccumulate in fish, molluscs, crustaceans, polychaetes and some echinoderms with consumers of contaminated organisms suffering from paralytic shellfish poisoning; there is also evidence of direct toxicity to fish (NIMPIS, 2018).

Whilst the toxic dinoflagellate species *Alexandrium catenella* were recorded during surveys conducted in 2002 and 2009 within the port (Pollard & Pethebridge, 2002; AECOM, 2010), none were found during the later 2011 survey (Worley Parsons, 2012).  In addition, no toxic dinoflagellate blooms have been recorded within Port Kembla. However the risk of blooms remain given the historical records of toxic dinoflagellate species at the port.

### 13.3.4 Water quality

Land use in the immediate vicinity of Port Kembla contributes to the ambient marine water quality within the port. The creeks and waterways that drain industrial, coal and iron ore stockpile areas (Figure 13-3) include:

- Allans Creek, Gurungaty Waterway and No. 1 Products Berth within the Inner Harbour
- The Cut passage which connects the Inner and Outer Harbours
- Darcy Road Drain within the Outer Harbour
- In addition, the ambient marine water quality within Port Kembla is also subject to tidal influences from the Port Kembla entrance (Figure 13-3).


Paper Size ISO A4

0 250 500 750 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Australian Industrial Energy
Port Kembla Gas Terminal

**Marine ecological habitat surrounding the project site**

Project No. 21-27477
Revision No. -
Date 31/10/2018

**FIGURE 13-3**

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Print date: 31 Oct 2018 - 16:16

Data source: . Created by: afoddy

Historically water quality within the Inner and Outer Harbours has been impacted by urban and industrial discharges as well as port activities as described in Chapter 12. Water quality monitoring within Port Kembla has indicated concentrations of metals (aluminium, cadmium, copper, lead, zinc, tin and arsenic) exceeded the ANZECC (2000) 95 % trigger values for protection of marine waters. These exceedances were generally highest in the vicinity of the creeks and waterways draining into the harbour from surrounding industrial catchments. Average total suspended solids were found to be higher within the Inner Harbour (5.9 milligram per litre) than the Outer Harbour (3.2 milligram per litre). pH levels were generally lower in the Inner Harbour than the Outer Harbour, indicating freshwater discharge influences from the existing waterways within the Inner Harbour.

Water temperatures within Port Kembla are generally higher than those measured offshore due to slower tidal flushing patterns and existing industrial thermal discharges (hot water discharge within Allans Creek) to the Inner Harbour. As a result, water temperatures within the Inner Harbour are generally one to two degrees warmer than temperatures beyond the entrance to the port. The Outer Harbour benefits from greater tidal flushing and is generally less than 0.25 degrees warmer than water temperatures beyond the entrance to the port (AECOM, 2010).

Additional information is provided in Chapter 12 Water Resources, of this EIS.

### 13.3.5 Sediment quality

Marine sediments within Port Kembla are generally characterised as soft silty clays dominating the surface sediments with an underlying layer of stiff clay. Metals (arsenic, cadmium, chromium, copper, manganese, mercury, lead, vanadium and zinc), Polycyclic Aromatic hydrocarbons (PAH), dioxins and Tributyltin (TBT) have been recorded within these sediments across the Inner Harbour exceeding the screening levels for ocean and land disposal (National Assessment Guideline for Disposal – NAGD, and National Environment Protection Measures – NEPM) (WorleyParsons, 2012; Geochemical Assessments, 2013). Further, bioavailability investigations also found concentrations of cadmium, copper, lead and zinc exceeded NAGD screening level in many samples (Geochemical Assessments, 2013).

Recent investigations undertaken as part of the EIS have indicated the presence of contaminated sediments within the proposed dredging and disposal areas and were generally consistent with previous investigations. Concentrations of contaminants of concern were largely consistent across the dredging and disposal areas, with the primary contaminants of concern including heavy metals, PAH, dioxins and TBT at concentrations above the nominated screening levels as outlined in Chapter 11 and Appendix E3.

## 13.4 Potential impacts

### 13.4.1 Overview

Planned project activities outlined in Section 13.2 have the potential to cause the following impacts:

- Disturbance of the biofouling and benthic communities
- Deterioration of water quality
- Noise pollution
- Artificial light emissions

Unplanned events from project activities have the potential to impact the marine environment, these include:

- Pest introduction and proliferation
- Marine fauna collisions
- Accidental release of solid waste
- Accidental release of hydrocarbon, chemicals and other liquid waste
- Damaged fuel tank associated with vessel collision

The impact assessment from planned and unplanned activities during construction and operation are provided below. Management measures recommended to reduce/ eliminate the impacts are provided in Section 13.5.

### 13.4.2 Biofouling and benthic community disturbance

Potential impacts upon biofouling and benthic communities are primarily associated with direct removal of habitat during construction and potential impacts to water quality during both construction and operation as discussed in Section 13.4.3.

Removal of the existing infrastructure, including extraction of the piles, will lead to the removal of the biofouling communities associated with the berth infrastructure. This will also lead to temporary loss of biodiversity from the project site, and the likely avoidance of/displacement from the area by associated mobile fauna. Slow moving or semi-sedentary mobile fauna may suffer mortality if located on the piles at the time of removal. This may include small, slow moving fishes such as Syngnathids.

Removal of the biofouling communities will not permanently affect the biodiversity of the project footprint. Recolonisation of the new piles is expected to commence immediately following installation, followed by a long-term natural recruitment succession process. It is expected that a mature level biofouling community, comparable to that currently present will be achieved within a few years (Hamer and Mills, 2015). The assemblages that occur on that infrastructure supports species which are more likely to be non-native and represented on other subtidal hard substrates within the Inner and Outer Harbour areas.

Piling activities have potential to generate turbid plumes, however these effects are expected to be localised to the immediate project area and wider impacts are unlikely to extend beyond the Outer Harbour. The area of disturbance due to pile driving activity is expected to be small and any sediment generated during works is predicted to have little impact.

Dredging activities have the potential to impact directly on biofouling and benthic communities through direct removal of the substrate from the environment, and indirectly through generation of turbid plumes that will lead to suspension of sediment, affecting filter feeding organisms (UNEP, 2013). The dredged areas within Berth 101 will eventually be covered with fine layers of silt from the vessel propeller wash, and will be colonised with similar benthic communities from surrounding areas within the Inner Harbour.

Development of the perimeter bund and disposal of the dredged sediment will directly impact on existing benthic communities within the Outer Harbour disposal area through smothering and burial of epibenthic fauna. These Outer Harbour benthic communities have been previously subject to six dredged material disposal campaigns. The construction of the perimeter bund and subsequent dredged sediment disposal is expected to permanently remove a maximum 16.5 hectares of benthic habitat and associated benthic communities from the Outer Harbour area. This however will be offset by the creation of the reclamation area infrastructure providing new surface for colonisation by biofouling communities.

The impacts to benthic infauna associated with the Inner Harbour are not expected to be permanent. Migration and recolonisation into the disturbed footprint from adjacent soft sediment environments will begin immediately following construction and occur over subsequent weeks and months.

### 13.4.3 Water quality

Activities potentially leading to a deterioration in water quality and associated impacts upon marine ecology are primarily associated with dredging and placement activities during construction and the discharge of cold seawater containing residual sodium hypochlorite used as heating in the regasification process during operation of the FSRU.

#### *Turbidity*

Numerical modelling undertaken has defined the potential impacts associated with sediment plume dispersion (Chapter 12 and Appendix F). The removal and placement of the sediment from Berth 101 area was identified as the activity with the greatest potential to impact upon turbidity levels. Model scenarios were developed to assess the impacts to total suspended solids (TSS) and sediment deposition associated with the dredging and disposal of sediments within the Inner and Outer Harbours..

Modelling predicts that the extent of the dredge plume will be confined to Port Kembla with significant total suspended solids (TSS) concentrations confined to the vicinity of the dredging and disposal areas.

Turbidity has the potential to impact fish feeding ability, with piscivorous fish being affected to a greater extent than planktivorous fish due to the requirement of visually identifying prey over greater distances (de Robertis *et al.* 2003). In extreme cases, high levels of suspended sediments can also cause gill damage in fish (Au *et al*. 2004; Wong *et al*. 2013).

The increase in turbidity and TSS may also affect the feeding and respiratory organs of filter-feeding organisms (Airoldi 2003; Maldonado *et al.* 2008). However, it is likely that such organisms are already established within a marine environment prone to large spikes in turbidity following rainfall events and historically exposed to numerous dredging and disposal campaigns within Port Kembla, these species will be resilient to any short-term increases in suspended solids resulting from dredging and disposal activities.

#### *Mobilisation of contaminants*

Sediment sampling and analysis conducted for the EIS has confirmed the presence of contaminated sediments within the proposed dredging and disposal areas. Handling of Berth 101 sediment through dredging and disposal has the potential to cause mobilisation of some of these identified contaminants into the water column.

Release of pollutants such as heavy metals, metalloids, TBT and PAHs into the water column can result in toxic effects on sessile invertebrates.  Resuspension of contaminated sediment has also been identified as a driver for the establishment of tolerant invasive species as well as in reducing recruitment of dominant species such as barnacles and polychaetes (Piola & Johnston 2007; Knott *et al.* 2009).

Fish of Port Kembla have also historically been found to have elevated metal and PCB concentrations in their tissues (He & Morrison, 2001). Whilst there is generally no recreational /

commercial fishing or aquaculture within Port Kembla, some recreational fishing occurs within the Outer Harbour (Worley Parsons, 2012). Hedge & Knott (2009) found that metal concentrations were lower in the oyster tissues located in the Outer Harbour; however the risk to human health from contaminant exposure through ingesting fish from the Outer Harbour still remains as fish move freely between the Inner and Outer Harbours.

High-level contaminant exposure has been linked to various toxic effects including immune system depression, disease breakouts, reproductive effects and endocrine disruption in marine mammals (Vos *et al.* 2003).

The release of contaminants is likely to be localised within the Port Kembla environment and medium-term in nature as described in detail in Chapter 12.  Suspended sediments will be confined within silt curtains at the berth while dredge material will be confined within the perimeter bund at the Outer Harbour to minimise the migration of sediment and contaminants during disposal. The duration of exposure to toxicants are considered to be short in duration while long-term toxic effects are considered unlikely.

### *Dinoflagellate cyst*

The toxic dinoflagellate species *Alexandrium catenella* has been previously recorded in 2002 and 2009, however no toxic dinoflagellate blooms have been historically observed within Port Kembla or associated with historical dredging campaigns. Dredging of sediments with potential dinoflagellate cyst may cause the cysts to germinate triggering blooms when conditions are favourable. Blooms of the toxic dinoflagellate may deplete dissolved oxygen and produce toxins, causing environmental damage including fish kills.

The risk of blooms is considered to remain given the historical records of toxic dinoflagellate species at Port Kembla, however the likelihood of a bloom occurring is considered to be low.

### Thermal water

Numerical modelling has been undertaken for this EIS to assess the behaviour and extent of the thermal discharge plume in light of the existing intakes and outlets operated by BlueScope Steel which currently discharge warm water into the Inner Harbour.

Modelling indicates that the release of cold water from the project will only have minor impacts on seawater temperatures, expected to be confined to within the limits of Port Kembla. Modelling also shows that the existing warm water discharges from BlueScope Steel have a significant influence on water temperatures within the Inner Harbour; these will be reduced by the proposed release of cold water within the Inner Harbour.

Differential plots of predicted seawater temperatures produced show that predicted reductions in temperature are greatest during winter when BlueScope warm water discharges are reduced. The model predicts that initial near field mixing will reduce the 5$^{th}$ percentile temperature differential to one degree at each end of the proposed berth. On average, temperatures within the port are generally expected to decrease by 0.1 to 0.2 degrees, which is unlikely to impact upon marine ecology. .

The FSRU will operate with an automated marine growth protection system (MGPS).The MGPS takes seawater from the surrounding area, uses its natural salts to produce a solution of sodium hypochlorite, which acts as a natural biocide that is used on-board to ensure all the systems remain free of marine growths. Sodium hypochlorite degrades naturally and so most of the created solution will be used within the vessel well before the water is ready for re-release.

However, some excess sodium hypochlorite is expected to remain prior to discharge and dilution within the Inner Harbour.

Prior to re-releasing the seawater back into the surrounding area, the operators of the vessel will aim to match the profile of the discharged water, as close as possible, to the pre-discharge profile and will ensure that free chlorine (total residual oxidant in estuarine/marine water) concentrations remain below 0.2 ppm.  The discharge plume is predicted to have diluted by a factor of four by the time the plume reaches the floor of the Inner Harbour and a dilution factor of 30 at a distance of 400m from the discharge point. Residual chlorine is expected to be primarily restricted to the Inner Harbour environment and is not expected to extend beyond the Outer Harbour.

It is expected that the marine communities in close proximity to the discharge point will be adversely affected by the decrease in temperature/presence of residual chlorine. This is likely to include the biofouling communities at adjacent pylons, the benthic community immediately under and adjacent to the FSRU and benthic/pelagic fish passing through the plume area. Potential impacts to these communities will vary depending on species, life history and stage, and season. Decreases in temperature and the presence of residual chlorine could lead to the avoidance of the area by mobile species, and the inhibition of growth, spawning or larval settlement of sessile organisms.

#### ***Artificial noise emissions***

Piling and dredging activities associated with Berth 101 redevelopment will generate underwater noise. Noise has the potential to displace fauna from the area, resulting in a temporary reduced diversity. Construction noise also has potential to cause a temporary or permanent threshold shift (TTS or PTS) in the hearing ability of sensitive fauna that use acoustic means of navigation or communication.

The South Australian Department of Planning, Transport and Infrastructure (DPTI) *Underwater Piling Noise Guidelines* (2012) provides relevant behavioural and physiological noise criteria for some species of megafauna as shown in Table 13-5.

**Table 13-5 Behavioural and physiological noise criteria for some megafauna**

| Species | Impact | Noise exposure criteria for impact piling |
|---|---|---|
| Cetaceans and pinnipeds | Behavioural | SPL 160 dB re: 1µPa |
| Low frequency cetaceans (All baleen whales, including southern right whale and humpback whale ) | Physiological (TTS) | Peak 224 dB re: 1µPa<br>SEL 183 dB (Mlf) re: 1µPa2-s |
| | Physiological (PTS) | Peak 230 dB re: 1µPa<br>SEL 198 dB (Mmf) re: 1µPa2-s |
| Mid frequency cetaceans (Majority of toothed whales including dolphins and killer whale) | Physiological (TTS) | Peak 224 dB re: 1µPa<br>SEL 183 dB (Mmf) re: 1µPa2-s |
| | Physiological (PTS) | Peak 230 dB re: 1µPa<br>SEL 198 dB (Mmf) re: 1µPa2-s |
| High frequency cetaceans (Other toothed whales) | Physiological (TTS) | Peak 224 dB re: 1µPa<br>SEL 183 dB (Mhf) re: 1µPa2-s |
| | Physiological (PTS) | Peak 230 dB re: 1µPa<br>SEL 198 dB (Mhf) re: 1µPa2-s |
| Pinnipeds (seals and sea lions including Australian fur seal) | Physiological (TTS) | Peak 212 dB re: 1µPa<br>SEL 171 dB (Mpw) re: 1µPa2-s |
| | Physiological (PTS) | Peak 218 dB re: 1µPa<br>SEL 186 dB (Mpw) re: 1µPa2-s |

Based on the noise exposure criteria presented above, dredging operations are likely to cause a temporary behavioral shift as marine fauna avoid the area immediately in the vicinity of dredging. Dredging activities also have the potential to result in temporary threshold shifts (TTS) for cetaceans (e.g. Dolphins, Southern right whale) and pinnipeds (e.g. Australian fur seal and Long-nosed fur seal) if these mammals are present during dredging activities.

Observed responses from cetaceans to artificially generated sound include changes in swimming direction, increases in swimming speed and marked ‘shocked’ reactions. Animals are expected to avoid areas where noise is being generated and return to the area following the cessation of construction works. Any displacement is expected to be temporary and will support mitigation of risk of impact upon the animals.

While animals are expected to move out of the zone of impact/influence of any noise generated during construction, pile driving works and rock placement are expected to generate noise thresholds that give potential to cause a temporary or permanent hearing shift in animals such as dolphins and seals. Appropriate management is required to minimise risk during key noise generating activities such as piling and rock placement.

Rays, skates and sharks utilise low frequency sound to detect prey and may exhibit avoidance of the source of acoustic disturbance. Review of the habitat and distribution of the grey nurse shark and white shark identified that the species are unlikely to occur in the project area, although may transit the wider region during movements between aggregation sites. It is therefore considered that the species are unlikely to be impacted by noise and frequencies generated during the project works.

The ability of fish to withstand underwater noise and their sensitivity to it varies widely across species. Impacts to fish from construction noise will be limited to behavioural response such as avoidance of the area and such actions would be temporary in nature and localised.

A variety of migratory and local shorebirds may occur in the region, with bird numbers and species being highly dependent upon the time of year. Pile driving and other construction activities may cause a local reduction in shorebird use of the project area during construction.

#### *Artificial light emissions*

Artificial lighting has the potential to affect fauna by altering use of visual cues for orientation, navigation or other purposes, resulting in behavioural responses, which can alter foraging and breeding activity in marine turtles, cephalopods, birds, fish, dolphins, and other pelagic species. Continuous lighting in the same location for an extended period may result in disturbance to marine fauna including:

- Fish and other pelagic species (e.g. zooplankton, squid, and larval fish) may be attracted to lights either directly or indirectly. This can in turn, alter predatory fish behaviour.
- Turtles can be attracted to lights (note turtles are unlikely to be present within the project area due to a lack of foraging and nesting habitat).

Berth 101 and surrounding areas within the Inner Harbour are currently lit at night, therefore it is assumed that marine fauna species using the project area will be habituated to extant light conditions. The project will contribute to but not elevate or increase the existing landscape lighting profile. As such, construction based lighting is not predicted to result in any change in migratory behaviours of birds that use the area and are already habituated to current light conditions.

#### *Pest introduction and proliferation*

Proposed activities may support spread, dispersal or expansion of existing marine pest populations within the project area. LNG carriers carrying invasive marine pests may unintentionally introduce new species to the region where the activity is occurring or carry pests from the region to other areas.

Marine pests may be carried within the external biological fouling on the LNG carrier hull, within seawater pipes (e.g. cooling water) and associated infrastructure or on submersible marine instruments and equipment. Ballast water exchange may also allow for the transportation and proliferation of marine pests within the area of activity.

Before vessels can proceed to the project site, quarantine obligations will have to be fulfilled by all vessels. For vessels sourced from high risk or international destinations, ballast water exchange record requirements will need to be complied with, including possession of relevant state and national documentation such as the Australian Quarantine and Inspection Service (AQIS) clearance documentation in order to verify compliance with ballast water and biofouling management measures.

#### *Marine fauna collision/interaction*

Interaction with marine fauna can potentially occur during the dredging and disposal activities or LNG carrier movements. There is potential for interactions with marine fauna during rock armour placement on the perimeter bund. The consequences of such collisions between marine fauna and vessels or construction materials for the marine organisms range from changes to fauna behavioural patterns to injury or death of the organism due to a direct collision.

The risk of potential vessel strike is considered low for all marine species likely to occur in the project area, including cetaceans, sharks and fish. This risk accounts for works being concentrated within a small area of the Inner and Outer Harbour limited by the port boundaries, and being undertaken at relatively low vessel speeds.

The risk of interaction between marine fauna and construction materials during rock armouring of the bund wall is low, as fauna would need to be directly in the path of the rock placement activities.

### *Accidental release of solid wastes*

A variety of hazardous and non-hazardous solid waste may be potentially released unintentionally into the environment from overfull and / or uncovered bins or if blown off the deck of a vessel. Accidental spillage during transfers of waste from vessel to shore, and incorrectly disposed items may also cause the unintentional release of solid waste into the surrounding environment.

Non-hazardous solid waste includes plastics, packaging and paper materials and products while examples of hazardous solid wastes include oily and contaminated wastes, aerosol products, fluorescent tubes, batteries and medical waste.

There is capacity for non-hazardous solid waste such as plastic bags to affect the environment and cause entanglement or ingestion by fauna. The ingestion of solid wastes like plastic bags can consequently result in internal tissue damage, prevention of normal feeding behaviours and potentially death of the affected fauna.

The pollution of the immediate environment with the release of hazardous solid waste has the likely consequence of negatively affecting the health of marine ecology within the area. Particularly fish and cetaceans are susceptible to chemical impacts, including disease or physical injury after ingesting or absorbing the waste.

### *Accidental release of hydrocarbons, chemicals and other liquid waste*

Vessels require a wide variety of liquids, chemicals and hydrocarbon compounds to operate and to be maintained. Vessel engines and equipment such as cranes, pile drivers and heavy machinery operate on diesel fuel while hydraulic and lubricating oils are required for the operation and continual maintenance of mechanical components. Fuel drums may also be retained in dedicated storage areas while some vessel engines adopt independent storage tanks. Examples of hazardous liquids include corrosion inhibitors, biocide and miscellaneous chemicals like cleaning agents and lubricating oils.

In addition, other liquid wastes such as sewage and food waste will be generated during construction. There are various scenarios that may result in accidental release of liquid waste, including tank failure, pipework failure or inadequate bunding.

If refuelling is required during the proposed activity, then refuelling events have the potential to cause environmental impacts through reduction in water quality and / or contamination of marine ecology. Spills during refuelling can occur through several pathways, including fuel hose breaks, coupling failure or tank overfilling.

There are no releases planned during the construction of the project. Rather, all liquid waste will be stored for discharge to an appropriate onshore facility. There is potential that a leak or spill of hydrocarbons or other liquids (including environmentally hazardous wastes and non-hazardous substances) may occur at the site. Such an occurrence would result in the localised reductions in water quality and contamination of nearby marine receiving environment.

### *Damaged fuel tank associated with vessel or plant collision*

There is potential for vessels or plant to collide. The rupture of a vessel's fuel tank is the predominant risk. The significance of the risk is attributed to the release of diesel into the environment from the damaged fuel tank. In the event of a tank rupture from vessel collision, a standard tank is expected to empty into the environment within hours.

An oil spill within Port Kembla due to vessel / plant collision and rupturing of a fuel tank may result in confined impacts upon a wide variety of organisms inhabiting the port environment depending upon the nature and extent of the oil spill. An oil spill occurred outside Port Kembla, impacts could extend to sensitive receptors such as rocky habitat (Red Point headland, Tom Thumb Islands and Five Islands Nature Reserve) and sandy beaches (Wollongong City Beach, Fisherman's Beach or North Beach) around Port Kembla, refer to Figure 13-3.

## 13.5 Management measures

Table 18-12 provides a summary of the management measures to address the marine ecology impacts of the project. All management measures would be collated in management plans prepared for construction and operation of the project.

**Table 13-6 Management measures for marine ecology**

| ID | Issue | Measure | Timing |
|---|---|---|---|
| ME1 | Biofouling and benthic community disturbance | Works to remove the current quay wall and piles will commence after a visual inspection for protected mobile fauna (e.g. Syngnathids). If present, these will be relocated to adjacent habitats, outside the zone of influence by the proposed works, where feasible.<br>Dredging will be carried out using mechanical backhoe dredge, split barges and supporting tug vessels, as opposed to suction-style dredging, to minimise the potential mobilisation of sediments within the Inner Harbour.<br>Disposal of the dredged material will be limited to the Outer Harbour disposal area within the perimeter bund. | Construction |
| ME2 | Water quality and marine ecology impacts from resuspension of sediments | The following controls should be implemented prior to dredge activities:<br>• Physical controls such as installation of silt curtains prior to commencement of construction works would be adequate in minimising the spread of any sediments within the water column at the dredging and disposal locations.<br>• Dredging techniques that minimise sediment resuspension during excavation and disposal (such as using mechanical methods over hydraulic methods) should be implemented | Construction |

| ID | Issue | Measure | Timing |
|---|---|---|---|
| | | throughout the project. Barge loads will also be controlled such that overflow of barge loads is avoided.<br>• Screening technologies will be implemented to ensure that any contaminated sediments are disposed of responsibly. Contaminated dredge material will be placed such that it may be capped by uncontaminated material in accordance with a dredge management plan.<br>• Implementation of a water quality monitoring program to ensure construction works do not exceed the project's agreed marine water quality criteria.<br>• Daily visual observations of any potential toxic dinoflagellate blooms within the Inner Harbour. | |
| ME3 | Water quality and marine ecology impacts from resuspension of sediments | Implementation of a water temperature monitoring program to document natural variations in water temperature and the extent of temperature differences and dispersion pathways of the cold water discharge plume. | Operation |
| ME4 | Impact of artificial noise emissions on marine fauna | During piling activities the following standard operational procedures are to be implemented (DPTI, 2012):<br>• Pre-start procedure – The presence of marine mammals should be visually monitored by a suitably trained crew member for at least 30 minutes before the commencement of the soft start procedure. Particular focus should be put on the shut-down zone but the observation zone should be inspected as well, for the full extent where visibility allows. Observations should be made from the piling rig or a better vantage point if possible.<br>• Soft start procedure – If marine mammals have not been sighted within or are likely to enter the shut down zone during the pre-start procedure, the soft start procedure may commence in which the piling impact energy is gradually increased over a 10-minute period. The soft start procedure should also be used after long breaks of more than 30 minutes in piling activity. Visual observations of marine mammals within the safety zones should be maintained by trained crew throughout soft starts. The soft start procedure may alert marine mammals to the presence of the piling | Construction |

| ID | Issue | Measure | Timing |
|---|---|---|---|
| | | rig and enable animals to move away to distances where injury is unlikely.<br>• Normal operation procedure – If marine mammals have not been sighted within or are not likely to enter the shut down or observation zone during the soft start procedure, piling may start at full impact energy. Trained crew should continuously undertake visual observations during piling activities and shut-down periods. After long breaks in piling activity or when visual observations ceased or were hampered by poor visibility, the pre-start procedure should be used. Night-time or low visibility operations may proceed provided that no more than three shut-downs occurred during the preceding 24 hour period.<br>• Stand-by operations procedure – If a marine mammal is sighted within the observation zone during the soft start or normal operation procedures, the operator of the piling rig should be placed on stand-by to shut-down the piling rig. An additional trained crew member should continuously monitor the marine mammal in sight.<br>• Shut-down procedure – If a marine mammal is sighted within or about to enter the shutdown zone, the piling activity should be stopped immediately. If a shut-down procedure occurred and marine mammals have been observed to move outside the shut-down zone, or 30 minutes have lapsed since the last marine mammal sighting, then piling activities should recommence using the soft start procedure. If marine mammals are detected the shut-down zone during poor visibility, operations should stop until visibility improves. | |
| ME5 | Impact of artificial noise emissions on marine fauna | Vessel and heavy machinery should be maintained in accordance with the manufacturer specifications to reduce noise emissions. | Construction |
| ME6 | Impact of on marine fauna through artificial noise or collision | The interaction of all vessels with cetaceans and pinnipeds will be compliant with Part 8 of the Environment Protection and Biodiversity Conservation (EPBC) Regulations (2000). The Australian Guidelines for Whale and Dolphin Watching (DoEE, 2017) for sea-faring activities will be implemented across the entire project. | Construction |

<table>
<tr><th>ID</th><th>Issue</th><th>Measure</th><th>Timing</th></tr>
<tr><td></td><td></td><td>This includes the implementation of the following guidelines:<br>• Caution zone (300 m either side of whales and 150 m either side of dolphins) –vessels must operate at no wake speed in this zone.<br>• Caution zone must not be entered when calf (whale or dolphin) is present<br>• No approach zone (100 m either side of whales and 50 m either side of dolphins) – vessels should not enter this zone and should not wait in front of the direction of travel or an animal or pod, or follow directly behind<br>• If there is a need to stop, reduce speed gradually<br>• Do not encourage bow riding<br>• If animals are bow riding, do not change course or speed suddenly.</td><td></td></tr>
<tr><td>ME7</td><td>The impact of artificial light emissions</td><td>Light spill from the nearshore vessel operations will be minimised where possible using directional lighting.</td><td>Construction<br>Operation</td></tr>
<tr><td>ME8</td><td>The impact of artificial light emissions</td><td>Lighting on vessel decks or the berth construction area will be managed to reduce direct light spill onto marine waters or surrounding landscape, unless such actions do not comply with site safety or navigation and vessel safety standards (AMSA Marine Orders Part 30: Prevention of Collisions; AMSA Marine Orders Part 21: Safety of Navigation and Emergency Procedures).</td><td>Construction</td></tr>
<tr><td>ME9</td><td>Pest introduction and proliferation</td><td>Locally sourced vessels (within NSW waters) to complete the construction works, where possible<br>International vessels to empty ballast water in accordance with the latest version of the Australian Ballast Water Management Requirements (DAWR, 2017)<br>If an IMP is identified or suspected, then the contractor is obliged to immediately (within 24 hours) notify the NSW Department of Primary Industries Aquatic Biosecurity Unit hotline on (02) 4916 3877<br>Project activities to adhere to the National System for the Prevention and Management of Marine Pest Incursions (National System) and NSW requirements for IMP identification and management.</td><td>Construction<br>Operation</td></tr>
</table>

| ID | Issue | Measure | Timing |
|---|---|---|---|
| ME10 | Accidental release of solid waste | Appropriate waste containment facilities will be included on site and managed to avoid overflow or accidental release to the environment.<br>No waste materials will be disposed of overboard of vessels, all non-biodegradable and hazardous wastes will be collected, stored, processed and disposed of in accordance with the vessel's Garbage Management Plan as required under Regulation 9 of MARPOL Annex V.<br>All marine vessels will be operated and maintained in accordance with the South Australian Government's Code of practice for vessel and facility management (marine and inland waters) 2008.<br>Hazardous wastes will be separated, labelled and retained in storage onboard within secondary containment (e.g. bin located in a bund).<br>All recyclable and general wastes to be collected in labelled, covered bins (and compacted where possible) for appropriate disposal at a regulated waste facility.<br>Solid non-biodegradable and hazardous wastes will be collected and disposed of onshore at a suitable waste facility. | Construction<br>Operation |
| ME11 | Accidental release of hydrocarbons, chemicals and other liquid waste | All liquid waste to be stored for discharge to an appropriate onshore facility<br>Chemicals and hydrocarbons will be packaged, marked, labelled and stowed in accordance with MARPOL Annex I, II and III regulations. These include provisions for all chemicals (environmentally hazardous) and hydrocarbons to be stored in closed, secure and appropriately bunded areas.<br>A Materials Safety Data Sheet (MSDS) will be available for chemicals and hydrocarbons in locations nearby to where the chemicals / wastes are stored<br>Vessel operators will have an up to date Shipboard Oil Pollution Emergency Plan (SOPEP) and Shipboard Marine Pollution Emergency Plan (SMPEP). All shipboard chemical and hydrocarbon spills will be managed in accordance with these plans by trains and competent crew.<br>Any contaminated material collected will be contained for appropriate onshore disposal | Construction<br>Operation |

| ID | Issue | Measure | Timing |
|---|---|---|---|
| | | Any equipment or machinery with the potential to leak oil will be enclosed in continuous bunding or will have drip trays in place where appropriate<br>Following rainfall events, bunded areas on open decks of the vessels or within any construction laydown areas will be cleared of rainwater<br>All hoses for pumping and transfers will be maintained and checked as per the PMS | |
| ME12 | Damaged fuel tank associated with vessel or plant collision | Visual observations will be maintained by watch keepers on all vessels and plant/moving machinery.<br>All vessels must comply with relevant marine navigation and safety standards.<br>Marine diesel oil compliant with MARPOL Annex VI Regulation 14.2 (i.e. sulphur content of less than 3.50% m/m) is the only diesel engine fuel to be used by the vessels<br>Oil spill responses will be executed in accordance with the vessel's SOPEP, as required under MARPOL<br>Emergency spill response procedures would be developed and implemented when required. | |

# 14. Terrestrial biodiversity

## 14.1 Overview

This chapter describes terrestrial biodiversity matters relevant to the construction and operation of the project. It summarises the more detailed Biodiversity Development Assessment Report (BDAR) in Appendix H.

The assessment has been prepared with reference to and in accordance with the Secretary's Environmental Assessment Requirements (SEARs) and the NSW Biodiversity Assessment Method (BAM). BAM is the assessment manual that outlines how an accredited person assesses impacts on biodiversity at development sites and stewardship sites. The scope of the BDAR broadly includes:

- A description of the existing environment from a desktop study to describe the landscape features of the study area and a field survey in accordance with the BAM to describe the biodiversity values of the project site. This included identification of flora and fauna species, mapping of vegetation communities and assessment of terrestrial and aquatic habitats in the study area and to determine the likelihood of threatened biota listed under the NSW Biodiversity Conservation Act 2016 (BC Act) and their habitats occurring in the study area or being affected by the project.
- A description of the conservation significance of the study area to identify the Matters of National Environmental Significance (MNES) listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) known or predicted to occur, and that will be potentially affected by the project.
- An assessment of the impacts from the project on freshwater fish habitat, key fish habitat, and threatened freshwater biota listed under the NSW Fisheries Management Act (FM Act).
- Presentation of the data used to perform the BAM calculations in order to quantify the residual biodiversity impacts of the project and to determine the ecosystem and species credits required to offset these impacts.
- Consideration of whether any additional assessment, approval or biodiversity offsets would be required under the FM Act or EPBC Act
- Identification of measures undertaken to avoid and minimise impact to biodiversity values.

Refer to Appendix H for the assessment methodology and assumptions.

## 14.2 Existing environment

### 14.2.1 Landscape features

Overall, the site is highly modified and disturbed, as much of it is located within the existing Port Kembla Coal Terminal (PKCT), NSW Ports land, BlueScope Steelworks and road reserves. A small patch of modified native vegetation occurs in the site west of Springhill Road. Some larger fragmented patches of native vegetation occur east of Springhill Road, however these will be avoided through the use of directional drilling. Landscape features in the study area relevant to the BAM calculations are summarised in Table 14-8.

**Table 14-1 Summary of landscape features present within the study area**

| Landscape feature | Study area |
|---|---|
| Interim Biogeographic regionalisation of Australia (IBRA) bioregion | The Sydney Basin Bioregion lies on the central east coast of NSW and covers an area of about 3,624,008 hectares which includes about 4.53 % of NSW. The bioregion extends from north of Batemans Bay to Nelson Bay, west to Mudgee and includes a significant proportion of the catchments of the Hawkesbury-Nepean, Hunter and Shoalhaven river systems. |
| IBRA subregion | The study area occurs mainly within the Illawarra IBRA. The Illawarra subregion includes vegetated cliff faces on coastal escarpments and barrier systems. |
| NSW landscape region | The study area is mapped predominantly within the 'Lake Illawarra Barrier' Mitchell Landscape. Small portions in the north-west and west of the study area are mapped within the 'Dapto-Wollongong Coastal Slopes', 'Kiama Coastal Slopes' and 'Lake Illawarra Alluvial Plains' (DECC, 2008a). Based on the native vegetation and geomorphology of the study area, Lake Illawarra Alluvial Plains is the Mitchell Landscape where most of the impacts occur. |
| % native vegetation | Calculated as 5.7 % within the 500 metre buffer area surrounding the centre line of the linear pipeline and berth. |
| Rivers, streams and estuaries | The project crosses Allans Creek and Gurungaty Waterway. Both flow into the Inner Harbour of Port Kembla and through highly disturbed land. However, the Allans Creek catchment includes natural areas of the Illawarra Escarpment. Allans Creek, Gurungaty Waterway and the Inner Harbour are mapped as key fish habitat by DPI (2007). |
| Wetlands | There are no Coastal Management SEPP wetlands or proximity area, nationally important wetlands or internationally important wetlands within the site or the buffer area. A small swamp is located between the rail corridor and Springhill Road in the 'horse paddock', located to the east of the project |
| Connectivity features | The study area is located with the industrial complex at Port Kembla Harbour. It is surrounded by urban development of Wollongong and Port Kembla. There is minimal connectivity with large areas of native vegetation. |
| Areas of geological significance or soil hazard features | Soil landscapes for the study area and surrounding buffer area are highly modified, and are subject to contamination from various sources. The project is located entirely within lands identified as Disturbed Terrain. Landfill in areas of Disturbed Terrain may include soil, rock, building and waste material (Hazelton and Tille 1990). Landscaped areas comprise revegetation upon substrates of dumped and formed steel slag (GHD 2018c) and may be subject to legacy soil contamination associated with industrial use, land reclamation and filling. Inner Harbour seabed materials comprise soft silty clay with potential contaminants including heavy metals, tributyltin (TBT) and polycyclic aromatic hydrocarbons (PAH) (GHD 2018a). Estuarine sediments within the harbour and are mapped as high probability of being acid sulphate soils (GHD 2018b). There are no karst, caves, crevices, cliffs or other areas of geological significance located within the study area or buffer area surrounding the site. |

### 14.2.1 Non-native vegetation

Vegetation throughout the majority of the project site has been classified as non-native vegetation in accordance with the BAM. This comprises mixed landscape plantings of native and non-native over-storey, over mown groundcover dominated by exotic plant species. No naturally regenerating canopy species, hollow-bearing trees, nor fallen woody debris occur within areas of non-native vegetation.

Typically, native over-storey plantings comprise *Casuarina glauca* (Swamp Oak), *Eucalyptus tereticornis* (Forest Red Gum), *E. botryoides* (Bangalay), *Melaleuca linariifolia* (Flax-leaved Paperbark), *M. styphelioides* (Prickly-leaved Tea Tree), and two species not endemic to the region - *Ficus microcarpa* var. *hillii* (Hill's Weeping Fig – Queensland) and *Lophostemon confertus* (Brushbox – northern New South Wales / Queensland).

Exotic over-storey planting within the project site include *Harpephyllum caffrum* (Kaffir Plum), *Schinus molle* var. *areira* (Peppercorn tree), *Jacaranda mimosifolia* (Jacaranda), *Triadica sebifera* (Chinese Tallowwood), *Gleditsia triacanthos* (Honey Locust Bean), *Erythrina* x *sykesii* (Indian Coral Tree), *Cinnamomum camphora* (Camphor Laurel) and *Lagunaria patersonii* (Norfolk Island Hibiscus). A range of other planted over- and mid-storey species are also scattered throughout the project site as well as numerous invasive woody weed species.

Common species within mown and predominantly exotic understorey include *Axonopus fissifolius* (Narrow-leaved Carpet Grass), *Bromus catharticus* (Prairie Grass), *Chloris gayana* (Rhodes Grass), *Cynodon dactylon* (Couch), *Ehrharta erecta* (Panic Veldtgrass), *Pennisetum clandestinum* (Kikuyu), *Paspalum dilatatum* (Paspalum) and *Sporobolus africanus* (Parramatta Grass). Isolated small patches of naturally established native grasses occur within the north of the project site, including *Bothriochloa decipiens* (Pitted Bluegrass), *Chloris truncata* (Windmill grass) and *Microlaena stipoides* (Weeping Grass).

Vegetation within these areas is classified as 'non-native' because it is mainly composed of exotic plant species cover, provides limited habitat resources for native fauna and does not form a functioning or potentially self-sustaining ecosystem. No natural regeneration of overstorey species was observed and there was minimal recruitment of native understorey plants. These areas are managed as open recreational and operational land including through period slashing, which would further limit any potential for the establishment of a functional native plant community.

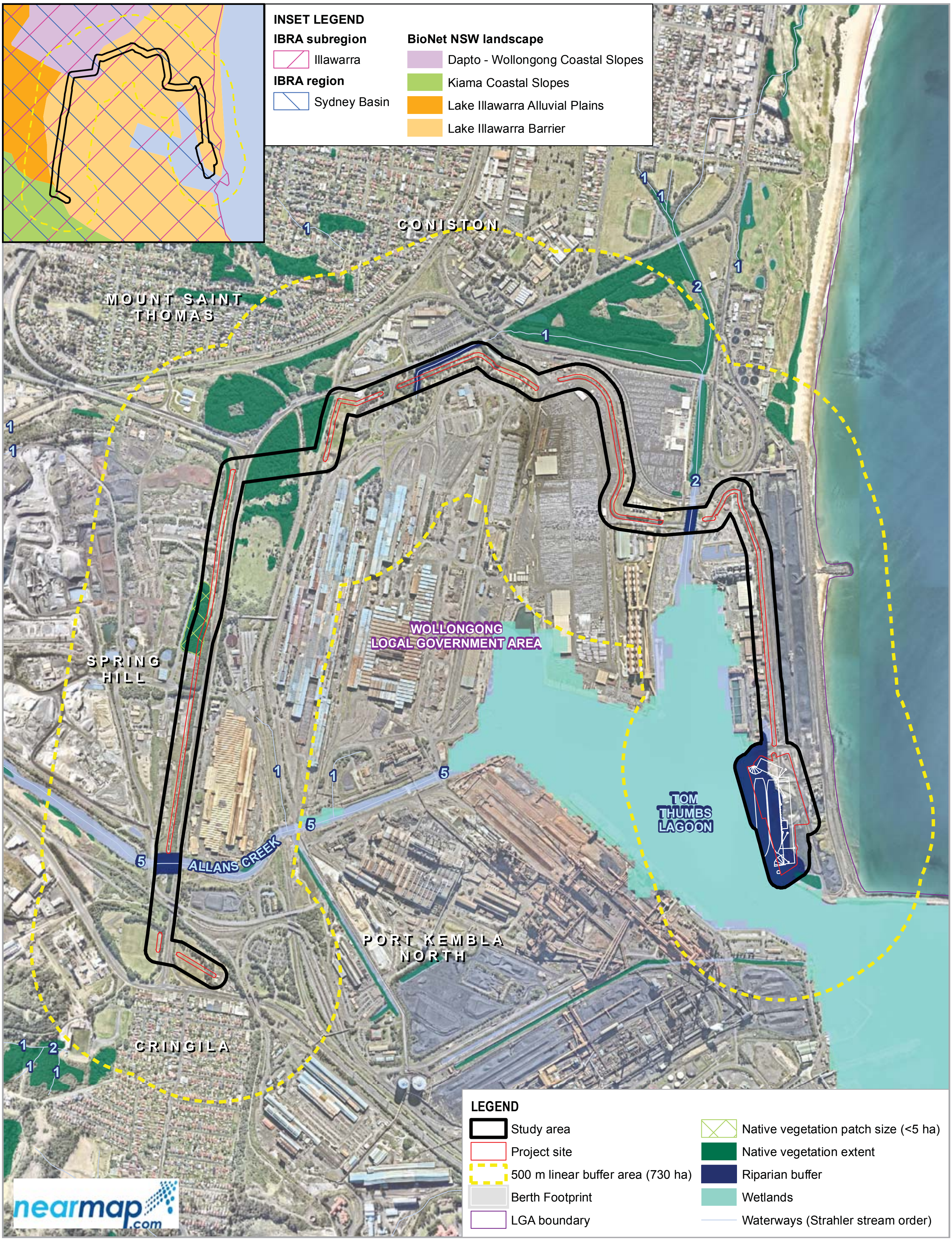
With the exception of an area of remnant woodland to the north of the western alignment, which will be avoided through directional drilling, the Wollongong City Council 2014 update of National Parks and Wildlife Service (NPWS) (2002) native vegetation mapping classifies vegetation throughout the study area as 'Disturbed landscapes' – 'Weeds and Exotics', 'Cleared lands' or 'Modified lands'.

### 14.2.2 Native vegetation and habitat

#### *Native vegetation cover*

A total of 41.30 hectares of native vegetation occurs within the 729.53 hectares landscape buffer area (comprising 5.7 % of the landscape buffer area) as shown on .

A total of 0.25 hectares of native vegetation occurs within the 14.55 hectares of the project site (comprising 0.02 % of the project site), entirely associated with a single, discrete patch of a single plant community type (PCT) covering an area of approximately two hectares.




Paper Size ISO A4

0 400 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

**Australian Industrial Energy**
**Port Kembla Gas Terminal**

**Native vegetation and landscape features**

Project No. **21-27477**
Revision No. **-**
Date **31/10/2018**

# FIGURE 14-1

G:\21\27477\GIS\Maps\Deliverables\Ecology\21_27477_Z001_BDAR_SiteLocation.mxd

Data source: Aerial imagery - nearmap 2018 (image date 16/04/2018 & 19/07/2018, date extracted 01/08/2018 & 12/10/2018) & sixmaps 2018 ; General topo - NSW LPI DTDB 2017, 2015 & 2015; IBRA, IBRA subregion, BioNet NSW Landscapes, wetlands, vegetation - OEH; Berth footprint - Australian Industrial Energy. Created by: afoddy

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### *Flora species*

A total of 26 flora species from 18 families were recorded within native vegetation at the project site, comprising 13 native and 13 exotic species. The Asteraceae (daisies, 5 species, 1 native) and Poaceae (grasses, 4 species, 3 native) were the most diverse families recorded. A full list of flora species recorded within native vegetation is provided in Appendix H.

### *Native vegetation zones*

Native vegetation and original substrates have been almost entirely removed from the study area, with no remnant native vegetation or natural substrates occurring within the project site.

Field surveys confirmed the presence of a single patch of native vegetation, comprising a small area of dense revegetation on modified/cleared lands at the approximate mid-point of the western pipeline alignment, within the project site. The vegetation is composed of a native canopy monoculture with a small number of native species regenerating in the understorey, amongst dense exotic species cover. The patch of native vegetation has been assigned to a PCT based on the classification of surrounding remnant vegetation (NPWS 2002), and likely substrates and landscape position in the area prior to their excavation and redevelopment (see Table 14-2). The vegetation zone at the project site is summarised in Table 14-2 and shown in Photograph 14-1

**Table 14-2 Vegetation zones**

| Zone no. | Vegetation zone | PCT ID[1] | PCT Common Name | Condition | Patch size (ha) | Area (ha) | VIS2 | Conservation significance |
|---|---|---|---|---|---|---|---|---|
| 1 | 1326_Moderate-good (Woollybutt – White Stringybark – Forest Red Gum grassy woodland) | 1326 | Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands | Moderate-good | 2 | 0.25 | 18.2 | Does not comprise an occurrence of any listed TEC |
| **Total area** | | | | | | **0.25** | | |

Notes: 1) the closest matching PCT has been assigned to planted native vegetation within cleared and modified lands.

2) VIS = vegetation integrity score

**Photograph 14-1 Woollybutt White Stringybark – Forest Red Gum grassy woodland on coastal lowlands**

An additional small area of natural regeneration in a man-made drain was also recorded within the study area to the north of the western portion of the pipeline alignment (see Figure 2-1). Native vegetation within the man-made drain is most closely aligned with PCT 1071 *Phragmites australis* & *Typha orientalis* on coastal freshwater wetlands, although native vegetation within the study area does not comprise an occurrence of a listed threatened ecological community.

### *Groundwater dependent ecosystems*

Table 14-3 shows a number of potential terrestrial Groundwater Dependent Ecosystems (GDE) in the study area (BOM, 2018). No aquatic GDEs are mapped in the study area.

**Table 14-3 Potential Groundwater Dependent Ecosystems in the study area**

| Type of GDE | Location |
|---|---|
| Low potential GDE | The majority of Gurungaty Waterway and Allans Creek (to be underbored by the project) |
| Moderate potential GDE | Small vegetated areas along Gurungaty Waterway and Allans Creek (to be underbored by the project)<br>Areas of native vegetation present at the northern end of Springhill Road (to be underbored by the project) |
| High potential GDE | Areas of native vegetation present at the northern end of Springhill Road (to be underbored by the project) |

### *Fauna species*

The field survey identified 25 fauna species in the project area and surrounds, comprising 23 bird species, one mammal species and one frog species. No threatened or migratory species were recorded during site investigations.

### *Habitat resources*

The following specific geographic and habitat features were identified within the project site and indicate the potential presence of threatened species that could contribute to the credit calculations:

- Semi-permanent/ephemeral wet areas.
- Land within one kilometre of wet areas/swamps.
- Land containing swamps.
- Swamp margins or creek edges.
- Land within 500 metres of swamps.

### Fauna habitats associated with native and non-native vegetation in the study area

Habitats for fauna associated with native vegetation are limited in the study area due to the history of industrial development at the site. A small patch of planted native vegetation dominated by Swamp Oak is located west of Springhill Road. A small drain with emergent vegetation is also located adjacent to Springhill Road. Swamp Oak revegetation and Typha wetland within the study area are shown in Photograph 14-2 and described in Table 14-4.

Potential fauna habitats associated with non-native vegetation in the study area predominantly comprise areas of sediment ponds planted vegetation, mown lawns and areas of weeds as described in Table 14-5. Non-native vegetation and constructed habitat features within the study area are shown in Photograph 14-3 and Photograph  14-4.

**Photograph 14-2 Left: Swamp oak revegetation Right: Typha wetland**

**Photograph 14-3 Left: planted trees and shrubs Right: exotic shrub**

**Photograph 14-4 Left: Mown lawns (exotic grassland) Right: Sediment ponds**

**Table 14-4 Fauna habitats associated with native vegetation**

| Swamp oak revegetation | | Typha wetland |
|---|---|---|
| Description | This area comprises a weed infested semi-mature, planted monoculture of Swamp Oak.<br>A small number of bird-dispersed native species are beginning to establish within the revegetation area. No hollow-bearing trees are present. | There is a narrow drain with emergent, naturally regenerating *Typha orientalis* vegetation located near the intersection of Springhill Road and Masters Road. It runs alongside a mown lawn associated with the electricity easement and has high levels of weeds present. No large areas of open water are present. |
| Typical fauna species recorded | A small number of nectarivorous bird species were observed foraging within the planted trees and shrubs including the White-plumed Honeyeater (*Lichenostomus penicillatus*), Rainbow Lorikeet (*Trichoglossus haematodus*) and Red Wattlebird (*Anthochaera carunculata*).<br>Insectivores including the Noisy Miner (*Manorina melanocephala*), Willie Wagtail (*Rhipidura leucophrys*) and Australian Magpie (*Cracticus tibicen*) were also observed. | This drain is likely to provide habitat for common frog species such as the Common Eastern Froglet (*Crinia signifera*) |
| Threatened fauna species recorded or likely to occur | No threatened species are likely to depend on the habitats present in this vegetation.<br>Mobile threatened species such as woodland birds and microchiropteran bats may forage in these habitats on occasion while moving between better quality areas of habitat. | This drain may provide habitat for the Green and Golden Bell Frog.<br>Given its small size and location adjacent to a busy road, it is more likely to be used transiently as foraging or basking habitat by individuals moving between areas of better quality habitat. Given the absence of open water and nearby shelter, breeding is highly unlikely at this location. |
| Migratory fauna species recorded | No migratory species are likely to depend on this habitat type. Species such as the Rufous Fantail or Satin Flycatcher could occur transiently while moving between better quality areas of habitat. | Migratory waders are unlikely to utilise this habitat frequently or for extended periods. |

### Table 14-5 Fauna habitats associated with non-native vegetation

| | Planted trees and shrubs | Exotic scrub |
|---|---|---|
| Description | Planted trees and shrubs occur within narrow linear plantings alongside the access road to the berth, in the northern portion of BlueScope Steel land, and planted figs along Springhill Road. No hollow-bearing trees were observed in this habitat type, although some small hollows may occur.<br>Planted *Eucalyptus* and *Ficus* species provide foraging and shelter resources for a range of birds and mammals of urban environments that are tolerant of regular disturbance from traffic and noise impacts.<br>Foraging resources include seasonal nectar resources, seeds and insects.<br>Woody debris is generally absent from this broad habitat type, however some leaf litter is present where canopy species are present. Fallen timber and leaf litter provides shelter substrate for small reptiles, snakes and small mammals. | Exotic scrub is present along the rail corridor.<br>Exotic scrub is dominated by dense midstorey vegetation of variable structural complexity and include Lantana. These areas were once cleared, but have not been regularly maintained and have since become overgrown.<br>Exotic scrub within the study area provide potential foraging habitat for a range of common bird and mammal species. Exotic scrub also provides good refuge habitat for many small insectivorous and nectarivorous birds. |
| Typical fauna species recorded | A small number of nectarivorous bird species were observed foraging within the planted trees and shrubs and included the White-plumed Honeyeater, Rainbow Lorikeet and Little Wattlebird. Insectivores including the Noisy Miner, Willie Wagtail and Australian Magpie were also observed. | Small birds such as the Red-browed Finch (*Neochmia temporalis*), Superb Fairy-wren (*Malurus suberbus*) and New Holland Honeyeater (*Phylidonyris novaehollandiae*) were observed foraging.<br>Native mammals including the Common Ring-tailed Possum (*Pseudocheirus peregrinus*) and small introduced mammals such as Black Rats (*Rattus rattus*) may den and forage in the dense midstorey of exotic scrub, although none were recorded. |
| Threatened fauna species recorded or likely to occur | The Grey-headed Flying-fox (*Pteropus poliocephalus*) is likely to forage in large Ficus individuals adjacent to Springhill Road and in planted eucalypts.<br>No breeding camps are present.<br>Other mobile threatened fauna (woodland birds or microchiropteran bats) could occur on occasion, but would not depend on the habitat for their survival in the locality. | Exotic scrub is unlikely to provide suitable habitat for threatened fauna species. |
| Migratory fauna species recorded | No migratory species are likely to depend on this habitat type. Rufous Fantail or Satin Flycatcher could occur transiently while moving between better areas of habitat. | No migratory species are likely to depend on this habitat type.<br>Species such as the Rufous Fantail or Satin Flycatcher could occur transiently while moving between better quality areas of habitat. |
| Introduced species | Spotted Turtle-dove (*Streptopelia chinensis*) | Common Myna (*Sturnus tristis*); Red-whiskered Bulbul (*Pycnonotus jocosus*) |

**Table 14-6 Fauna habitats associated with non-native vegetation (continued)**

| Exotic grassland | | Hardstand and sediment ponds |
|---|---|---|
| Description | Exotic grassland is present within parts of Bluescope Steel and along Springhill Road and the rail corridor.<br>Exotic grassland is interspersed with ballast, bare ground and other artificial substrate.<br>These areas would have historically supported native vegetation but have been extensively modified by previous clearing and land reclamation.<br>These areas are devoid of shrubs and trees. Exotic grassland contains few habitat resources of relevance to most native species due to its low structural and floristic diversity.<br>Exotic grasses and herbs would provide foraging resources for relatively mobile and opportunistic native fauna species. | Areas of hardstand (roads, pavements, and berths) and constructed sediment ponds are located throughout the coal terminal and Bluescope Steel land. These areas provide limited habitat for fauna species. |
| Typical fauna species recorded | Bird species commonly recorded include the Crested Pigeon (*Ocyphaps lophotes*), Welcome Swallow (*Hirundo neoxena*), Magpie-lark (*Grallina cyanoleuca*), and Willie Wagtail. These species are insectivorous and were observed foraging within mown portions of the grassland. Small, common lizards such as the Dark-flecked Garden Sunskink (*Lampropholis delicata*) are likely to occur, particularly in areas where shelter such as ballast or woody debris is present. | A tern (*Sternula sp.*) was observed resting on the edge of the berth. The Australian Raven (*Corvus coronoides*) was also observed foraging on the ground. |
| Threatened fauna species | No threatened species are likely to rely on this habitat. Microchiropteran bats such as the Eastern Bentwing Bat may forage above the grassland on occasion.<br>There is potential for the green and Golden Bell Frog to occur in these areas on rare occasions when moving between areas of better quality habitat. | Hardstand areas and artificial sediment ponds provided minimal habitat for threatened species.<br>The Green and Golden Bell Frog has, however, been recorded in these habitats in the study area previously and this species is known to occur in highly disturbed environments including those with moderate surface water contamination. It is likely that the species would only use these habitats temporarily while moving between areas of better condition habitat. |
| Migratory fauna | No migratory fauna are likely to occur in these areas. | No migratory waders are likely to utilise artificial sediment ponds within the study area except on rare occasions. |
| Introduced species | Spotted Turtle Dove | Rock Dove (*Columba livia*) |

### Connectivity

Native vegetation in the study area and surrounding buffer area is extensively fragmented by clearing for existing industrial development. Limited connectivity for fauna movement is present in the study area. The main fauna corridor is located along Springhill Road, where planted trees provide habitat for birds. Areas of weedy vegetation are also present along the rail corridor and would provide habitat for birds, small mammals, reptiles and frogs.

Movement habitat of the key population of the Green and Golden Bell Frog at Port Kembla is generally typified by wet areas such as creek lines, drains, periodically damp areas, connecting or partially connecting vegetation, easements, laneways and even open areas that do not restrict movement (DEC, 2007). This species may on occasion use disturbed habitats in the study area to move between other areas of habitat.

#### *Aquatic habitat*

Allans Creek and Gurungaty Waterway are highly disturbed aquatic habitats as shown in Photograph 14-1 and described in Table 14-7.

**Photograph 14-1 Left: Allans Creek within Bluescope Steel land Right: Gurungaty Waterway upstream of the project site**

**Table 14-7 Fauna habitats: Aquatic habitat**

| Aquatic habitat | |
|---|---|
| Description | Allans Creek and Gurungaty Waterway are crossed by the pipeline alignment. The pipeline would be underbored beneath both creeks. Allans Creek, Gurungaty Waterway and the Inner Harbour are mapped as key fish habitat by DPI (2007).<br>Allans Creek has modified banks along much of the reach within the study area. A number of pipelines are located alongside the creek. The creek is also crossed by various bridges. Limited riparian vegetation is present. A number of planted figs are located on the banks near Springhill Road. No emergent vegetation was observed.<br>Gurungaty Waterway is also highly modified due to its location in an industrial area. It is crossed by various roads and rail lines before entering the Inner Harbour. It contains areas of saltmarsh and mangroves, which comprise 'marine vegetation' under the FM Act. These occur upstream of the project site and would not be directly impacted by the project. |
| Typical fauna species | Given their estuarine nature, a number of saltwater fish species are likely to occur in these creeks. Further detail is provided in the marine ecology report (Appendix G). |
| Threatened species | Allans Creek and Gurungaty Waterway are unlikely to provide habitat for any threatened freshwater fish species (DPI, 2018a). |
| Migratory fauna species | Migratory waders may occur on occasions along small areas of mudflats on Gurungaty Waterway and the remnant of Tom Thumb Lagoon. |

### 14.2.3 Conservation significance

This section describes the conservation significance of the study area in terms of threatened biota and their habitats, and MNES that are known or predicted to occur.

#### *Identification of threatened species under the BAM*

#### Predicted threatened species

Based on the vegetation types and habitat resources present within the site, the BAM calculator generates a list of threatened fauna species that are predicted to utilise the study area. The list was refined based on the habitat assessment and field surveys conducted. The suite of threatened species associated with ecosystem credits required for the study area are listed in Table 14-8. For each predicted threatened species, a sensitivity class rating and vegetation zones they are predicted to be associated with are also provided. Targeted surveys are not required for these species.

**Table 14-8 Habitat for predicted threatened species**

| Common Name | Scientific Name | BC Act | EPBC Act | Sensitivity class1 | Habitat present |
|---|---|---|---|---|---|
| Eastern Bentwing-bat | *Miniopterus schreibersii oceanensis* | Vulnerable | | High | Yes – likely to forage above the project site |
| Eastern Freetail-bat | *Mormopterus norfolkensis* | Vulnerable | | High | Yes – may forage on occasion at the project site |
| Flame Robin | *Petroica phoenicea* | Vulnerable | | Moderate | Yes – may forage on site on occasion |
| Gang-gang Cockatoo | *Callocephalon fimbriatum* | Vulnerable | | Moderate | Yes – may forage on site on occasion |
| Glossy Black-Cockatoo | *Calyptorhynchus lathami* | Vulnerable | | High | Yes – may forage on site on occasion |
| Grey-headed Flying-fox | *Pteropus poliocephalus* | Vulnerable | Vulnerable | High | Yes – may forage on occasion at the project site |
| Little Bentwing-bat | *Miniopterus australis* | Vulnerable | | High | Yes – may forage on occasion at the project site |
| Little Eagle | *Hieraaetus morphnoides* | Vulnerable | | Moderate | Yes – may forage on site on occasion |
| Little Lorikeet | *Glossopsitta pusilla* | Vulnerable | | High | Yes – may forage on site on occasion |
| Masked Owl | *Tyto novaehollandiae* | Vulnerable | | High | Yes – may forage on site on occasion |
| Powerful Owl | *Ninox strenua* | Vulnerable | | High | Yes – may forage on site on occasion |
| Scarlet Robin | *Petroica boodang* | Vulnerable | | Moderate | Yes – may forage on site on occasion |
| Square-tailed Kite | *Lophoictinia isura* | Vulnerable | | Moderate | Yes – may forage on site on occasion |
| Varied Sittella | *Daphoenositta chrysoptera* | Vulnerable | | Moderate | Yes – may forage on site on occasion |
| Yellow-bellied Sheathtail-bat | *Saccolaimus flaviventris* | Vulnerable | | High | Yes – may forage on occasion at the project site |

### Species credit species

Species credit refers to the class of biodiversity credit created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the Threatened Species Profile Database (OEH, 2018). Given the highly disturbed and modified nature of the study area, no suitable habitat for candidate species credit species occurs within the project site. No species credit species were opportunistically recorded in the study area during the GHD surveys.

Dispersal habitat and artificial refuge habitat for the Green and Golden Bell Frog is assumed to be present based on recent records in the area, however this is not associated with any PCTs in the project site.

The North Port Kembla sub-population of the Green and Golden Bell Frog is likely to extend across much of the industrial lands in and around the Port Kembla Steelworks and a range of constructed habitats have been established in order to protect and encourage the remaining population.  They are believed to utilise drainage features, rail easements, roads, culverts and other low lying features and associated vegetation as habitat. The use of these habitat features may be transient, intermittent and dependent on suitable weather conditions (DEC, 2007).

Constructed habitat for Green and Golden Bell Frog is located to the north of the site in the south-east corner of Greenhouse Park. No individuals of Green and Golden Bell Frog have been recorded at the Greenhouse Park habitat over the last five years (Gaby Kirwood, Jen Byrne, pers. com. 2017), and the numbers recorded in the Inner Harbour have also decreased significantly in recent years. However, Bluescope Steel noted that a number of individuals were observed in constructed habitat in March 2017, after there being no significant sightings of the species for about seven years at this location (BlueScope, 2017).

The project site covers an area that is a potential movement corridor of the Green and Golden Bell Frog. Connections between the Tom Thumb Lagoon population to the north of the study area and other populations are exceedingly tenuous and would only be possible along rail easements, and creek and drainage lines (including Allans Creek) in the vicinity of the BlueScope steelworks complex. Connectivity between the North Port Kembla population (to the south of the study area) and the sub-populations further to the south is also likely to be tenuous (DEC, 2007).