



City & Southwest

Clyde Barging Facility Review of Environmental Factors

PROJECT: SYDNEY METRO CITY & SOUTHWEST - TSE WORKS
DECEMBER 2017



Contents

- Glossary of terms.....4**
- Executive summary.....5**
- 1.0 Introduction9**
- 1.1 Overview9
- 1.2 Background.....9
- 1.3 Structure and content of this REF 11
- 2.0 Need and options considered.....12**
- 2.1 Strategic need for the proposal 12
- 2.2 Alternatives and options considered 12
- 2.3 Preferred option 14
- 3.0 Description of the proposal15**
- 3.1 Overview of the proposed works..... 15
- 3.2 Design 16
- 3.3 Work methodology 16
- 3.4 Site establishment..... 17
- 3.5 Site operations (use of the site) 19
- 3.6 Decommissioning..... 19
- 3.7 Hours of work 20
- 3.8 Plant and equipment 20
- 3.9 Workforce..... 20
- 4.0 Statutory and planning framework.....22**
- 4.1 Overview 22
- 4.2 NSW legislation and regulations 22
- 4.3 Other relevant environmental planning instruments..... 27
- 4.4 Commonwealth legislation 30
- 4.5 Summary of legislative requirements 31
- 5.0 Consultation34**
- 5.1 Overview 34
- 5.2 Consultation objectives 34
- 5.3 Consultation strategy 34
- 6.0 Environmental assessment.....37**
- 6.1 Construction traffic and transport 37
- 6.2 Construction noise and vibration..... 43

6.3	Flora and fauna	45
6.4	Soils and water	50
6.5	Waste management and recycling	54
6.6	Land use, property and socio economic	55
6.7	Hazard and risk	56
6.8	Air quality	57
6.9	Historic heritage	58
6.10	Aboriginal heritage	59
6.11	Visual impact	61
6.12	Sustainability	62
6.13	Cumulative impacts	63
7.0	Environmental management	64
7.1	Construction Environmental Management Plan	64
7.2	Management and mitigation measures	65
7.3	Licencing and approvals	73
8.0	Justification and conclusion	74
8.1	Justification	74
8.2	Ecologically sustainable development considerations	74
8.3	Objects of the EP&A Act	75
8.4	EP&A Regulation considerations	76
8.5	Consideration of matters of national environmental significance	79
8.6	Conclusion	79
9.0	Certification	81
10.0	References	82
	Appendix A – Noise and vibration assessment	83
	Appendix B – Terrestrial and marine flora and fauna assessment	84
	Appendix C – Preliminary Hazard Analysis	85
	Appendix D – Historic heritage assessment	86
	Appendix E – Aboriginal heritage assessment	87

Glossary of terms

Term/ acronym	Definition
Crown Lands and Water	Crown Lands & Water Division, Department of Industry (formerly DPI Water)
CNVIS	Construction Noise and Vibration Impact Statement
EIS	Sydney Metro City & Southwest Chatswood to Sydenham Environmental Impact Statement, May 2016
EPA	Environment Protection Authority
EPBC	<i>Environment Protection and Conservation Act, 1999</i> (national)
EPL	Environment Protection Licence under the POEO Act
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i> (NSW)
EP&A Regulation	<i>Environmental Planning and Assessment Regulation 2000</i> (NSW)
ESCP	Erosion and Sedimentation Control Plan
ESD	Ecologically sustainable development
GGBF	Green and Golden Bell Frog
JHCPBG	John Holland CPB Ghella
ISEPP	State Environmental Planning Policy (Infrastructure) 2007
OEH	Office of Environment and Heritage
POEO Act	<i>Protection of the Environment Operations Act 1997</i> (NSW)
Project	Sydney Metro City & Southwest
Project Planning Approval	Critical State Significant Infrastructure Sydney Metro & Southwest Chatswood to Sydenham Infrastructure Approval dated 9 January 2017 (Application no. SSI 15_7400)
Proposal	Establishing and operating a barging facility adjacent to the Parramatta River at Clyde
REF	Review of Environmental Factors
SEPP	State Environmental Planning Policy
SIS	Species Impact Statement
Spoil	All material generated by excavation into the ground, including the excavation of station boxes and tunnels
Submissions and Preferred Infrastructure Report	Sydney Metro City & Southwest Chatswood to Sydenham Submissions and Preferred Infrastructure Report, October 2016
TfNSW	Transport for New South Wales (Proponent)

Executive summary

Project overview

Sydney Metro is Australia's biggest public transport project. It will transform Sydney, delivering more trains and faster services for customers across the network.

Sydney Metro City and Southwest Project extends the new metro network from the end of Sydney Metro Northwest at Chatswood, under Sydney Harbour, through the CBD, and west to Bankstown – a total of 66 kilometres of metro rail.

When services start in 2024, there will be a train at least every four minutes in the peak – customers won't need a timetable, they'll just turn up and go.

Transport for New South Wales (TfNSW) is delivering the Project on behalf of the New South Wales (NSW) Government. John Holland CPB Contractors Ghella (JHCPBG) has been awarded the contract to build the twin tunnels from Chatswood to Sydenham and excavate six new Sydney Metro stations.

The Project was approved on 9 January 2017 (SSI 15_7400) (Project Planning Approval). Condition E84 requires that opportunities to maximise tunnel spoil removal by non-road methods are investigated to minimise truck movements in town centres and the Sydney Central Business District (CBD).

Clyde temporary barging facilities

To reduce the number of trucks travelling through Sydney's CBD, JHCPBG propose to use barges from Barangaroo and Blues Point to transport Tunnel Boring Machine (TBM) components and the rock (spoil) excavated from the Barangaroo Station and underground structures, including the under-harbour tunnel and the Blues Point shaft.

This Review of Environmental Factors (REF) has been prepared to assess the potential environmental impacts of establishing and operating a barging facility adjacent to the Parramatta River at Clyde to support the proposed barging operation (the proposal). The site is located in Viva Energy Australia's Clyde Terminal on Durham Street, Rosehill.

Site establishment works would start in early 2018 and take approximately two months to complete. The following works would be required to establish the site:

- Installing concrete barriers, fencing and environment controls
- Removing some vegetation (casuarinas) along the access road and small stands of trees within the worksite
- Upgrading the access road involving earthworks, and upgrading drainage and connection to Grand Avenue
- Minor earthworks to level the loading area
- Upgrading the existing wharf to cater for the barges
- Installing a site office, amenities and a weighbridge at the site entry on Grand Avenue.

The site operations would commence in mid-2018 and be completed in early 2020. Spoil, plant and equipment would arrive at this site by barge. The spoil would be transferred to trucks by excavators, and plant and equipment, including TBM components, would be transferred by self-propelled mobile equipment trailers loaded onto trucks. Trucks would transport the materials to approved locations throughout Sydney and NSW using the arterial road network.

Decommissioning would commence in early 2020 and take approximately one month to complete. The upgrades to the wharf would remain in place at the completion of operation to allow for the continued use of the wharf by Viva Energy Australia. The scope of decommissioning required would be determined in consultation with Viva Energy Australia.

Need for the proposal

To reduce the number of trucks travelling through Sydney's CBD, JHCPBG propose to use barges from Barangaroo and Blues Point to transport TBM components and the rock (spoil) excavated from the Barangaroo Station and underground structures including the under-harbour tunnel and Blues Point Shaft.

Barging of spoil would remove trucks from the constrained streets of Barangaroo and North Sydney removing approximately 20,000 truck arrivals (truck and trailer) over a period of 26 months. Hickson Road is already home to the Barangaroo Development Area, with extensive construction works underway, and there is also significant truck transport associated with the Overseas Passenger Terminal. As such, spoil barging would greatly assist in reducing traffic conflicts and congestion in this area.

Many community submissions received in response to exhibition of the Environmental Impact Statement (EIS) expressed concerns about the proposed use of Blues Point as a TBM retrieval site, particularly in respect of pedestrian safety and noise from truck movements. Blues Point Road is a relatively narrow and winding road with many street trees and a vibrant restaurant precinct. Spoil barging from Blues Point would remove approximately 1,150 truck arrivals (singles) over a period of three months and would have significant amenity and safety benefits compared to road transport. As a number of community submissions to the EIS recommended that barging be considered for Blues Point, implementing this proposal would be a positive outcome of community consultation.

In total, the opportunity to barge spoil and transport plant, equipment and TBM components would remove in the order of 22,000 trucks from congested CBD and North Sydney road network.

Statutory and planning framework

The State Environmental Planning Policy (Infrastructure) 2007 (ISEPP) aims to facilitate the effective delivery of infrastructure across New South Wales. Clause 79 of the ISEPP permits development on any land for the purpose of a rail corridor to be carried out by or on behalf of a public authority without consent. TfNSW would obtain a short term lease over the portion of worksite owned by Viva Energy Australia to support the delivery of the TSE Works component of the Project. Development permissible without consent is required to be assessed under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and development consent from council is not required.

This REF fulfils the requirements of Section 111 of the EP&A Act, and has been prepared in accordance with Clause 228 of the *Environmental Planning and Assessment Regulation 2000* and having regard to the relevant provisions within the *Environment Protection Conservation Act 1999* (EPBC Act).

The proposal is not likely to have a significant impact on matters of national environmental significance or the environment of Commonwealth land within the meaning of the EPBC Act. The proposal will be referred to the Australian Department of the Environment and Energy to confirm that it is not a controlled action.

Key potential environmental impacts of the proposal

The key potential environmental impacts associated with the proposal would likely comprise:

- Construction traffic and transport – There would be approximately 21,875 truck and trailer movements over the life of the proposal. Dependent on the progress of tunnelling, approximately 63 truck and trailers would be required per day to remove spoil from the proposed worksite. During peak periods there would be up to 125 truck and trailers are required per day to remove spoil from the proposed worksite. Increased vehicle movements resulting from the proposal are not expected to impact on the safety and operation of the adjacent road network.
- Construction noise and vibration – The proposal is located in an industrial area and the nearest residential receiver is on the opposite side of the Parramatta River, approximately 350 metres from the wharf. Site establishment and operational noise is predicted to comply with construction noise criteria, except during piling which would occur intermittently over a two-month period.
- Flora and Fauna – The proposal would require minor vegetation removal adjacent to a wetland known to contain Green and Golden Bell Frogs, a threatened species. Impacts on flora and fauna have been assessed in detail, and comprehensive mitigation and management measures set out in this REF.
- Soil and water – Site establishment would involve minor earthworks, and wharf upgrade works would need to be carefully planned and managed to reduce potential for disturbance of the river bed. During barge unloading operations, there is potential for spoil to be dropped into the Parramatta River. Suitable controls would be identified as part of detailed construction planning, and a site-specific Erosion and Sediment Control Plan would be prepared, implemented, and updated as construction progresses.
- Air quality – Site establishment, operations and decommissioning works all have the potential to generate dust and would generate vehicle emissions. A range of mitigation measures would be implemented to minimise air quality impacts.

These and other potential environmental impacts are assessed in detail in this REF.

Next steps

A range of stakeholder and community consultation activities will be undertaken to inform the community and stakeholders about the proposal and seek feedback – see Section 5.0 for more details.

TfNSW will exhibit the REF between 15 December 2017 and 15 January 2017 to enable the community and stakeholders to consider the details of the proposal and its impacts as detailed in the REF and to provide written comments on the proposal.

At the close of the exhibition period, TfNSW will consider the issues raised in submissions received in response to the exhibition of the REF. A submissions report will be prepared to address and respond to the issues raised in submissions. This report, along with the REF and any other relevant information, will be used by TfNSW to assess and determine the proposal.

Should the proposal be approved, TfNSW will make the submissions report and any conditions of approval publicly available. The local community will be notified by way of advertisements in local newspapers, community newsletters and the project website <https://www.sydneymetro.info/documents>.

Correspondence will also be sent to people that made a submission, which would include contact details for further information and an indication of the anticipated timing of construction work.

Should the project be approved, additional stakeholder and community consultation would continue to be implemented to inform the community and stakeholders about the proposal throughout the detailed design and construction phases.

1.0 Introduction

1.1 Overview

Sydney Metro is Australia's biggest public transport project. It will transform Sydney, delivering more trains and faster services for customers across the network.

Sydney Metro City and Southwest Project extends the new metro network from the end of Sydney Metro Northwest at Chatswood, under Sydney Harbour, through the CBD, and west to Bankstown – a total of 66 kilometres of metro rail.

When services start in 2024, there will be a train at least every four minutes in the peak – customers won't need a timetable, they'll just turn up and go.

Transport for New South Wales (TfNSW) is delivering the Project on behalf of the New South Wales (NSW) Government. John Holland CPB Contractors Ghella (JHCPBG) has been awarded the contract to build the twin tunnels from Chatswood to Sydenham and excavate six new Sydney Metro stations.

To reduce the number of trucks travelling through Sydney's Central Business District (CBD), JHCPBG propose to use barges from Barangaroo and Blues Point to transport tunnel boring machine (TBM) components and the rock (spoil) excavated from the Barangaroo Station and underground structures including the under-harbour tunnel and the Blues Point shaft.

This Review of Environmental Factors (REF) has been prepared to assess the potential environmental impacts of establishing and operating a barging facility adjacent to the Parramatta River at Clyde to support this operation (the proposal). The site is located in Viva Energy Australia's Clyde Terminal on Durham Street utilising the existing wharf.

This REF has been prepared to address requirements under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). For the purposes of these works, TfNSW is the proponent and determining authority under Part 5 of the EP&A Act. The description of the proposal (Section 3.0) and associated potential environmental impacts (Section 6.0) have been undertaken in the context of clause 228 of the *Environmental Planning and Assessment Regulation 2000* and other relevant legislation, as set out in Section 4.0.

1.2 Background

1.2.1 Sydney Metro overview

Sydney Metro is one of Australia's biggest public transport projects and will deliver a step change in public transport in Sydney. Construction and planning of this 66 kilometre project is now well advanced. The Sydney Metro Project forms part of the NSW Government's Sydney's Rail Future plan. This is a long-term plan to modernise Sydney's trains and is an integral component of the NSW Government's Long Term Transport Master Plan. Sydney's new metro trains will be capable of carrying around 40,000 people per hour, compared with the current capacity of 24,000 people per hour on current suburban trains.

Stage 2 of the Sydney Metro Program involves extending metro rail from Sydney's Northwest region, beneath Sydney Harbour, through new underground CBD stations and beyond to Bankstown. Services on Sydney Metro City & Southwest are expected to start in 2024.

The Project comprises two core geographic components:

- Chatswood to Sydenham – new 15.5 km twin tunnels from Chatswood, under Sydney Harbour through Sydney's CBD to Sydenham.

- Sydenham to Bankstown upgrade – proposed upgrade and conversion of the existing 13.5 km railway from Sydenham Station to Bankstown to metro standards.

The TSE Works involves the design and construction of tunnels and underground station excavation, station structures at Barangaroo, cross passages and associated civil works from Chatswood to Sydenham (see Figure 1).



Figure 1: Sydney Metro City & Southwest project and TSE route overview

Sydney Metro City & Southwest will have the ultimate capacity to operate 30 trains an hour through the CBD – or one train every two minutes in each direction, with 98 per cent on-time running reliability.

Sydney Metro City & Southwest will provide a number of benefits, including doubling the number of train paths available from the north, strengthening connections and access across Sydney and its rail network, and improving the capacity, reliability and efficiency of the existing transport system. This will help to improve network resilience through the Sydney CBD and across Sydney Harbour, improve travel times, and reduce crowding at existing Sydney CBD stations, North Sydney and St Leonards.

In May 2016, an Environmental Impact Statement for the Chatswood to Sydenham section of the Project (the EIS) was placed on public exhibition for a period of 48 days (six weeks). A

Preferred Infrastructure Report on the Chatswood to Sydenham component (the SPIR) was prepared and publicly released in October 2016. The SPIR assessed the impacts of barging operations at Barangaroo and Blues Point, however a barge destination site was not identified or assessed.

The Project was approved on 9 January 2017 (SSI 15_7400) (Project Planning Approval). Condition E84 requires that opportunities to maximise tunnel spoil removal by non-road methods are investigated to minimise truck movements in town centres and the Sydney CBD.

1.3 Structure and content of this REF

The structure and content of the REF is outlined in Table 1.

Table 1: Structure and content of the REF

REF Section	Description
Section 1.0 – Introduction	Sets out the background of the Proposal.
Section 2.0 – Need and options considered	Provides an overview of the Proposal need and a description of the options considered.
Section 3.0 – Description of the Proposal	Presents a detailed description of the proposal, including elements of the Proposal and construction requirements.
Section 4.0 – Statutory and planning framework	Outlines relevant environmental planning instruments and policies, and provides an assessment of their relevance to the Proposal.
Section 5.0 – Consultation	Summarises community and stakeholder consultation requirements during the Proposal’s development and assessment, and during construction phases.
Section 6.0 – Environmental assessment	Presents an assessment of the potential impacts of the Proposal on key environmental aspects, including traffic and transport, noise and vibration, biodiversity, soil and water, hazard and risk, waste management, historic and Aboriginal heritage, air quality, and sustainability.
Section 7.0 – Environmental management	Outlines the management and mitigation measures to be implemented during construction of the Proposal to minimise and manage potential impacts identified in this REF.
Section 8.0 – Justification and conclusion	Summarises justification for the proposal and presents the conclusions of this REF.

This REF is supported by technical assessments of specific issues associated with the proposal. These technical papers form appendices to the REF and have been used to inform the REF, as follows:

- Appendix A – Noise and vibration assessment
- Appendix B – Terrestrial and marine flora and fauna assessment
- Appendix C – Preliminary Hazard Analysis
- Appendix D – Historic heritage assessment
- Appendix E – Aboriginal heritage assessment.

2.0 Need and options considered

2.1 Strategic need for the proposal

The proposal would support the construction of the TSE Works. One of the objectives of the Sydney Metro City & South West Project set out in the EIS is to implement a feasible solution recognising impacts, constraints and delivery risk. To reduce the number of trucks travelling through Sydney's CBD, JHCPBG propose using barges from Barangaroo and Blues Point to transport TBM components and the rock (spoil) excavated from the Barangaroo Station and underground structures including the under-harbour tunnel and Blues Point Shaft.

Barging of spoil would remove trucks from constrained streets of Barangaroo and North Sydney. Spoil barging from Barangaroo would remove approximately 20,000 truck arrivals (truck and trailer) over a period of 26 months. Hickson Road is already home to the Barangaroo Development Area with extensive construction works underway and there is also significant truck transport associated with the Overseas Passenger Terminal. As such, spoil barging would greatly assist in reducing traffic conflicts and congestion in this area.

Many community submissions received in response to exhibition of the EIS expressed concerns about the proposed use of Blues Point as a TBM retrieval site, particularly in respect of pedestrian safety and noise from truck movements. Blues Point Road is a relatively narrow and winding road with many street trees and a vibrant restaurant precinct. Spoil barging from Blues Point would remove approximately 1,150 truck arrivals (singles) over a period of three months and would have significant amenity and safety benefits compared to road transport. As a number of community submissions on the EIS recommended that barging be considered for Blues Point, implementing this proposal would be a positive outcome of community consultation.

2.2 Alternatives and options considered

JHCPBG completed a review of available barging infrastructure and identified the following potential barge destination options:

1. Port Kembla – Outer Harbour development
2. Camelia Industrial Precinct– Private development applications
3. White Bay – Industrial wharfs
4. Clyde - Viva Energy Australia's Clyde Terminal

To assess these options, advantages and disadvantages were identified and compared. This analysis is summarised in Table 2.

Table 2: Options analysis

Option	Advantages	Disadvantages
1. Port Kembla – Outer Harbour development	<ul style="list-style-type: none"> • Existing mooring facilities 	<ul style="list-style-type: none"> • Approximately 50 nautical miles from Barangaroo • Rough seas may restrict operations • Development consent for spoil receipt has not been obtained and redevelopment timelines are uncertain
2. Camelia Industrial Precinct – Private development applications	<ul style="list-style-type: none"> • Approximately 11 nautical miles from Barangaroo 	<ul style="list-style-type: none"> • There are not currently any sites that have existing mooring facilities • Would require extensive clearing of mangroves to establish wharf • Not easily trafficable due to low bridges and draft restrictions
3. White Bay – Industrial wharfs	<ul style="list-style-type: none"> • Approximately 0.74 nautical miles from Barangaroo • Existing mooring facilities 	<ul style="list-style-type: none"> • Limited available space because of other significant projects and industrial uses • Rail infrastructure previously utilised on the North Side Storage Project has been removed • No potential for spoil to be reused in close proximity to this barge receipt site • Still requires the spoil to be trucked through surrounding suburban streets and areas
4. Clyde - Viva Energy Australia's Clyde Terminal	<ul style="list-style-type: none"> • Approximately 9.5 nautical miles from Barangaroo • Existing wharf and mooring facilities • Adjacent land uses are industrial • Access to arterial road network avoids traffic on local streets • Viva Energy Australia is currently consolidating its operational footprint at Clyde. This activity will liberate a significant area as surplus to operational needs which has the potential to require reuse of spoil as part of any future development activity. 	<ul style="list-style-type: none"> • Existing wharf facilities would require upgrading • Potential for impacts on adjacent fuel infrastructure need to be considered during detailed design

2.3 Preferred option

Option 4, use of Viva Energy Australia's Clyde Terminal was identified as the preferred option as it would utilise an existing wharf facility, located in an industrial area with ready access to the arterial road network and site establishment works and operations are not expected to have significant environmental impacts. Option 4 is therefore detailed in Section 3.0.

3.0 Description of the proposal

3.1 Overview of the proposed works

To reduce the number of trucks travelling through Sydney’s CBD, JHCPBG propose to use barges from Barangaroo and Blues Point to transport TBM components and the rock (spoil) excavated from the Barangaroo Station and underground structures including the under-harbour tunnel and the Blues Point shaft.

The proposal assessed in this REF involves establishment and operation of a barging facility adjacent to the Parramatta River at Clyde to support this operation. The site is located in Viva Energy Australia’s Clyde Terminal on Durham Street.

The site would be located on industrial land accessed off Grand Avenue and would comprise an area of approximately 8000 m². The site is fenced and largely clear, with sparse vegetation. The proposed site establishment works include upgrading the existing wharf, and minor upgrades and extension to the existing access road to allow for heavy vehicle movements.

Spoil, plant and equipment would arrive at this site by barge. The materials would be transferred to land by excavators and self-propelled mobile trailers and loaded onto trucks. Trucks would transport the materials to various locations throughout Sydney and NSW using the arterial road network.

The Clyde barging facility would be established in early 2018 and would operate until early 2020.

Figure 2 provides a site locality plan.



Figure 2: Site locality plan

3.2 Design

3.2.1 Design criteria

The proposal would be designed to be consistent with the principles, standards and criteria adopted for all the Sydney Metro projects. Relevant design guidelines for the wharf include Fairfull and Witheridge (2003).

3.2.2 Engineering and environmental constraints

The Gore Bay fuel pipeline is located along the northern boundary of the site. There is a decommissioned watermain located north of the site. The site is accessed via a single lane access road that runs along the boundary of the former refinery, and there is an easement to Grand Avenue located between Hy-mix and a waste processing facility. There is an existing concrete bridge over the decommissioned watermain. A Caltex fuel pipeline is located on the north eastern side of the access track, and a wetland is located to the west of the access track. Potential impacts on existing facilities have been and would continue to be considered in the design of the access and barging facility.

3.3 Work methodology

An indicative construction plan is provided below, including indicative construction methods, staging, plant and equipment requirements, approximate earthwork volumes, anticipated material requirements and traffic management controls. The actual construction plan and method may vary from the description provided in this section due to the identification of additional constraints during pre-construction, ongoing detailed design refinements, community consultation feedback, and construction contractor requirements/limitations.

The construction stages and activities are summarised in Table 3, and Figure 3 provides an indicative site layout plan.

Table 3: Proposed construction stages and key activities

Construction Stage	Description	Indicative timeframe
Stage 1: Site establishment	<p>The following works would be required to establish the site:</p> <ul style="list-style-type: none">• Installing concrete barriers, fencing and environment controls• Removing some <i>Casuarina sp.</i> along the access road and small stands of trees within the worksite• Upgrading the access road involving earthworks, and upgrading drainage and connection to Grand Avenue• Minor earthworks to level the loading area• Upgrading the existing wharf to cater for the barges• Installing a site office, amenities and a weighbridge at the site entry on Grand Avenue.	Site establishment works would start in early 2018 and take approximately two months to complete

Construction Stage	Description	Indicative timeframe
Stage 2: Use of the site	Spoil, plant and equipment would arrive at this site by barge. The spoil would be transferred to truck and trailers by excavators and plant and equipment, including TBM components, would be transferred using self-propelled mobile equipment trailers and loaded onto trucks.	The site operations would commence in mid-2018 and be completed in early 2020
Stage 3: Decommissioning	Demobilisation may include the removal of all the concrete barriers and the piles installed to protect the Gore Bay fuel pipeline. The site office and amenities along with the weighbridge, wheel wash and associated foundations and services would be removed. The upgrades to the wharf would remain in place at the completion of operation to allow for the continued use of the wharf by Viva Energy Australia.	Decommissioning would commence in early 2020 and take approximately one month to complete

Details on each of these construction stages is provided below in Sections 3.4 to 3.6.



Figure 3: Indicative site layout plan

3.4 Site establishment

3.4.1 Preliminary works

To delineate the wharf and access road from Viva Energy Australia’s Clyde Terminal site temporary security fencing would be installed to define the work area boundary. As part of

site delineation and access works a new vehicle access would be installed at the end of Grand Avenue and the existing fencing between the internal access road and the new site access point would be removed.

Positive identification of all underground services would then be undertaken using ground penetrating radar and non-destructive digging along the alignment of the existing wharf, access road and the proposed access off Grand Avenue. This would include the positive identification of the Caltex pipeline located immediately east of the existing access road.

Infrastructure protection works around the Gore Bay fuel pipeline including the installation of concrete barriers to prevent possible vehicle strikes would form part of site establishment works.

Installation and connection of essential services such as power and water would be undertaken during site establishment to service the site amenities planned to be located within the easement at the end of Grand Avenue. Services would be connected from existing power and water located along Grand Avenue.

The existing trees and vegetation along the defined access road alignment as well as two isolated stands of trees adjacent to the wharf would be removed to accommodate the proposed operations at the site.

A gate house, weigh bridge, wheel wash, site offices and amenities would be installed at the proposed site entrance to Grand Avenue.

To facilitate the construction of the site a small temporary construction compound and laydown area would be established for the duration of construction to store/house materials and equipment directly related to the proposed access road and wharf upgrade works. All material for site levelling and roadway construction on the proposal would be imported, as such there is no requirement for batching or large processing areas.

3.4.2 Earthworks and roadworks

Minor earthworks would be required to extend the existing access road through the easement to the new site access at the end of Grand Avenue. The existing access road would be upgraded to provide for truck movements and the existing drainage lines would also require clearing and upgrading. The road would be sealed. Exact traffic arrangements and controls would be confirmed during detailed design and if two-way movements are not provided for, temporary traffic signals or a passing bay may be used.

Earthworks to reduce the gradient on the access road approaches to the existing bridge over the water main would be undertaken to allow for heavy vehicle passage. Minor earth works would be required to level the site (less than one metre) next to the wharf to provide a level surface for plant and vehicle movements.

3.4.3 Wharf upgrade works

The proposal would utilise barges up to 55 metres in length. To allow for the operation of the barges, the wharf would require upgrading. The existing 35m wharf may be extended in length, likely to the south and/or extended over the river to the east. The upgrade of the wharf would involve piling. Additional piles would be installed within Parramatta River to provide additional protection for the existing pipeline and allow for the barges to be moored safely.

The final design of the wharf upgrade would be confirmed once additional surveys and geotechnical investigations are complete and size of the barges is confirmed.

3.5 Site operations (use of the site)

The Clyde barging site would receive barges carrying spoil excavated from the new Sydney Metro Barangaroo Station and underground structures including the under-harbour tunnels and the Blues Point shaft. This material would be loaded onto trucks and trailers at the receival site using excavators and transported to approved disposal locations throughout Sydney.

Barges transferring plant and equipment, including TBM components, would also use the site. Plant and equipment would be transferred to land using self-propelled mobile trailers and either stored at the site or transported off site via truck.

Under the proposal, barges of up to 55 metres in length would be utilised. Required barge movements would depend on the size and load capacity of the barges and an indicative summary is provided in Table 4.

Table 4: Barge sizes and indicative numbers

Barge size	Maximum load capacity	Indicative No. of barge movements
55 metres long and 18 metres wide	2000 tonnes	400
35 metres long and 12 metres wide	1200 tonnes	667

Over 760,000 tonnes of excavated material is expected to be received at the site over the life of the TSE Works. There would be approximately two spoil barges arriving per day. 10-15 barges in total during operations would be used to transfer plant and equipment including TBM components.

The size of the barges to be used and the capacity would be determined during detailed design and take into consideration the depth of the riverbed during different tidal conditions, ferry routes and final design of the upgraded wharf.

The spoil would be transferred into truck and trailers for reuse at approved residential and commercial developments. There would be approximately 21,875 truck and trailers departing from the Clyde site over the life of the proposal. Dependent on the progress of tunnelling, approximately on average 63 truck and trailers would be required per day to remove spoil off-site. During peak periods there would be up to 125 truck and trailers required per day to remove spoil off-site. Truck access would be via a new site entrance at the end of Grand Avenue, Rosehill. From Grand Avenue, trucks are proposed to turn left onto James Ruse Drive and onto M4 west, avoiding residential areas. Some oversize plant and equipment may need to be transported to the site through access roads within Viva Energy Australia's facility.

3.6 Decommissioning

At the completion of operations demobilisation works would be required. Demobilisation may include the removal of all the concrete barriers and the pile installed to protect the Gore Bay fuel pipeline. The site office and amenities along with the weighbridge, associated foundations and services would be removed. The upgrades to the wharf would remain in place at the completion of operation to allow for the continued use of the wharf by Viva Energy Australia.

The extent of decommissioning works would be determined in consultation with Viva Energy Australia.

3.7 Hours of work

Site establishment, operations and decommissioning works would generally be undertaken Mondays to Fridays 7:00am to 6:00pm and Saturdays 8:00am to 1:00pm. There may be a need for works outside of these hours, particularly due to tides or to coordinate with other vessel movements or restrictions on oversize road vehicle movements.

Any work undertaken outside standard construction hours would need to be in accordance with the Interim Construction Noise Guideline (DECC, 2009) and TfNSW's Sydney Metro City and Southwest Construction Noise and Vibration Strategy.

Out of hours works would be undertaken in accordance with the requirements of an Environment Protection Licence.

3.8 Plant and equipment

Indicative plant and equipment required during site establishment, operations and decommissioning includes:

- Light vehicles
- Road truck for deliveries
- Concrete truck
- Concrete pump
- Compressor
- Excavators
- Water cart
- Graders
- Roller
- Piling rig
- Crane
- Wheel loaders
- Barges
- Tug boats
- Truck and trailers.

Additional plant and equipment to that identified above may be needed. The requirement for additional equipment would be determined by JHCPBG to support the establishment, operation and decommissioning works.

3.9 Workforce

The workforce associated with the various elements of the proposal is anticipated to be as shown in Table 5.

Table 5: Anticipated workforce

Construction stage	Number of workforce (daytime)	Number of workforce (night time)
Stage 1: Site establishment	15 workers	-
Stage 2: Use of the site	4 workers during a 12 hour day shift	4 workers during a night shift, if required
Stage 3: Decommissioning	6 workers	-

4.0 Statutory and planning framework

4.1 Overview

This section outlines the statutory requirements and environmental planning instruments relevant to the construction and operation of the proposal, and explains the environmental planning and approvals processes for the proposal.

4.2 NSW legislation and regulations

4.2.1 Environmental Planning and Assessment Act 1979

The EP&A Act regulates land use planning and development in NSW. The proposal constitutes an ‘activity’ for the purposes of Part 5 of the EP&A Act by reason of clause 79 of the ISEPP—refer to Section 4.3.1, below. As such, the proposal is permissible without development consent.

TfNSW is a determining authority in respect of the activity for the purposes of Part 5 of the EP&A Act. Section 111 of the EP&A Act requires TfNSW to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity. Section 6.0 of this REF assesses the likely effect of the proposal on the environment and threatened species, populations and ecological communities. Having regard to the provisions of Sections 111 and 112 of the EP&A Act, the proposal is not likely to significantly affect the environment or threatened species and therefore neither an EIS, nor a Species Impact Statement is required. Section 7.0 of this REF details appropriate mitigation measures to manage and minimise impacts on the environment.

This REF document will be exhibited and made publicly available between 15 December 2017 and 15 January 2018. During the exhibition period, the community would be encouraged to make submissions to TfNSW on the proposal and information contained in the REF. Following the exhibition period, TfNSW will consider issues raised in submissions and respond to community and stakeholder feedback in a Submissions Report. If required, TfNSW may also propose changes to the proposal and detail these in the Submissions Report. These documents will be available to the public via the Sydney Metro website (sydneymetro@transport.nsw.gov.au).

Following the preparation of the Submissions Report, TfNSW will determine whether to proceed with the proposal. If the proposal proceeds, it would be designed and constructed in accordance with the mitigation measures outlined in this REF and the Submissions Report.

The process for determining the proposal under Part 5 of the EP&A Act is outlined in Figure 4.

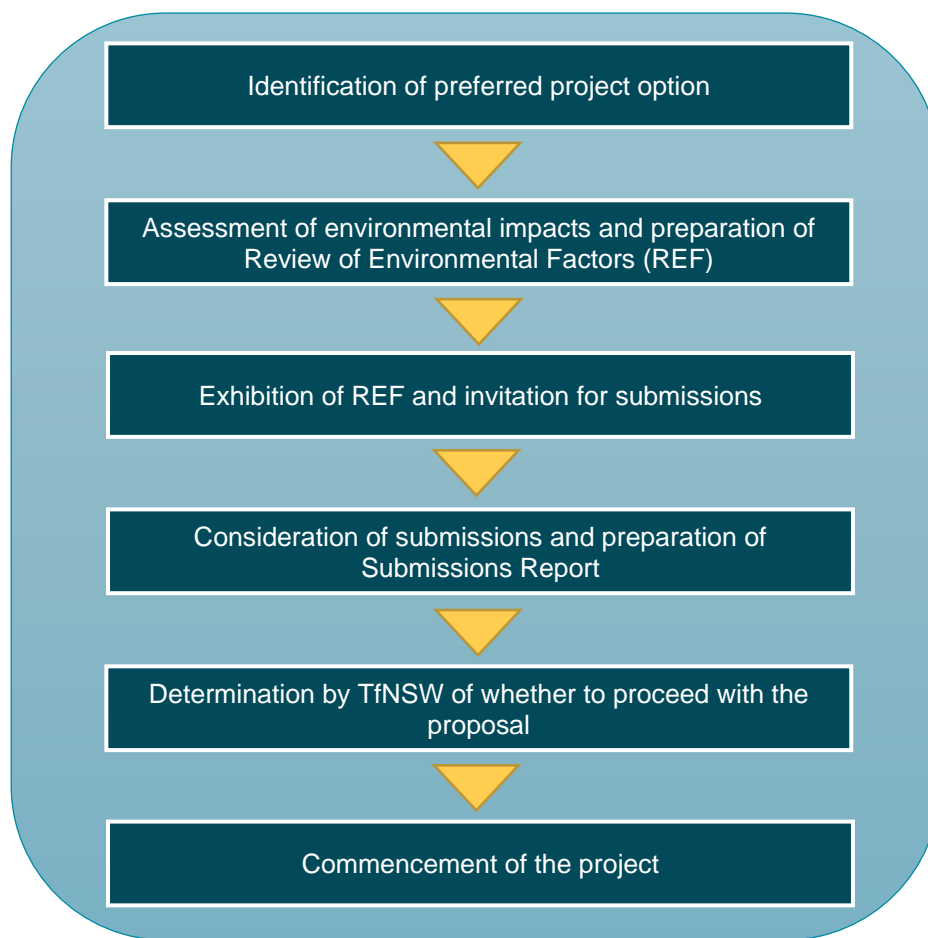


Figure 4: Planning approvals process for the proposal under the EP&A Act

4.2.2 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997 (NSW)* (the POEO Act) provides a licencing regime for specific activities relating to air, water and noise pollution, and waste management. The (NSW) Environment Protection Authority (EPA) and local government, where relevant, administer the POEO Act.

Development under the EP&A Act also requires an environment protection licence (EPL) under the POEO Act if that development constitutes a scheduled activity as set out in Schedule 1 to the POEO Act.

Regardless of whether a licence for the proposal is required, the following restrictions during construction and operation of the proposal would apply under the general terms of the POEO Act:

- Works must not pollute the environment;
- Waste must be classified, handled, transported and disposed of in an appropriate manner in accordance with the POEO Act and the Protection of the Environment Operation (Waste) Regulation 2014;
- Environmental incidents involving actual or potential harm to human health or the environment must be notified to the EPA and other relevant authorities.

The proposal would be carried out under the existing TSE Works' EPL No. 20971, with the site of the proposal premised under this licence.

4.2.3 Maritime statutory requirements

Wharf improvement works will require land owner consent from Roads and Maritime Services (RMS) and need to address the requirements of *Ports and Maritime Administration Act 1995*, the *Marine Safety Act 1998*, and the *Marine Pollution Act 2012*.

See Section 6.1 for details of potential impacts and management safeguards.

4.2.4 Marine Pollution Act 2012

The *Marine Pollution Act 2012*, requires Ship Masters and owners to implement comprehensive waste management and emergency planning and reporting procedures. Works within the Parramatta River, including barge operations, would be managed in accordance with this Act.

4.2.5 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) aims 'to conserve, develop and share the fishery resources of the State for the benefit of present and future generations' and, in particular, to:

- Conserve fish stocks and key fish habitats
- Conserve threatened species, populations and ecological communities of fish and marine vegetation
- Promote ecologically sustainable development, including the conservation of biological diversity, and, consistently with those objectives
- Promote viable commercial fishing and aquaculture industries
- Promote quality recreational fishing opportunities
- Appropriately share fisheries resources between the users of those resources
- Provide social and economic benefits for the wider community of New South Wales
- Recognise the spiritual, social and customary significance to Aboriginal persons of fisheries resources and to protect, and promote the continuation of, Aboriginal cultural fishing.

The FM Act requires a permit to be obtained for works that, among other things, are likely to:

- Harm marine vegetation such as mangroves, seagrasses and seaweeds
- Involve the use of explosives
- Obstruct fish passage
- Require dredging or reclamation.

The proposal does not involve harm to marine vegetation explosives, obstruction of fish passage or require any dredging or reclamation works.

4.2.6 Coastal Management Act 2016

The *Coastal Management Act 2016* reflects the natural, social, cultural and economic values of NSW coastal areas and promotes the principles of ecologically sustainable development in managing these values. The *Coastal Management Act 2016* divides the coastal zone into four coastal management areas, defined by the unique features of different local areas.

These four areas are defined in the new Act as part of the pending Coastal Management State Environmental Planning Policy (SEPP).

The proposal is located on land mapped as 'Coastal Wetlands' and 'Proximity Area for Coastal Wetlands' under the Coastal Management Act. The objectives for coastal wetlands areas under this Act are:

- (a) to protect coastal wetlands and littoral rainforests in their natural state, including their biological diversity and ecosystem integrity,
- (b) to promote the rehabilitation and restoration of degraded coastal wetlands and littoral rainforests,
- (c) to improve the resilience of coastal wetlands and littoral rainforests to the impacts of climate change, including opportunities for migration,
- (d) to support the social and cultural values of coastal wetlands and littoral rainforests,
- (e) to promote the objectives of State policies and programs for wetlands or littoral rainforest management.

Potential impacts of the proposal on flora and fauna have been assessed in terrestrial and marine ecology assessments, as outlined in Section 6.3. The findings of these assessments determined that ecological impacts of the proposal are considered minor provided the mitigation measures detailed in Section 7.0 are implemented

4.2.7 Biodiversity Conservation Act 2016

The Biodiversity Conservation Act 2016 (NSW) (the BC Act) provides for the protection and conservation of threatened species, protected animals and plants, declared areas of outstanding biodiversity value, and ecological communities and their habitats in NSW. It is a defence to a prosecution for an offence under Division 1 of Part 2 of the BC Act if the activity is carried out by a determining authority under Part 5 of the EP&A Act.

Part 7 of the BC Act provides for the biodiversity assessment in relation to approvals under the EP&A Act. Section 7.8 of the BC Act states that, for the purposes of Part 5 of the EP&A Act, an activity is to be regarded as an activity likely to significantly affect the environment if it is likely to significantly affect threatened species. In that case, the EIS prepared under Part 5 of the EP&A Act must include or be accompanied by a species impact statement or a biodiversity development assessment report and certain concurrence requirements apply (see section 7.12).

Section 7.2 provides that an activity is "likely to significantly affect a threatened species" if it is likely to significantly affect threatened species or ecological communities, or their habitats, according to the test in section 7.3.

Section 7.3 sets out the test for determining whether proposed development or activity is likely to significantly affect threatened species. The proponent must take into account whether:

- a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,
- b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:
 - i. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

- ii. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,
- c) In relation to the habitat of a threatened species or ecological community:
- i. The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and
 - ii. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and
 - iii. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,
- d) Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),
- e) Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

Potential impacts of the proposal on flora and fauna have been assessed in a terrestrial and marine ecology assessment, as outlined in Section 6.3 below. This assessment concluded that ecological impacts of the proposal are considered minor, provided the mitigation measures detailed in Section 7.0 are implemented. As such, preparation of a SIS is not required for the proposal.

4.2.8 Heritage Act 1977

The *Heritage Act 1977* (the Heritage Act) provides for the conservation of environmental heritage in NSW. Environmental heritage is defined as items that are of State and local importance. Heritage items usually have historical, scientific, cultural, social, archaeological, architectural, natural or visual value to the State or a particular local area. The Heritage Act protects heritage places, buildings, works, moveable objects, precincts and archaeological sites that are important to the people of NSW. Items that have particular importance to the State of NSW are listed on the State Heritage Register (SHR). Such items can include those of Aboriginal and non-Aboriginal heritage significance.

Under Section 139 of the Heritage Act, approval from OEH is required prior to the disturbance or excavation of land if a project will, or is likely to result in, a relic being discovered, exposed, moved, damaged or destroyed. Section 170 of the Heritage Act requires government agencies to maintain a heritage and conservation register (Section 170 register). These registers provide a list of government assets which may have State or local heritage significance.

An Archaeological Assessment of the proposal site was carried out by AMBS Ecology and Heritage in 2017. The assessment did not identify any items of Commonwealth, National or State significance, but did identify a number of items of local heritage significance located at the proposal site. A Statement of Heritage Significance (SoHI) was prepared and concluded that impacts to the local heritage items would be minor and that an Unexpected Finds Procedure would be an appropriate mitigation strategy.

4.2.9 Roads Act 1993

Section 138 of the *Roads Act 1993* (the Roads Act) requires TfNSW to obtain consent from the relevant roads authority for the erection of a structure, or the carrying out of work in, on or over a public road, or the digging up or disturbance of the surface of a road. However, under Clause 5(1) in Schedule 2 of the Roads Act, public authorities do not require consent for works on unclassified roads. Whilst it is not anticipated that the proposal would impact on any

classified roads, consent from the appropriate roads authority, being the RMS or the local council as relevant, may be required in accordance with Section 138 of the Roads Act in respect of work carried out by a 'public authority' if the works were to impact on a classified road.

The proposal is not anticipated to impact a classified road. However ongoing consultation would be undertaken with the relevant council(s) and/or Roads and Maritime as to the potential impacts that may occur to all of the roads along the proposed alignment and to identify any potential consent that may be required.

4.2.10 National Parks and Wildlife Act 1974 & National Parks and Wildlife Amendment Regulation 2010

The *National Parks and Wildlife Act 1974* (NSW) (**NPW Act**) provides for the management of all national parks, historic sites, nature reserves, reserves, Aboriginal areas and State game reserves. It also provides for the protection of Aboriginal places and objects throughout NSW. Under the Act it is an offence to knowingly destroy, deface or damage an Aboriginal object or place without consent.

When an activity is likely to impact upon an Aboriginal object or place, approval may be required. An Aboriginal Heritage Due Diligence Assessment was also carried out by AMBS, and determined that there are no Aboriginal heritage items or places within the study area listed on the SHR and that an Unexpected Finds Procedure would be an appropriate mitigation strategy.

The *National Parks and Wildlife Amendment Regulation 2010* excludes activities carried out in accordance with the Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW from the definition of harm in the NPW Act, meaning that test excavations may be carried out in accordance with this Code of Practice, without requiring an AHIP. The Regulation also outlines Aboriginal community consultation requirements (Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010), and a Due Diligence Code of Practice which specifies activities that are low impact, thus providing a defence to the strict liability offence of harming an Aboriginal object.

4.2.11 Water Management Act 2000

The subject site is located within 40 metres of the Parramatta River, which constitutes "waterfront land" under the *Water Management Act 2000* (WM Act). Section 91E(1) of the WM Act states that it is an offence to carry out a controlled activity in, on or under waterfront land:

- Without holding a controlled activity approval for that activity
- In a manner that does not comply with the terms and conditions of a controlled activity approval
- When a controlled activity approval is suspended.

TfNSW is the proponent and determining authority for the Proposal. Subject to Clause 38 of the Water Management (General) Regulation 2011 a public authority is exempt in relation to all controlled activities that it carries out in, on or under waterfront land (i.e. section 91E (1) of the Water Management Act).

4.3 Other relevant environmental planning instruments

The following environment planning instruments are considered relevant to the proposal:

- State Environmental Planning Policy (Infrastructure) 2007 (ISEPP)

- State Environmental Planning Policy – 33 Hazardous and Offensive Development (SEPP 33)
- Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 (Harbour REP)
- Parramatta Local Environmental Plan 2011(Parramatta LEP)

4.3.1 State Environmental Planning Policy – Infrastructure 2007

One of the aims of the Infrastructure SEPP is to provide a consistent planning framework for the delivery of infrastructure and the provision of services across NSW.

Part 3 of the ISEPP identifies the development controls for certain types of infrastructure or services, including port, wharf or boating facilities; railways; and road infrastructure facilities. The development controls specify the following planning categories:

- Development permissible without consent
- Development permissible with consent
- Exempt development
- Prohibited development
- Complying development.

Clause 79 of the ISEPP provides that development for the purpose of a railway or rail infrastructure facilities are permissible without the need for development consent under Part 4 of the EP&A Act, when undertaken by, or on behalf of a public authority.

TfNSW would obtain a short term lease over the worksite to support the delivery of the TSE Works component of the Project. Development permissible without consent is required to be assessed under Part 5 of the *Environmental Planning and Assessment Act 1979* and development consent under the provisions of Part 4 of the EP&A Act is not required.

Part 2 of the ISEPP contains provisions for public authorities to consult with local councils and other public authorities prior to the commencement of certain types of development. Consultation, including consultation as required by the ISEPP (where applicable), is discussed in Section 5.0 of this REF.

4.3.2 State Environmental Planning Policy – 33 Hazardous and Offensive Development

This Policy aims, among other things, to ensure that in considering any application to carry out potentially hazardous or offensive development, the consent authority has sufficient information to assess whether the development is hazardous or offensive and to impose conditions to reduce or minimise any adverse impact.

“Potentially hazardous industry” means a development for the purposes of any industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would pose a significant risk in relation to the locality:

- To human health, life or property; or
- To the biophysical environment

and includes a hazardous industry and a hazardous storage establishment (clause 3).

The operational activities of the proposal were assessed against the criteria of the SEPP No.33. The proposal was determined not to meet the definition of a 'potentially hazardous industry' or 'potentially offensive industry', however given the presence of the critical fuel infrastructure located within the assessment area a Preliminary Hazard Analysis was prepared to identify the key risks of the proposal as a due diligence exercise. See Section 6.7 for details.

4.3.3 Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005

The Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 (SREP) (a deemed SEPP) applies to all the waterways of Sydney Harbour, the foreshores and its wider catchment as shown in the Sydney Harbour catchment map. The SREP aims to protect, enhance and maintain the catchment, foreshores, waterways and islands of Sydney Harbour. The SREP also aims to establish a balance between promoting a prosperous working harbour, maintaining a healthy and sustainable waterway environment and promoting recreational access to the foreshore and waterways.

The proposal has been assessed against the objectives of the SREP, as set out in Table 6

Table 6: Objectives of the Sydney Harbour SREP

Objective	Comment
(a) To ensure that the catchment, foreshores, waterways and islands of Sydney Harbour are recognised, protected, enhanced and maintained as an outstanding natural asset and as a public asset of national and heritage significance for existing and future generations.	The proposal involves upgrading an existing wharf facility, which would be utilised temporarily to receive spoil and plant and equipment from the TSE Works.
(b) to ensure a healthy sustainable environment on land and water.	The proposal would not result in any ongoing adverse impacts on the environment of the land or water. Appropriate safeguards would be applied to the work to minimise impacts in both construction and operation.
(c) to achieve a high quality and ecologically sustainable urban environment.	The proposal would facilitate the sustainable reuse of spoil from the TSE Works in approved residential and industrial developments in Sydney.
(d) to ensure a prosperous working harbour and an effective transport corridor.	The proposal would enhance the role of the harbour as a working harbour. Site establishment works and operations would be managed to avoid impacts on ferries and scheduled cruise boats.
(e) to encourage a culturally rich and vibrant place for people.	Not relevant to the proposal.
(f) to ensure accessibility to and along Sydney Harbour and its foreshores.	Not relevant to the proposal.

Clause 20 of the SREP sets out matters that must be taken into consideration by public authorities before they carry out activities to which Part 5 of the EP&A Act applies.

An assessment of the proposal against the matters for consideration listed in Division 2 of Part 3 of the SREP is provided in Table 7.

Table 7: Division 2 Matters

Division 2 Matters	Comment
Clause 21 Biodiversity, ecology and environment protection	Flora and fauna issues have been considered and assessed for the proposal. An aquatic ecology assessment has been undertaken which indicates that there would be no significant long-term harm to marine species as a result of the proposal. Impacts on vegetation would be temporary and minimised by appropriate environment protection management measures.
Clause 22 Public access to, and use of, foreshores and waterways	There would be some temporary disruptions to public water transport, during the construction period, however these would not be long term changes. The changes would be communicated to Sydney Ferries and commercial craft operators ahead of the work commencing.
Clause 23 Maintenance of a working harbour	The proposal would enhance the role of the harbour as both a working harbour and an effective transport corridor by facilitating spoil transportation by barge and reducing impacts on the road network at Barangaroo and North Sydney.
Clause 24 Interrelationship of waterway and foreshore uses	The interrelationship of waterway and foreshore uses would be unchanged in the long term as a result of the proposal.
Clause 25 Foreshores and waterways scenic quality	The proposal would have a minor, short-term impact on the scenic quality of the area as discussed at Section 6.11.
Clause 26 Maintenance, protection and enhancement of views	The proposal would have a minor, short-term impact on the maintenance, protection and enhancement of views as discussed at Section 6.11.
Clause 27 Boat storage facilities	The proposal does not involve boat storage facilities.

4.3.4 Parramatta Local Environmental Plan 2011

The proposal is located within the Parramatta Local Government Area (LGA), on land zoned as IN3 Heavy Industrial under the *Parramatta Local Environmental Plan 2011* (Parramatta LEP), and adjacent to the Parramatta River, which is zoned as W2 Recreational Waterways. The operation of the ISEPP means that the Parramatta LEP would not apply to the extent that it imposes controls that are inconsistent with the ISEPP, and permissibility for the proposal is provided under the provisions of the ISEPP. Notwithstanding, during the preparation of this REF, the provisions of the Parramatta LEP were considered.

Part 5, Clause 5.10 'Heritage Conservation' of the Parramatta LEP is consistent with current heritage best practice guidelines, and provides for the protection of heritage items, places, conservation areas, and archaeological sites. Schedule 5 'Environmental heritage' does not include any Aboriginal objects or places of heritage significance within the study area or its vicinity.

4.4 Commonwealth legislation

4.4.1 Environment Protection and Biodiversity Conservation Act 1999 (Cth)

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the EPBC Act as 'matters of national environmental significance'.

Under the EPBC Act, any action that has, would have, or is likely to have a significant impact on a matter of national environmental significance or on Commonwealth land, triggers the EPBC Act and may require approval from the Commonwealth Minister for Environment.

An action may include a project, development, undertaking, activity, or series of activities. If the Commonwealth Minister for Environment determines that an approval is required under the EPBC Act, the proposed action is deemed to be a 'controlled action'. It must then undergo assessment and approval under the EPBC Act before the action is carried out. The Act provides that a proponent of an action that may be, or is, a controlled action must refer the proposal to the Minister for the Minister's decision as to whether the action is a controlled action.

Potential impacts of the proposal on flora and fauna are assessed in Section 6.3 of this REF. The proposal is not likely to have a significant impact on matters of national environmental significance or the environment of Commonwealth land within the meaning of the EPBC Act. The proposal will be referred to the Australian Department of the Environment and Energy to confirm that it is not a controlled action.

4.5 Summary of legislative requirements

A summary of the potential licences, permits, approvals and notifications that may be required for the construction, maintenance and operation of the proposal are outlined in Table 8, below.

Table 8: Summary of potential licences, permits and approvals

Legislation	Authority	Requirement	Comment
NSW State Legislation			
EP&A Act	TfNSW	Consideration: Clause 79 of the ISEPP outlines that development for the purpose of a railway and railway infrastructure facilities are permissible without the need for development consent under Part 4 of the EP&A Act when undertaken by a public authority. This REF fulfils the requirements of Section 111 of the EP&A Act, and has been prepared in accordance with Clause 228 of the Environmental Planning and Assessment Regulation 2000	This REF has been prepared to meet the assessment requirements under the EP&A Act. This REF has considered factors under clause 228 in Appendix A.
ISEPP	City of Parramatta Council	Notification: under Sections 13 to 15, 21 days notice is required for the following: (a) Substantial impact on council related infrastructure. (b) Impacts to local heritage. (c) Works which may impact flood liable land.	Notification will be given to City of Parramatta Council as part of the proposal (refer to Section 5.0), specifically with reference to Section 13, substantial impact on council related infrastructure. Consultation with Council is not triggered under Section 14, as potential impacts of the proposal on local heritage items would be minor. Similarly, Council consultation is not triggered under Section 15 as the proposal would not change flood patterns other than to a minor extent.
ISEPP	Sydney Harbour Foreshore Authority (now Property NSW)	Notification: under Section 16(2)(d), 21 days notice is required to Sydney Harbour Foreshore Authority (now Property NSW) for development in the foreshore area within the meaning of the <i>Sydney Harbour Foreshore Authority Act 1998</i> .	Notification will be given to Sydney Harbour Foreshore Authority (now Property NSW) as part of the proposal (refer to Section 5.0), specifically with reference to Section 16(2)(d), development in the foreshore area.
ISEPP	RMS	Notification: under Section 16(2)(e), 21 days notice is required to RMS for development comprising a fixed or floating structure in or over navigable waters.	Notification will be given to RMS as part of the proposal (refer to Section 5.0), specifically with reference to Section 16(2)(e), development comprising a fixed or floating structure in or over navigable waters.

Legislation	Authority	Requirement	Comment
POEO Act	EPA	Licence: The TSE Works are consistent with the definition of Rail Systems Activities described in Schedule 1 of the POEO Act. The TSE Works will also include precast segment manufacture which meets the definition of Concrete Works as defined by the POEO Act. These activities trigger the requirement to obtain and EPL for the TSE works.	John Holland has obtained EPL No. 20971 for the TSE Works. The proposal would be premised under this EPL.
Roads Act 1993	RMS	Approval: under Section 138, approval is required for road work on a Classified Road.	JHPCBG will consult City of Parramatta Council, RMS and Sydney Coordination Office.
Ports and Maritime Administration Act 1995	NSW Port Authority	Approval: Wharf improvement works will require land owner consent from Roads and Maritime Services (RMS) and need to address the requirements of Ports and Maritime Administration Act 1995, the Marine Safety Act 1998, and the Marine Pollution Act 2012.	Traffic Management Plan(s) and Communication Plan(s) would be prepared by JHPCBG in consultation with RMS and the Harbour Master for the wharf upgrade works and barging operations.
Water Management Act 2000 (WM Act).	NSW Department of Primary Industries, Crown Lands and Water	Section 91E(1) of the WM Act states that it is an offence to carry out a controlled activity in, on or under waterfront land: <ul style="list-style-type: none"> Without holding a controlled activity approval for that activity In a manner that doesn't comply with the terms and conditions of a controlled activity approval When a controlled activity approval is suspended 	The subject site is located within 40 metres of the Parramatta River, which constitutes "waterfront land" under the WM Act. TfNSW is the proponent and determining authority for the Proposal. Subject to Clause 38 of the Water Management (General) Regulation 2011 a public authority is exempt in relation to all controlled activities that it carries out in, on or under waterfront land (i.e. section 91E (1) of the WM Act).
Commonwealth Legislation			
EPBC Act	Commonwealth Department of Environment and Energy	Referral: Any action that has, would have, or is likely to have a significant impact on a matter of national environmental significance or on Commonwealth land, triggers the EPBC Act and may require approval from the Commonwealth Minister for Environment.	The proposal will be referred to the Australian Department of the Environment and Energy to confirm that it is not a controlled action.

5.0 Consultation

5.1 Overview

This section summarises the community and stakeholder consultation planned with relation to the proposal, including engagement activities to support the REF exhibition and construction phase of the proposal. The REF exhibition period will include targeted consultation to provide an opportunity for stakeholders and the community to provide feedback on the proposal.

5.2 Consultation objectives

A communications and consultation strategy has been developed to support the REF program. Consultation activities to be undertaken aim to encourage stakeholder and community involvement in the proposal. The purpose of the consultation activities is to:

- Inform nearby residents, businesses, community and other stakeholders about the proposal
- Provide quality information about the nature of the works to be undertaken at the facility, timing and likely impacts
- Foster an understanding of the mitigation measures to manage impacts to the environment and community
- Provide the community and key stakeholders with avenues to obtain further information about the proposal and provide feedback

This REF will be publicly exhibited. Through this process the community and stakeholders will be invited to make submissions, raise issues, seek clarification or ask questions about any aspect of the proposal. All issues that are raised in the submissions will be considered and responded to in a report. Where required, community updates would be provided online and delivered to local residents.

5.3 Consultation strategy

5.3.1 Land owner

The barging facility would be located on land owned by Viva Energy Australia and a portion of the site owned by RMS which is leased to Viva Energy Australia. A short term lease agreement would be entered into with Viva Energy Australia for the duration of the use of the site. Consultation with Viva Energy Australia has commenced.

5.3.2 Government agency consultation

The following consultation requirements are triggered under Division 1 of the ISEPP:

- Consultation with City of Parramatta Council under Section 13, due to potential impact on council related infrastructure or services
- Consultation with the Sydney Harbour Foreshore Authority (SHFA, now part of Property NSW) under Section 16(2)(d), due to the proposal being located within the foreshore area within the meaning of the Sydney Harbour Foreshore Authority Act 1998.
- Consultation with RMS under Section 16(2)(e), due to the proposal involving development comprising a fixed or floating structure in or over navigable waters.

In addition, the following government agencies will also be consulted regarding the proposal:

- NSW Port Authority

- Sydney Ferries
- Sydney Coordination Office (SCO)
- NSW Department of Primary Industries - Crown Lands and Water (CLW)
- Commonwealth Department of Environment and Energy
- NSW Environment Protection Authority.

5.3.3 Consultation during public exhibition

This REF will be placed on public exhibition from Friday 15 December 2017 until Monday 15 January 2018. During the exhibition period, written submissions will be accepted for consideration. Table 9 lists the key consultation and engagement activities and tools and how they will be used to engage with the community and stakeholders during the public exhibition of the REF.

Table 9: Key community and stakeholder engagement tools and activities

Engagement tool	Activity
Proposal Website	sydneymetro.info/citysouthwest
Fact sheet	<p>A fact sheet will be distributed via letterbox drop to residential and commercial properties within one kilometre of the proposed facility.</p> <p>The fact sheet will notify the community about the proposal, provide information about the works and likely impacts, how to make a submission and details regarding the community information session.</p> <p>The fact sheet will be available on the project website.</p>
Stakeholder briefings	<p>Briefing sessions will be offered to City of Parramatta Council, RMS, Harbour Master (Sydney Ports), Sydney Ferries, Sydney Coordination Office, Crown Lands and Water, Property NSW (Sydney Harbour Foreshore Authority), EPA and the Commonwealth Department of the Environment and Energy, on the proposed works that are the subject of this REF.</p> <p>Ongoing liaison with the land owners, Viva Energy Australia, and RMS will continue during the REF exhibition.</p>
Advertisement	An advertisement will be placed in the Parramatta Advertiser. The advertisement will notify the community about the proposal, how to make a submission and details regarding the community session.
Community information session	A community information session will be held during the public exhibition of the REF. This will be held at the Ermington Library on Monday 8 January 2018 between 4pm and 7pm.

The REF will be available on sydneymetro.info/citysouthwest and exhibited at Ermington Library, River Road, Ermington

Community members and stakeholders are invited to submit their feedback on the proposal to TfNSW by emailing sydneymetro@transport.nsw.gov.au or writing to:

Sydney Metro

PO Box K659

Haymarket NSW 1240

Submissions should be clearly marked 'Comments on Clyde Barging Facility REF'.

During the exhibition period, community members and stakeholders can direct any enquiries to TfNSW:

Enquiries phone line: 1800 171 386

Email: sydneymetro@transport.nsw.gov.au

5.3.4 Submissions Report

Following the REF exhibition, a Response to Submissions Report will be prepared by TfNSW. This report will:

- Summarise the issues raised in the submissions
- Provide responses to each issue raised in the received submissions
- Describe the proposed modifications and describe and assesses the environmental impact of these changes
- Identify any proposed new or revised environmental safeguards and management measures.

TfNSW will write to individuals and organisations that have made submissions advising them that their submission will be addressed in the Response to Submissions Report. The Response to Submissions Report will be published on the Sydney Metro City and Southwest website sydneymetro.info/citysouthwest

5.3.5 Ongoing or future consultation

Should TfNSW approve the proposal, ongoing consultation and communication activities would be undertaken with the land owner, surrounding residents and businesses, and key stakeholders as required. These activities would be undertaken by the TSE Works contractor, JHCPBG, in consultation with TfNSW.

6.0 Environmental assessment

6.1 Construction traffic and transport

6.1.1 Existing environment

Road network

Grand Avenue is located between James Ruse Drive and the Parramatta River and is an extension of Hassall Street. It is located within the industrial area of Rosehill and generally consists of one lane in each direction with parking unrestricted along its length. The speed limit along Grand Avenue is 60km/hr. Grand Avenue is a recognised B-Double route and services a number of industrial businesses, together with providing service entry to Rosehill Racecourse.

State roads located adjacent to Grand Avenue include James Ruse Drive, M4 Western Motorway, Great Western Highway and Victoria Road. Figure 5 shows the location of Grand Avenue and its proximity to the State Road system. Figure 6 provides an overview of the existing road configuration in the area.

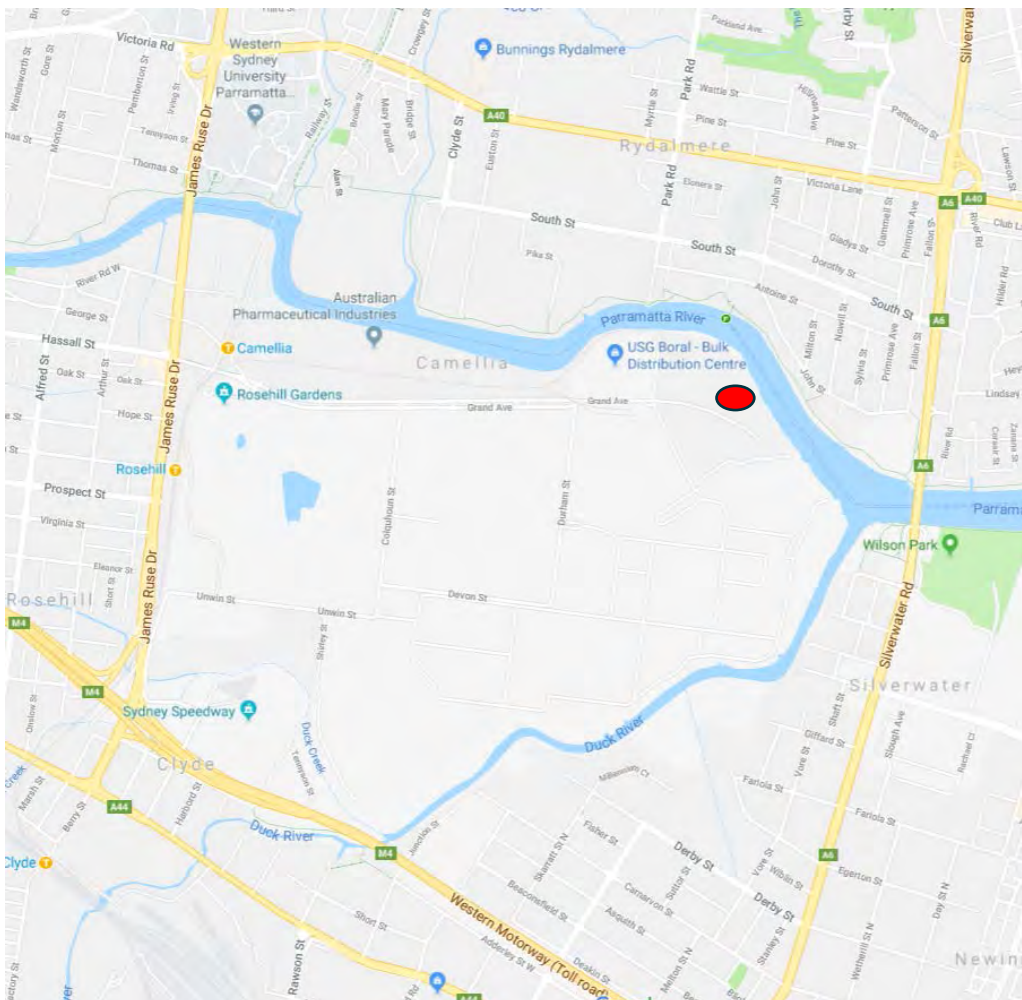


Figure 5: Grand Avenue location



Figure 6: Existing road configuration in the Camellia area (Source GTA Consultants Technical Paper 1 Parramatta Light Rail)

Public transport network

Public transport is largely focused on the use of Rosehill Racecourse with no public transport operating along Grand Avenue. On race days shuttle services operate between Parramatta and Harris Park rail stations and the drop off/pick up zones are accessed from James Ruse Drive. The T6 Carlingford rail line has a station which has direct access to the racecourse and to James Ruse Drive. Refer to Figure 7 for details on public transport options near Grand Avenue.

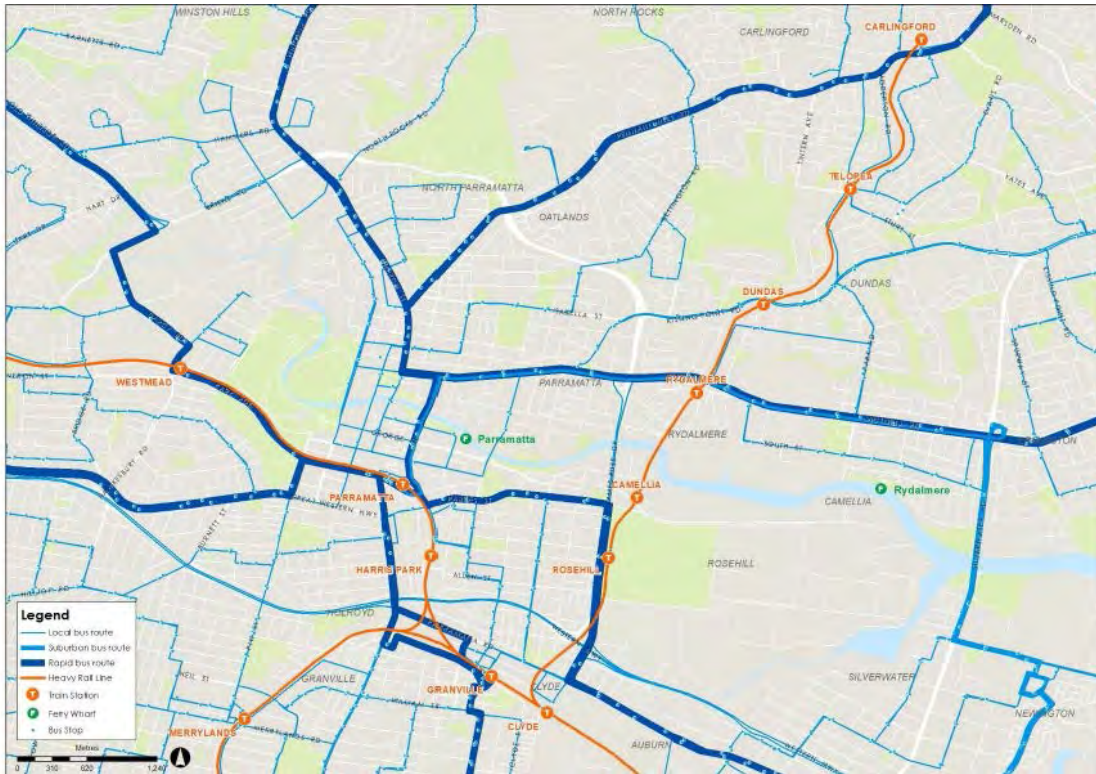


Figure 7: Public transport availability (Source GTA Consultants Technical Paper 1 Parramatta Light Rail)

Cycling and walking

There are limited cycling facilities on Grand Avenue with a shared off-road path from James Ruse Drive which then meets the on-road cycleway. The on-road section of the cycleway is nominated as moderate difficulty on the RMS Cycle Way Finder. Refer to Figure 8 below.

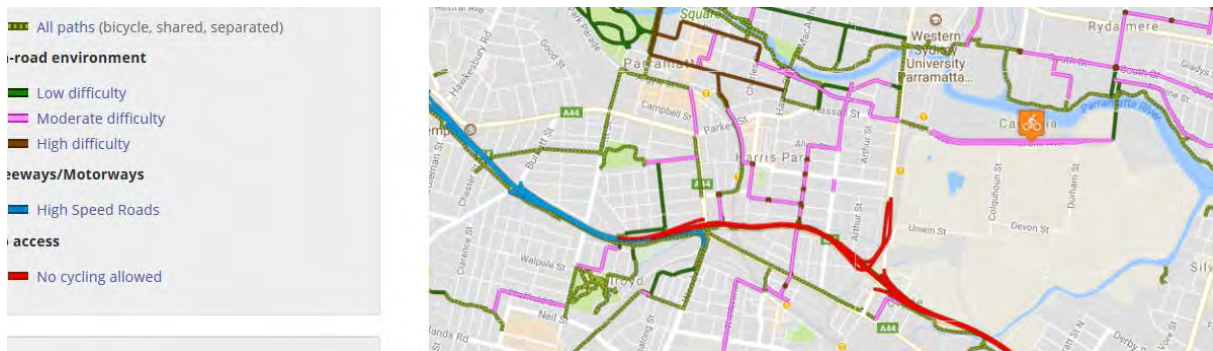


Figure 8: Cycleways on Grand Avenue (Source <http://www.rms.nsw.gov.au/roads/bicycles/cyclewayfinder>)

There are no dedicated crossing points along Grand Avenue North. There are signalled crossings at the intersection of James Ruse Drive across all intersection legs.

Ferries and other river users

Sydney Ferry services run along the Parramatta River and the worksite is located between the Rydalmere and Sydney Olympic Park ferry wharfs. Ferry services pass the worksite at a frequency of approximately two per hour during am and pm weekday peaks.

The section of the Parramatta River adjacent to the worksite is also used by private cruise operators. Recreational boating including fishing is not permitted west of the Silverwater Bridge.

The Parramatta River Catchment group has reintroduced swimming at Parramatta Lake further upstream but swimming in the section of the Parramatta River adjacent to the worksite is not permitted.

6.1.2 Potential impacts

Proposal overview

As noted in Section 3.4.2, the proposal includes extending the existing access road through the easement to the new site access at the end of Grand Avenue. The existing access road would be upgraded to provide for truck movements and the existing drainage lines would also require clearing and upgrading. Exact traffic arrangements and controls would be confirmed during detailed design and if two-way movements are not provided for, temporary traffic signals or a passing bay may be used. Earthworks to reduce the gradient on the access road approaches to the existing bridge over the water main would be undertaken to allow for heavy vehicle passage.

As noted in Section 3.5, during operation the worksite would receive barges carrying spoil excavated from the new Sydney Metro Barangaroo Station and underground structures including the under-harbour tunnels. This material would be loaded onto trucks and trailers at the receipt site using excavators and transported to approved locations throughout Sydney for reuse.

Barges transferring plant and equipment, including TBM components, would also use the site. Plant and equipment would be transferred to land using self-propelled mobile trailers and either stored at the site or transported off site via truck.

Under the proposal, barges of up to 55 metres in length would be utilised. Over 760,000 tonnes of excavated material is expected to be received at the site over the life of the TSE Works. There would be approximately two spoil barges arriving per day and during operations a total of 10-15 barges would be used to transfer plant and equipment including, TBM components.

The size of the barges to be used and the capacity would be determined during detailed design and take into consideration the depth of the riverbed during different tidal conditions, ferry routes and final design of the upgraded wharf.

The spoil would be transferred into truck and trailers for reuse at approved locations. There would be approximately 21,875 truck and trailer departures over the life of the proposal. Dependent on the progress of tunnelling, approximately on average 63 truck and trailers would be required per day to remove spoil off-site. During peak periods there would be up to 125 truck and trailers required per day to remove spoil off-site. Truck access would be via a new site entrance at the end of Grand Avenue, Rosehill. From Grand Avenue, trucks are proposed to turn left onto James Ruse Drive and onto M4 west, avoiding residential areas. Some oversize plant and equipment may need to be transported to the site through access roads within Viva Energy Australia's facility.

Operating conditions

The only access/egress to the site would be via Grand Avenue except for oversize loads which would need to be transported through Viva Energy Australia's facility. Trucks would be able to be accommodated on the site and have no requirement for layover on the road system. During peak operations there would be 20 heavy vehicle movements (total inbound and outbound) per hour. These vehicles would need to enter Grand Avenue the intersection of James Ruse Drive. Staff numbers at this site would typically be low and all light vehicles can be accommodated on site.

Cumulative impacts

Viva Energy Australia are currently operating a fuel distribution terminal and decommissioning redundant infrastructure in preparation for redevelopment. Currently there are approximately 10 heavy vehicle movements (total inbound and outbound) per hour, 24 hours per day, seven days per week. These trucks access the Viva Energy Australia facility via Durham Street and turn onto Grand Avenue access sites.

Parramatta Light Rail is due to commence enabling works in the third quarter of 2018 with construction due to commence at the latter half of the fourth quarter 2018/first quarter of 2019, refer to Figure 9 below.

ACTIVITY	2018				2019				2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Enabling works																								
Main construction works																								
Testing and commissioning																								

Figure 9: Parramatta Light Rail indicative construction program (Source: Parramatta Light Rail Stage 1 Westmead to Carlingford via Camellia Environmental Impact Statement)

The Stabling and Maintenance Facility is proposed as part of for the Parramatta Light Rail and is proposed to be located at 6 Grand Avenue, as shown in Figure 10. Remediation works on the site will commence prior to the construction period and will be subject to a separate environmental assessment.



Note: Red line indicates proposed project alignment and stops

Figure 10: Parramatta Light Rail route and facilities (Source: Parramatta Light Rail Stage 1 Westmead to Carlingford via Camellia Environmental Impact Statement)

During the construction period, Parramatta Light Rail will see an average of 96 heavy vehicles (total inbound and outbound) operate from the Stabling and Maintenance Facility site.

Haulage routes

TSE Works trucks would travel along Grand Avenue and onto James Ruse Drive and then onto the M4 Motorway. The return trip would follow the route in reverse. Refer to Figure 11 below.

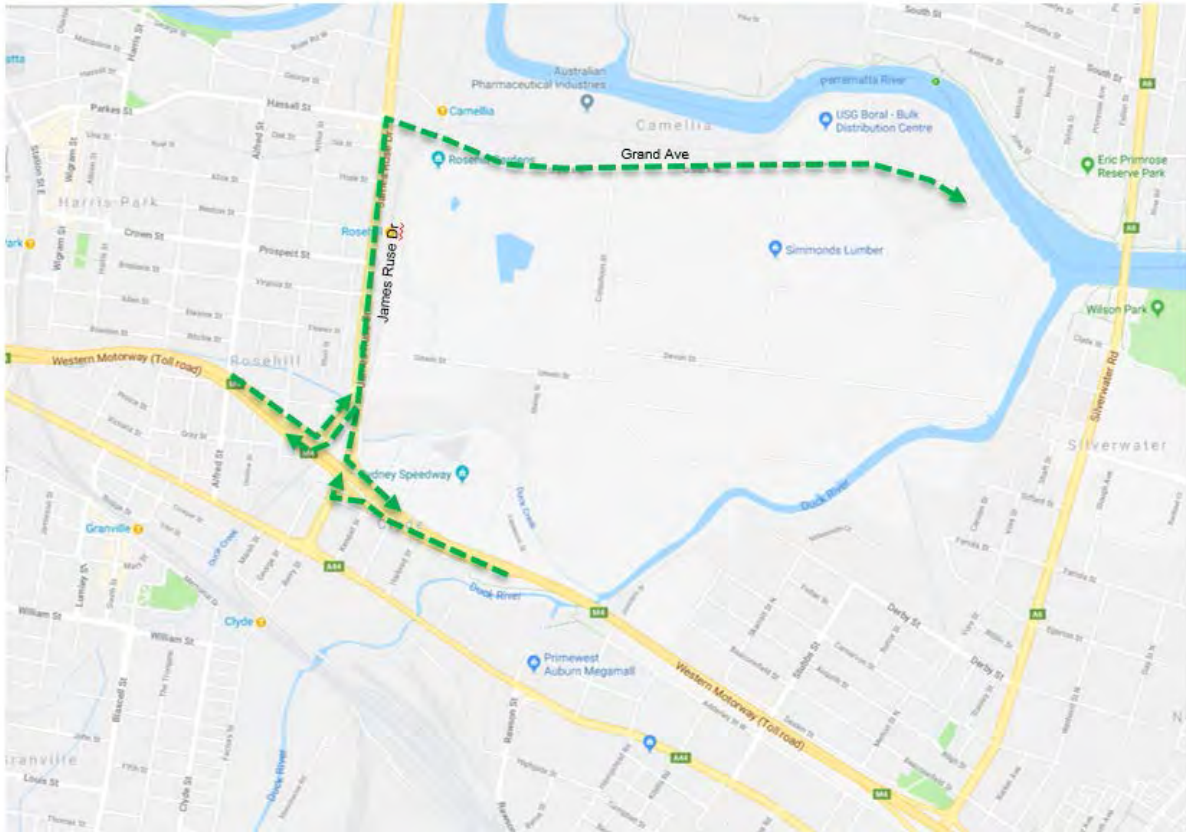


Figure 11: Haulage routes

River and harbour traffic

As noted above, use of the Parramatta River adjacent to the worksite is largely limited to Sydney Ferry services and scheduled private harbour cruises. Wharf upgrading works can be managed without the need to suspend these services, subject to the implementation of controls including warning signage and lights.

6.1.3 Safeguards and management measures

Table 10 identifies environmental safeguards and management measures that would be implemented to address the potential traffic and transport impacts of the proposal.

Table 10: Construction traffic and transport safeguards and management

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
T1	Construction traffic and transport	<p>A Construction Traffic Management Plan (CTMP) would be developed for road based traffic associated with the worksite. This CTMP would address:</p> <ul style="list-style-type: none"> a) Consideration of methods to minimise peak period traffic disruptions b) Safe provision for vehicles, cyclists and pedestrian traffic c) Implement appropriate operational and other measures 	Traffic and Transport Manager	Prior to the commencement of construction

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
		to ensure the safety of vulnerable road users. The CTMP would be prepared in consultation with Parramatta Council, endorsed by the Sydney Coordination Office and approved by RMS		
T2	Construction traffic and transport	Road safety audits would be undertaken during the development of the CTMP and following completion of site establishment works	Traffic and Transport Manager	Detailed design and construction
T3	Construction traffic and transport	Traffic Management Plan(s) and Communication Plan(s) would be prepared in consultation with RMS and the Harbour Master for the wharf upgrade works and barging operations.	Approvals, Environment and Sustainability Manager	Prior to the commencement of works within Parramatta River

6.2 Construction noise and vibration

A noise and vibration impact assessment prepared by Renzo Tonin and Associates is provided in Appendix A. A summary of this assessment is provided in this Section.

6.2.1 Existing environment

The worksite is located within an industrial area. Residential receivers in the suburb of Rydalmere (John St, Fallon St, Primrose Ave, Sylvia St, Nowill St and Milton St) are located to the north. The nearest receivers in this area are approximately 320 metres from the proposed barging facility.

Residential receivers in the suburb of Ermington (River Rd on the east side of Silverwater Rd) are located to the north-west. The nearest receivers in this area are approximately 350 metres from the proposed barging facility.

Eric Primrose Reserve (passive and active recreation area) is located north of the barging receival site on the northern bank of the Parramatta River (approximately 250 metres from the proposed barging facility). Silverwater Park (passive and active recreation area) is located east of the worksite site on the southern bank of the Parramatta River (approximately 175 metres from the proposed barging facility).

Criteria for the assessment of construction noise are generally derived from the existing noise environment of an area. Fact Sheet B of the NSW EPA 'Noise Policy for Industry' (NPfI) outlines two methods for determining the background noise level of an area, being 'B1 – Determining background noise using long-term noise measurements' and 'B2 – Determining background noise using short-term noise measurements'. This assessment has used a combination of short-term noise monitoring and estimated average background L_{A90} noise levels from Australian Standard AS 1055.2-1997. Background noise monitoring undertaken in November 2017 confirmed that some of the residences around the worksite are impacted by road traffic noise, with levels ranging from 40 to 55 dB(A).

6.2.2 Potential impacts

Site establishment, operations and decommissioning works would generally be undertaken Mondays to Fridays 7:00am to 6:00pm and Saturdays 8:00am to 1:00pm. There may be a

need for works outside of these hours, particularly due to tides or to coordinate with other vessel movements or restrictions on oversize road vehicle movements.

Potential noise emissions from the worksite have been assessed against the NSW 'Interim Construction Noise Guideline' (ICNG, 2009). The construction works are proposed to be undertaken only during standard construction hours. As such, the Noise Management Levels at residential receivers are based on the Ratings Background Level + 10 dB. Assessment of representative construction scenarios have been undertaken using a Cadna-A computer noise model developed for this worksite. Predicted noise levels exceed the noise management objectives at the nearest residential receivers to the north (away from Silverwater Road) and at passive recreation areas in Silverwater Park and Eric Primrose Reserve during piling activities at the wharf which would be undertaken intermittently over a two-month period. All other activities are predicted to comply with the noise management objectives.

Vibration impacts have been assessed using the NSW 'Assessing Vibration; a technical guideline' and British Standard 7385: Part 2-1993 *Evaluation and measurement of vibration in buildings* to confirm working distances for cosmetic property damage. Prior to the commencement of construction activities, a detailed site survey should be undertaken to determine if there are any sensitive structures and/or buried pipework within the minimum working distances. If any such structures are identified, detailed assessment is required to establish safe vibration levels and a proposed monitoring plan to ensure that vibration levels comply with the appropriate criterion.

6.2.3 Safeguards and management measures

Table 11 identifies environmental safeguards and management measures that would be implemented to address the potential noise and vibration impacts of the proposal.

Table 11: Construction noise and vibration safeguards and management

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
NV1	Construction noise and vibration	Site establishment, operations and decommissioning works would generally be undertaken Mondays to Fridays 7:00am to 6:00pm and Saturdays 8:00am to 1:00pm. There may be a need for works outside of these hours, particularly due to tides or to coordinate with other vessel movements or restrictions on oversize road vehicle movements.	Site Supervisor	During construction
NV2	Construction noise and vibration	A detailed Construction Noise and Vibration Impact Statement (CNVIS) would be prepared following detailed design to confirm the exact mitigation measures to be implemented during site establishment, operations and decommissioning.	Project Environment Manager	Prior to the commencement of construction
NV3	Construction noise and vibration	The following noise management measures would be included in the CNVIS: <ul style="list-style-type: none"> a) Community notification b) Site inductions and tool box talks 	Project Environment Manager	Prior to the commencement of construction

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
		c) Behavioural practices		
NV4	Construction noise and vibration	Undertake attended monitoring during representative noise generating works.	Project Environment Manager	During construction

6.3 Flora and fauna

6.3.1 Existing environment

Terrestrial

A field inspection was undertaken on 6 October 2017 by AMBS Ecology and Heritage. The inspection included a flora survey of the area where the proposed road works would be undertaken and the area for the proposed barging facility upgrade. The field inspection also included an examination of the wetland area adjacent to the worksite known Green and Golden Bell Frog (GGBF) habitat.

A constructed wetland is situated directly west of the proposed Clyde barging facility access road. The wetland is surrounded by a band of vegetation with varying width of mostly planted terrestrial vegetation dominated on the eastern fringe with Swamp Oaks and various Eucalypts. There is also a narrow strip of mangrove trees growing along the edges of the Parramatta River to the north and south of the proposed barging facility.

A detailed description of the flora and fauna identified is listed in the terrestrial flora and fauna assessment undertaken by AMBS and is included in Appendix B.

The assessment undertaken by AMBS identified that the Clyde barging facility forms a large component of the area supporting the "Clyde/Rosehill key population" of the GGBF. Within the Clyde Wetlands area, the species was recorded on the western side of the northern main pond during surveys by UBMC in 2006 and AECOM in 2012, and on the eastern side of the southern main pond during surveys by AECOM in 2012 and Jacobs in 2016. There are no records of the species from within the subject site in any of the studies conducted and AMBS did not record the occurrence any GGBF during their field assessment in 2017.

Marine

A field assessment was carried out to ascertain the current condition of the site and surrounding study area and the presence, or likely presence, of threatened or protected species, populations and communities. This was undertaken in the afternoon of 5 October 2017 to coincide with low tide.

The assessment identified estuarine vegetation communities within the locality that included mangroves, saltmarsh and Swamp-oak Forest. The assessment did not identify any seagrass within the study area which is consistent with AECOM (2010) study which found that seagrasses were only found downstream of Concord Road, Ryde Bridge approximately 5 km downstream of the Site.

There are no RAMSAR listed wetlands within the Parramatta River estuary catchment.

The majority of the Estuarine Mangrove Communities of the study area would not qualify as Coastal Saltmarsh Endangered Ecological Community as they are dominated by dense stands of Grey Mangrove with absent understorey and groundcover.

One species of bony fish has been recorded within the locality and it is listed as Vulnerable under the FM Act. The Black Cod (*Epinephelus daemeli*) is a large, reef-dwelling species belonging to the grouper family, which is found in warm temperate and subtropical parts of the south-western Pacific. They generally inhabit near-shore rocky and offshore coral reefs at depths down to 50 m. Recently settled juvenile black cod (i.e. individuals that have recently completed the pelagic, drifting larval stage) are often found in coastal rock pools while slightly older juvenile black cod are often found in estuary systems. Juveniles of this species have some potential to be found in the Study Area.

6.3.2 Potential Impacts

Terrestrial

Potential impacts of the proposed development include:

- Removal of vegetation and habitat, including part of the EEC Swamp Oak Forest, possibly part of the EEC Freshwater Wetlands, and part of the terrestrial habitat within 200 metres of a known GGBF site
- Providing a potential vector for weeds and pathogens
- Introduction/increase in noise and activity near an area of potential habitat for migratory birds
- Introduction of a saline influence to the wetland from the Parramatta River
- Pollution, erosion and sedimentation, particularly potential impacts on water quality in the wetland and the Parramatta and Duck Rivers
- Dust.

The Clyde Wetlands, although highly modified, are a significant local resource in an otherwise industrial landscape and contain flora and fauna of National, State and regional significance. The proposal would directly impact on some of these biota. However, the direct impacts of the proposal are limited to a small area of partly-planted Swamp Oak Forest and possibly a very small area of weed-infested Freshwater Wetland along the northern edge of the wetlands area. The proposal is temporary and vegetation would be re-planted following completion of construction.

Provided that the proposal is carried out in a particular manner and incorporates the measures detailed in Table 12, the proposal is not likely to have a significant impact on threatened species, populations or ecological communities. The proposal would however, remove terrestrial habitat from a known GGBF area, which is a trigger for a referral under the EPBC Act.

Marine

An assessment of significance to assess the potential impacts on the Black Cod listed as Vulnerable under the FM Act concluded that the risks to this species are minimal and could be managed with commonly applied measures, and therefore it is considered unlikely that this proposal would cause significant impacts and hence the preparation of a Species Impact Statement is not required.

Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions was the only marine matter listed under the BC Act considered to potentially be at risk from this proposal. The test for determining whether the proposal is likely to significantly affect the EEC concluded that this community was not at direct risk and that any potential indirect impacts

could be managed with the implementation of commonly applied mitigation measures. The assessment determined that the preparation of a Species Impact Statement was not required.

The marine flora and fauna assessment undertaken by AMBS is included in Appendix B

6.3.3 Safeguards and management measures

Table 12 identifies environmental safeguards and management measures that would be implemented to address potential flora and fauna impacts of the proposal.

Table 12: Flora and fauna safeguards and management

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
FF1	Flora and Fauna	Access to the wetland area and surrounding vegetation would be avoided except for environmental mitigation and monitoring purposes.	Project Environment Manager	Pre-construction and construction
FF2	Flora and Fauna	A pre-clearance survey in the Swamp Oak Forest would be undertaken within two weeks prior to construction in order to identify any nests or other features within the construction zone. If nests, hollows or coarse woody debris occur an ecologist would be present during vegetation clearing to manage fauna that may be present.	AMBS	Prior to site establishment works
FF3	Flora and Fauna	A temporary frog-fence would be established along the southern side of the construction area and maintained for the life of the project. Pre-clearance searches for sheltering GGBFs would be undertaken after erection of the fence and prior to construction. This would include diurnal and nocturnal searches and incorporate the easement area and along the KLF waste management facility fence line.	Project Environment Manager AMBS	During site establishment works
FF4	Flora and Fauna	Implement frog hygiene protocols consistent with the <i>Hygiene protocol for the control of disease in frogs</i> (DECC 2008) and erect information signs to prevent non-disinfected vehicles/equipment/people from entering the site.	Project Environment Manager	Pre-construction and construction
FF5	Flora and Fauna	Construct a chytrid fugus (<i>Phytophthora cinnamomi</i>) and weed wash area at the Grand Avenue access. Vehicle wheels, equipment and shoes must be cleaned so that they are free of dirt and debris, then sprayed or washed with solution containing 10% bleach.	Site supervisor	Pre-construction and construction

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
FF6	Flora and Fauna	<p>Site supervisors are to be inducted on Hygiene protocol for the control of disease in frogs (DECC 2008) and frog handling techniques.</p> <p>Workers would be inducted on the location and identification of threatened entities, the importance of the Clyde Wetlands area, and what to do if a frog or other animal is encountered.</p>	Project Environment Manager	Prior to commencing work
FF7	Flora and Fauna	Exclusion zones would be set up at the limit of clearing to protect the adjacent wetland, Swamp Oak Forest and Mangrove Forest Community	Project Environment Manager	During site establishment works
FF8	Flora and Fauna	Any fill to be brought onsite for construction purposes should be clean and tested or processed to ensure no contaminants are present	Construction Manager	During site establishment works
FF9	Flora and Fauna	<p>While work is being undertaken on site conduct daily checks of the following:</p> <ul style="list-style-type: none"> a) Frog exclusion fences b) Monitor the chytrid barrier wash area c) Confirm other sterilisation procedures are being implemented correctly <p>A daily checklist would be prepared to assist in implementation of this requirement.</p>	Site Supervisor	Daily when works are being undertaken
FF10	Flora and Fauna	Timber from native trees removed would be re-used as coarse woody debris in the adjacent woodland, particularly along the northern edge of the wetland, and as advised by AMBS.	Site Supervisors AMBS	During site establishment works
FF11	Flora and Fauna	It is recommended that the area of vegetation cleared for the project is re-vegetated post-development. Revegetation works would be co-ordinated with other bush regeneration and management activities undertaken in the study area and be consistent with UBM (2017)	Project Environment Manager	Post construction
FF12	Flora and Fauna	Weed control and monitoring would be undertaken prior, during and post-construction. Any weeds removed would be undertaken using low impact techniques to minimise disturbance and/or destruction of significant flora and fauna,	Project Environment Manager	During site establishment works

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
		mobilisation of sediments, and pollution by herbicides.		
FF13	Flora and Fauna	Herbicides used must be registered or permitted for aquatic situations and personnel must follow all product label directions.	Project Environment Manager	During site establishment and construction
FF14	Flora and Fauna	Green waste including weeds is to be disposed of responsibly. Seed bearing debris, bulbs, corms, rhizomes and succulents which regenerate from fragments are to be bagged and removed off-site at the end of work sessions (not stockpiled overnight). All green waste must be taken off-site and disposed at an appropriately licenced facility.	Project Environment Manager	During site establishment works
FF15	Flora and Fauna	Any temporary stockpiling of soil that may contain seed of exotic species would be away from adjacent vegetation or stormwater drains where they could be spread during rainfall events	Site supervisor	During site establishment works
FF16	Flora and Fauna	Night-time truck movements would be limited as far as practicable and a speed limit of 20 km/hr at night would be enforced	Site supervisor	During operation
FF17	Flora and Fauna	Light spill into the wetland and surrounding vegetation would be minimised as much as possible. There is to be no additional lighting of the access road and lights on the wharf, truck turning area and site office area would be subdued as much as possible and directed away from the wetland.	Site supervisor	During operation
FF18	Flora and Fauna	Noise such as horns and air brakes would be avoided except during emergencies and noise generally kept to a minimum, particularly along the section of road through the Swamp Oak Forest.	Site supervisor	During operation
FF19	Flora and Fauna	A temporary visual screen would be erected on the southern side of the track between the easement and the section of track running north-east from the easement, to screen truck movements from water birds in the wetland.	Project Environment Manager	During site establishment works
FF20	Flora and Fauna	No chemicals, fuels and / or wastes would be stored within or near any natural or stormwater drainage lines or on the foreshore. All such substances are to be contained in sealed vessels of appropriate	Site supervisor	During site establishment works and operation

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
		volumes and, where necessary, stored within bunded areas.		
FF21	Flora and Fauna	All in-water activities associated with piling would be scheduled to coincide with favourable tidal conditions to ensure that sediment re-suspension and dispersion is minimised, e.g. calm conditions and minimal tidal fluctuation where practicable.	Site supervisor	During site establishment works
FF22	Flora and Fauna	Floating booms, silt curtains or screens would be used during in-stream activities to minimise the mobilisation of sediments and the spread of suspended sediments.	Site supervisor	During site establishment works
FF23	Flora and Fauna	Aquatic habitat would be protected in accordance with Section 3.3.2 <i>Standard precautions and mitigation measures of the Policy and guidelines for fish habitat conservation and management Update 2013</i> (NSW DPI 2013) and <i>NSW control Plan for the Noxious Marine Alga <u>Caulerpa taxifolia</u></i> (I&I NSW 2009)	Project Environment Manager Site supervisor	Prior to and during construction
FF24	Flora and Fauna	If the blocked drain between the wetland and the river is repaired, the drainage upgrades would ensure that the normal water levels of the Parramatta River and Duck River cannot flow into the wetland. The drainage would be one-directional, allowing water to drain from the wetland to the river during overflow events, but not the reverse.	Site supervisor	During site establishment works

6.4 Soils and water

6.4.1 Existing environment

Soils

The topography of the property is generally flat to slightly undulating. Soils within the study area are classified as Disturbed Terrain, comprising a relatively level ground extensively disturbed by human activity through land reclamation and levelling (see Figure 12). Dominant soils in the area comprise loose black sandy loam, variable transported fill and dark dredged muds and sands (Chapman and Murphy 1989:132:133).

Acid sulfate soils (ASS) are soils and sediments containing iron sulphides that, when exposed to oxygen, generate sulphuric acid and potentially toxic quantities of aluminium and other heavy metals. The sulfuric acid and heavy metals are produced in forms that can be readily released and absorbed into the environment, with potential adverse effects on the natural and built environment and human health. Department of Land and Water Conservation Acid Sulfate Soil Risk maps (Murphy, 1997) identify the proposed site as having a high probability of ASS within one metre of the ground surface.

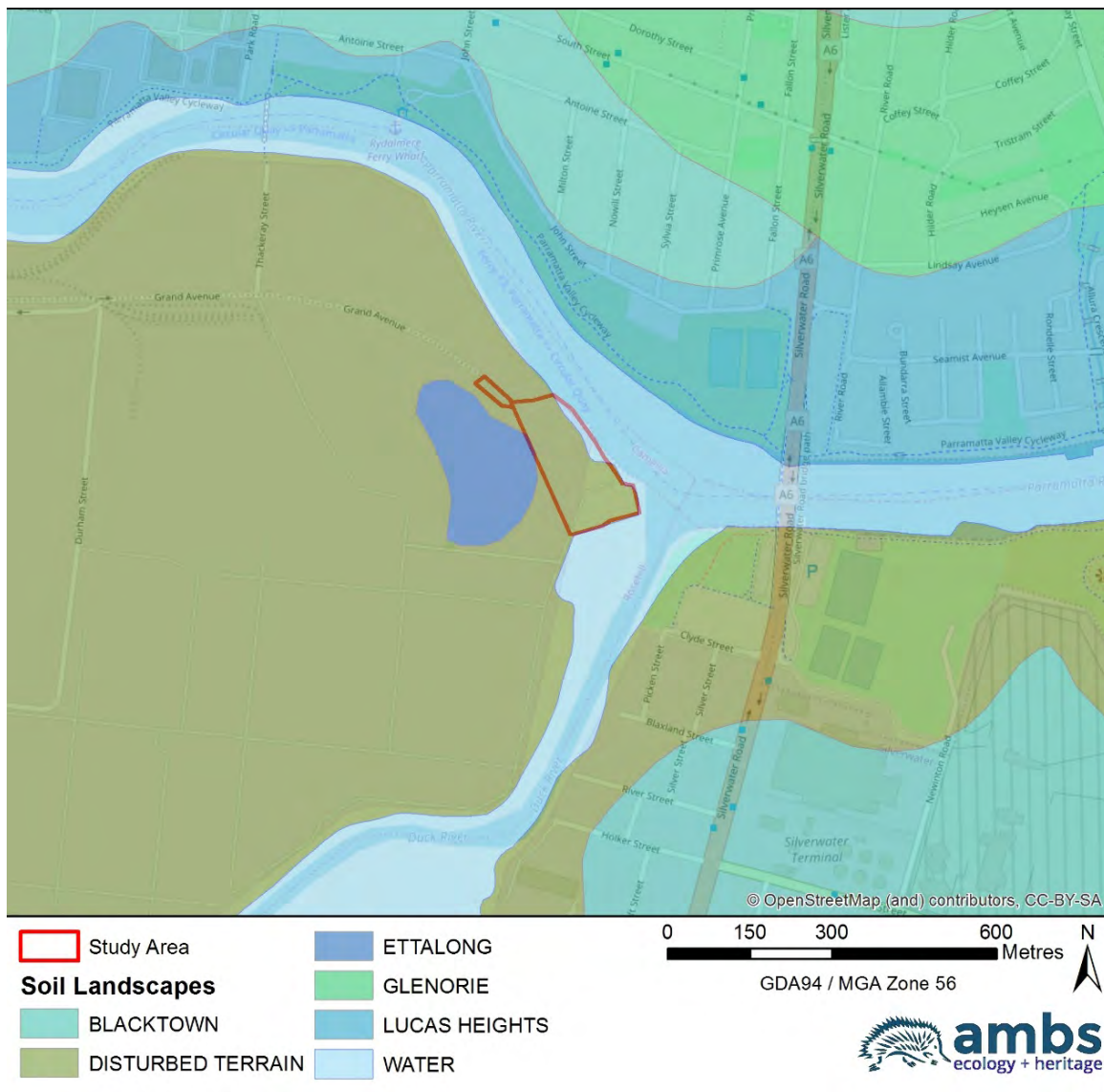


Figure 12: Soil landscapes in the vicinity of the study area (soil landscape information from Chapman and Murphy et al 2009)

Contamination

AECOM (2013) indicates that based on current and historical soil and groundwater conditions within the Viva Energy Australia facility, as well as boundary groundwater monitoring network, there is no groundwater affected by Contaminants of Concern (COCs) in concentrations above applicable EPA criteria migrating offsite, nor is it impacting adjacent sediments or river systems.

Catchment, surface water and flooding

The proposed site is located within the Parramatta River sub-catchment, one of eight sub-catchments in the Sydney catchment, and managed by the Sydney Metropolitan Catchment Management Authority. The Parramatta River is the main tributary of Sydney Harbour, extending from Blacktown Creek in the west to the confluence of the Lane Cove River in the east. The Parramatta River catchment area is over 257 km², with the estuary covering 12 km². It is one of the most urbanised catchments in Australia. Historical land uses have highly modified the nature of the estuary, with a range of sediments and pollutants impacting on water quality and habitat values.

Water quality within the Parramatta River sub-catchment is varied across location and over time (Laxton et al, 2008). There are a number of environmental concerns with regards to the general health of the Parramatta River including turbid water, sickness from primary contact with the water, excessive algal and weed growth, unhealthy fauna, gross pollutants in waterways, oil and grease presence in the water and loss of creek habitats including vegetation and fauna shelters. Table 13 details the factors affecting water quality of the Parramatta River between 1990 and 2007.

Table 13: Factors affecting water quality in the Parramatta River between 1990 and 2007 (Laxton et al, 2008)

Environmental factor	Impact on water quality
Nitrogen and phosphorous presence	Nitrogen and Phosphorous concentrations in the Parramatta River range between 0.5 to 2 mg/L and 0.05 to 0.25 mg/L respectively. High nutrient concentrations have resulted in increases in weed and algal growth.
Turbidity	During wet weather, turbidity within the Parramatta River is considered to be poor.
Faecal coliforms	Levels are generally safe for secondary contact during dry weather, but conditions are unsafe during wet weather due to significant sewer overflows.
Sediment	Sediment levels are higher than what would be expected in a natural system.
Oil	Oil concentrations are considered to be significant as a result of uncontrolled runoff from many roads and hardstand areas.
Heavy metals	Heavy metal concentration is not considered to be detrimentally affecting water quality; however, levels are up to 12 times higher than acceptable limits in bottom sediments.

AECOM (2013) indicates that the proposed site lies within the 1:100 year flood event, and the Probable Maximum Flood area. Grand Avenue is largely unaffected by flooding. Viva Energy Australia's facility currently has an extensive stormwater management system which was substantially upgraded in the mid-1990s. All Viva Energy storm water flows to one of two interceptor systems before either being released to Duck Creek via licensed discharge points, or alternatively proceeding through a biotreater for additional treatment prior to release into Duck Creek.

Parramatta river is tidal and the tidal range approximately 1.9 metres.

6.4.2 Potential impacts

With respect to contamination and ASS, site establishment works would only involve minimal excavation activities to an estimated maximum depth of 300mm. It is therefore unlikely that groundwater would be encountered during these works. ASS soils if encountered during earthworks, can be managed in accordance with standard practices.

Drainage arrangements would be upgraded where required as part of the proposal and this would reduce the risk of flooding, particularly along the site access road. Given the extent of existing hardstand and limited vegetation clearing required to establish the site, the proposal would not result in significantly different volumes of stormwater runoff from the site area and is therefore not anticipated to increase flooding risks for surrounding areas. The proposal

does not involve any clearing of vegetation on the Parramatta River banks and the barge movements would not create significant wash. Therefore, the proposal would not impact on tidal regimes in the area. The tidal range will be considered in the planning for construction and barging activities.

The water discharged from the proposed site would continue to be heavily influenced by storm events. During site establishment, operations and decommissioning works there is potential for site runoff to contain elevated sediment levels.

The barging facility upgrade works would need to be carefully planned and managed to reduce potential for disturbance of the river bed. During barge unloading operations there is potential for spoil to be dropped into the Parramatta River. Suitable controls would be identified as part of detailed construction planning and may include installation of a connection lip between moored barges and the wharf and/or silt curtains.

These controls would be detailed in a site-specific Erosion and Sediment Control Plan which would be prepared, implemented and progressively updated.

6.4.3 Safeguards and management measures

Table 14 identifies environmental safeguards and management measures that would be implemented to address potential soil and water impacts of the proposal.

Table 14: Soil and water safeguards and management

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
SW1	Soil and water	Earthworks would be designed and managed to control and protect the health and safety of people onsite. If contaminated soils are discovered during excavations, they would be separated and managed in accordance with a site specific Contamination and Acid Sulfate Soils Management Procedure	Construction Manager	Prior to and during site establishment
SW2	Soils and water	Monitoring for the presence of ASS in accordance with the monitoring parameters specified in the Acid Sulphate Soils Assessment Guidelines would be undertaken and the site specific Contamination and Acid Sulfate Soils Management Procedure would include management measures for ASS and a contingency plan to be implemented to manage impacts that have the potential to occur if specified management strategies are unsuccessful.	Project Environment Manager	During site establishment
SW3	Soils and water	A detailed Erosion and Sediment Control Plan (ESCP) would be prepared in advance of construction to detail mitigation measures and progressively updates as required during site establishment, operations and decommissioning. The ESCP would include measures to minimise	Project Environment Manager	Prior to and during construction

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
		opportunities for mobilised sediments to extend into Parramatta and Duck Rivers.		
SW4	Soils and water	Erosion and sediment control measures would be implemented in accordance with Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Managing Urban Stormwater: Soils and Construction Volume 2 (Department of Environment and Climate Change, 2008a). Measures would be designed as a minimum for the 80th percentile; 5-day rainfall event.	Project Environment Manager	During construction
SW5	Soils and water	Fuels, oils and other potentially harmful substances would be stored when not in use in a bund sized to be at least 110% of the largest container to be stored.	Project Environment Manager	During construction
SW6	Soils and water	Water quality monitoring upstream and downstream of the worksite would be undertaken during wharf upgrade works at a frequency of at least one sample per fortnight.	Project Environment Manager	During wharf upgrade works
SW7	Soils and water	A site-specific Spill Management Procedure would be developed and implemented. It would identify spill management equipment to be kept onsite and procedures to be implemented in the event of a spill.	Project Environment Manager	Prior to and during construction

6.5 Waste management and recycling

6.5.1 Potential impacts

Site establishment would require a wide range of materials including aggregate, timber and concrete. Opportunities to utilise recycled building material would be explored.

During construction the following waste streams would be generated:

- Soil waste, including construction waste from demolition of existing infrastructure for example, concrete and pavement from the construction of the connection to Grand Avenue
- Liquid waste such as oils and chemicals from equipment maintenance
- Domestic waste from site personnel including food scraps, glass and plastic bottles, paper and plastic containers
- Site sewerage office amenities.

The proposal would facilitate the sustainable reuse of tunnel spoil from the TSE Works.

6.5.2 Safeguards and management measures

Table 15 identifies environmental safeguards and management measures that would be implemented to address potential waste management impacts of the proposal and ensure reuse of materials where practicable.

Table 15: Waste management and reuse

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
WM1	Waste management	A Waste and Recycling Management Procedure would be implemented during construction to correctly classify waste that is produced during construction for reuse, recycling or disposal to an appropriately licenced facility in accordance with EPA Waste Classification Guidelines.	Project Environment Manager	During construction
WM2	Waste management	Sewerage waste would be disposed of by a waste contractor in accordance with Sydney Water requirements.	Site Supervisor	During construction

6.6 Land use, property and socio economic

6.6.1 Existing environment

The site is owned by Viva Energy Australia and RMS and was previously used to receive barges. The proposed worksite is largely level cleared area comprising of predominately compacted road base and a concrete hard stand with sparse vegetation. The Gore Bay fuel pipeline is located along the northern boundary of the site, with Duck River located on the southern boundary, and the Parramatta River directly adjacent to the east.

The site is accessed via a single lane access road which runs along the boundary of the former refinery and there is an easement to Grand Avenue located between Hymix and KLF Holdings waste processing facility. There is an existing concrete vehicle bridge over the decommissioned watermain to provide access between the site and the existing access track. A Caltex fuel pipeline is located on the northern eastern side of the access road and there is a wetland located to the west of the access track.

6.6.2 Potential impacts

This proposal is located on land zoned IN3 Heavy Industrial under the Parramatta LEP. The proposal is consistent with the objectives of this land use zoning.

The proposal would require the short-term lease of the approximately 8000m² of land.

A workforce of approximately 15 people would be employed during site establishment and approximately four people would be employed during operations as set out in Section 3.9

The proposal would improve the access road which is used for inspection and maintenance of the Caltex fuel pipeline and Gore Bay fuel pipeline. Hazards and risks associated with this infrastructure is assessed below in Section 6.7.

The wharf upgrade works and any required asset protective measures would be designed and planned in consultation with Viva Energy Australia and RMS.

6.6.3 Safeguards and management measures

Table 16 identifies environmental safeguards and management measures that would be implemented to address potential land use, property and socio economic impacts of the proposal.

Table 16: Land use, property and socio-economic safeguards and management

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
LS1	Land use, property and socio economic	Wharf upgrade works would be designed and planned in consultation with RMS	Construction Manager	Prior to construction

6.7 Hazard and risk

6.7.1 Existing Environment

The proposed Clyde barging facility is located within the existing Viva Energy Australia Clyde fuel storage terminal. The terminal currently receives, stores, and distributes finished petroleum products via a transfer pipeline from the Gore Bay fuel terminal. The area is a major distribution hub for petroleum products with the Clyde facility being one of the key fuel supply operations servicing NSW. The Gore Bay fuel pipeline enters the Clyde terminal from the Parramatta River at the northern end of the existing wharf that is the subject of this assessment and runs above ground into the fuel storage area located to the west of the site.

6.7.2 Potential Impacts

The operational activities of the proposal were assessed against the criteria of the SEPP No.33 – Hazardous and Offensive Development. The proposal was determined not to meet the definition of a ‘potentially hazardous industry’ or ‘potentially offensive industry’, however given the presence of the critical fuel infrastructure located within the assessment area a Preliminary Hazard Analysis (PHA) was prepared to identify the key risks of the proposal as a due diligence exercise. The key risks identified as part of the PHA would form part of a broader site-specific risk assessment designed to identify and address all potential construction and operational risks associated with the proposal.

The PHA undertaken for the proposal is included in Appendix C.

6.7.3 Safeguards and management measures

Table 17 identifies environmental safeguards and management measures that would be implemented to address potential hazards and risks of the proposal.

Table 17: Hazard and risk safeguards and management

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
HR1	Hazard and risk	Integrate the risks and indicative mitigation strategies identified in Appendix C into Work Area Plan (WAP) risk assessments and Safe Work Method Statements (SWMS).	Construction Manager	Prior to construction

6.8 Air quality

6.8.1 Existing environment

The Bureau of Meteorology operates a network of stations around the country. The closest Bureau of Meteorology meteorological monitoring station to the proposed worksite is located at Parramatta North, approximately 5 kilometres to the north-west.

As noted in Section 6.2.1, the proposed worksite is located within an industrial area. Residential receivers in the suburb of Rydalmere (John St, Fallon St, Primrose Ave, Sylvia St, Nowill St and Milton St) are located to the north. The nearest receivers in this area are approximately 320 m from the proposed barging facility.

Residential receivers in the suburb of Ermington (River Rd on the east side of Silverwater Rd) are located to the north-west. The nearest receivers in this area are approximately 350 m from the proposed barging facility.

6.8.2 Potential impacts

Site establishment, operations and decommissioning works all have the potential to generate dust and would generate vehicle emissions. Truck movements along the access road have the potential to generate dust, and therefore sealing the upgraded access track would reduce dust levels.

6.8.3 Safeguards and management measures

Table 18 identifies environmental safeguards and management measures that would be implemented to address potential air quality impacts of the proposal.

Table 18: Air quality safeguards and management

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
AQ1	Air quality	The engines of all on-site vehicles and plant would be switched off when not in use for an extended period	Site Supervisor	During construction
AQ2	Air quality	Plant would be well maintained and serviced to minimise emissions. Emissions from plant would be considered as part of pre-acceptance checks.	Site Supervisor	During construction
AQ3	Air quality	Hard surfaces would be regularly cleaned	Site Supervisor	During construction
AQ4	Air quality	Unsealed work areas would be regularly damped down in dry and windy conditions	Site Supervisor	During construction
AQ5	Air quality	All road vehicles and barges carrying loose or potentially dusty material to or from the site would be covered.	Site Supervisor	During construction
AQ6	Air quality	Stockpiles would be managed to minimise dust generation.	Site Supervisor	During construction

6.9 Historic heritage

6.9.1 Existing environment and potential impacts

An Archaeological Assessment of the proposed site was carried out by AMBS Ecology and Heritage in 2017. AMBS's Historic Heritage assessment undertaken on the proposal is included in Appendix D.

The assessment identified that the study area was part of Elizabeth Farm, which comprised lands granted and acquired from 1793 by John Macarthur. The farming estate included a dairy, gardens, various crops, horses, cattle, and sheep, and continued until 1880, when the farm was sold, and the estate subsequently subdivided and sold off in portions. Gradual silting of the Parramatta River past the confluence of the Parramatta and Duck Rivers, affected the ability of ferries to sail to the Queen's Wharf from the early 1840s, and in the late 1800s a series of wharves were constructed at Redbank, to the northwest of the study area.

In 1883 a tramway was constructed accessing the area, from the Domain gates in Parramatta to a wharf and associated facilities established at Redbank, at the confluence of the Parramatta and Duck Rivers. It ran along a right of way leased from the Elizabeth Farm Estate, crossing a specially built bridge over Clay Cliff Creek (Dictionary of Sydney: Camellia). The tramway was closed on 31 March 1943. An 1885-1889 sale advertisement for the area of the Elizabeth Farm Estate later occupied by the Shell Oil Refinery shows the tramway running from Redbank Wharf.

The Shell Oil Refinery was established in 1928, and the company gradually expanded to acquire lands from the surrounding industrial landholders. The refinery continued operating until 2011, when it ceased operations as a refinery and is currently owned and operated by Viva Energy Australia as a fuel storage facility. As per other 20th century industries in the local area, the refinery made use of the wharves in the current study area for movement of goods and equipment.

The proposed site of the Clyde Barging Facility is not listed on the National Heritage List, Commonwealth Heritage List or the State Heritage Register. It is not listed on the non-statutory Register of the National Estate or National Trust Register and there are no items within the near vicinity included on these lists or registers. However, within the footprint of the proposal there are parts or sections of local heritage items including the tramway alignment listed on the Parramatta LEP and the Shell Oil Refinery Wharf, listed on the Harbour SREP.

The following statutory and non-statutory lists and registers were reviewed as part of the AMBS archaeological assessment of the proposed site to identify the location and significance of historic heritage items and places in the vicinity of the study area:

- National Heritage List (NHL)
- Commonwealth Heritage List (CHL)
- State Heritage Register (SHR)
- Maritime NSW Heritage & Conservation (Section 170) Register
- Harbour SREP
- Parramatta LEP 2011
- Parramatta Historical Archaeological Landscape Management Study (PHALMS)
- National Trust of Australia (NSW) Register
- Register of the National Estate (RNE)

There is potential for physical remains of early wharfage and tram tracks associated with the local heritage items to still be present within the proposal area. The proposed earthworks during site establishment would remove relatively shallow overburden which have the potential to expose tramway track, and the wharf extension would entail piling around the existing piles, which would be retained in situ.

The historic heritage assessment concluded that impacts to the local heritage items would be minor and that an Unexpected Finds Procedure would be an appropriate mitigation strategy.

6.9.2 Safeguards and management measures

Table 19 identifies environmental safeguards and management measures that would be implemented to address potential historic heritage impacts of the proposal.

Table 19: Historic heritage safeguards and management

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
HH1	Historic heritage	An Unexpected Finds Protocol would be implemented during construction	Project Environment Manager	During construction

6.10 Aboriginal heritage

6.10.1 Existing environment and potential impacts

An Aboriginal Archaeological Assessment of the proposed site was carried out by AMBS Ecology and Heritage in 2017. The assessment can be found in Appendix E.

The assessment determined that the pre-disturbance environment of the study area would have comprised low-lying estuarine mudflats, salt marsh and mangroves which are likely to have represented a significant faunal resource area for Aboriginal people, but which would not have been suitable for prolonged occupation. No Aboriginal heritage sites have previously been recorded on AHIMS or any other statutory heritage register within the study area, and the nearest recorded AHIMS site is located approximately one kilometre east of the study area on the northern side of the Parramatta River. Past levelling and land reclamation of the local area during establishment of wharves, the tramway, and the adjacent fuel storage facility has resulted in the removal or extensive disturbance of natural soils with potential to retain Aboriginal heritage objects across the entire study area. Based on the research undertaken, the Aboriginal archaeological potential of the Clyde Barging Facility area is assessed as low.

The potential impact on Aboriginal cultural heritage was assessed in accordance with current heritage best practice and OEH guidelines, as specified in the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (DECCW 2010). As such, the assessment addressed the following requirements:

- Identification of any previously recorded Aboriginal sites
- Development of a predictive model for local Aboriginal archaeological sites, including any landscape features within the study area which are likely to indicate the presence of Aboriginal objects, and
- Identification of any constraints resulting from Aboriginal objects that may be present within the study area, and any requirements for additional Aboriginal heritage investigations.

An assessment of the appropriate level of investigation, pursuant to Section 8 of the Due Diligence Code of Practice has been conducted. The results of this assessment are shown in Table 20.

Table 20: Due Diligence Process

Due diligence assessment process	Response
Step 1. Will the activity disturb the ground surface or any culturally modified trees?	The proposed development would disturb the ground surface in the study area. No culturally modified trees are present in the study area. Proceed to Step 2a.
Step 2a. Are there any relevant confirmed site records or other associated landscape feature information on the AHIMS database?	No previously recorded Aboriginal heritage sites are recorded on the AHIMS database in the vicinity of the study area. Proceed to Step 2b.
Step 2b. Are there any other sources of information of which a person is already aware? Other sources of information can include previous studies, reports or surveys which you have commissioned or are otherwise aware of.	Archaeological assessments relating to the local area have been reviewed. Proceed to Step 2c.
Step 2c. Are there landscape features present likely to indicate presence of Aboriginal objects?	The study area and surrounds have been significantly impacted by past levelling and land reclamation during establishment of wharves, a tramway, and the adjacent Shell Oil Refinery, resulting in the removal or extensive disturbance of natural soils. Proceed to Step 3.
Step 3. Can harm to Aboriginal objects listed on AHIMS or identified by other sources of information be avoided, and/or can the carrying out of the activity at the relevant landscape features be avoided?	No Aboriginal objects listed on AHIMS are present in the study area, and no identified Aboriginal objects, or landforms with potential to retain Aboriginal objects, were identified within the study area by other sources of information. Proceed to Step 4.
Step 4. Does a desktop assessment and visual inspection confirm that there are Aboriginal objects or that they are likely?	The desktop assessment has identified that, given the identified level of disturbance, it is unlikely that Aboriginal objects are present within the study area. No visual inspection has been undertaken for this assessment.

On the basis of the registered archaeological sites in the region, the environmental context of the study area, and the review of previous archaeological studies, the following conclusions were drawn by AMBS regarding the potential presence and location of Aboriginal heritage sites in and around the study area:

- Stone artefact sites are the most common site type occurring in the local region, predominantly located on well-drained, level or gently sloping ground such as creek and river banks and alluvial flats, in association with water sources. Stone artefact sites are found in all environmental contexts, but are most readily identified in areas where vegetation is limited and ground surface is visible.
- The pre-disturbance environment of the study area and surrounds comprised low-lying mudflats, salt marsh and mangroves, which are likely to have represented a significant faunal resource area for Aboriginal peoples, but are unlikely to have been suitable for ongoing occupation which could have created Aboriginal heritage sites.

- Past levelling and land reclamation of the area during establishment of wharves, the tramway, and the adjacent Shell Oil Refinery has resulted in the removal or extensive disturbance of natural soils. As such, there is no potential for Aboriginal heritage objects to remain in the study area.
- Historic wide scale vegetation clearance has resulted in the removal of all original native vegetation, and there is therefore no potential for culturally modified trees to survive in the study area.
- Stone quarry sites, axe grinding grooves, stone engravings/art and shelter sites are highly unlikely to be found in the study area due to the lack of suitable stone outcrops.
- Burials and ceremonial sites (including stone arrangements) are unlikely to be present in the area given the disturbance caused by levelling and land reclamation.

An unexpected finds procedure would be implemented in the unlikely event that previously unrecorded items of Aboriginal heritage are recorded during ground disturbance works.

6.10.2 Safeguards and management measures

Table 21 identifies environmental safeguards and management measures that would be implemented to address potential Aboriginal heritage impacts of the proposal.

Table 21: Aboriginal heritage safeguards and management

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
AH1	Aboriginal heritage	An Unexpected Finds Protocol would be implemented during construction	Project Environment Manager	During construction

6.11 Visual impact

6.11.1 Existing environment

As noted in Section 6.2.1, the proposed worksite is located within an industrial area. Residential receivers in the suburb of Rydalmere (John St, Fallon St, Primrose Ave, Sylvia St, Nowill St and Milton St) are located to the north. The nearest receivers in this area are approximately 320 m from the wharf.

Residential receivers in the suburb of Ermington (River Rd on the east side of Silverwater Rd) are located to the north-west. The nearest receivers in this area are approximately 350 m from the wharf.

The proposed worksite is largely level cleared area comprising of predominately compacted road base and a concrete hard stand with sparse vegetation. Vegetation along the Parramatta River bank has been cleared to construct the existing wharf.

6.11.2 Potential impacts

The proposal would require limited vegetation clearing and no clearing of riverbank vegetation would be required.

The proposed barging facility would be visible to river users including passenger ferries and cruise boats but would not substantially transform the visual environment. Views from the nearest residential receivers that are located on the other side of the river to the east of the

worksite would not be impacted. It noted that the Silverwater Road bridge is located between these residences and the worksite and is a dominate feature.

6.11.3 Safeguards and management measures

Table 22 identifies environmental safeguards and management measures that would be implemented to address potential visual impacts of the proposal.

Table 22: Visual impact safeguards and management

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
VI1	Visual impacts	The worksite would be maintained in a clean and tidy condition	Site Supervisor	During construction

6.12 Sustainability

6.12.1 TfNSW Sustainability Strategy

TfNSW's Sydney Metro City & Southwest Sustainability Strategy 2017-24 (July 2017) outlines:

- What sustainability means for Sydney Metro
- Performance targets
- Initiatives and outcomes to be adopted across key policy areas
- Roles and responsibilities
- Compliance management and reporting.

This Strategy would be implemented in delivering the proposal as far as it can be applied to the scope of work.

6.12.2 Safeguards and management measures

Table 23 identifies environmental safeguards and management measures that would be implemented to address potential visual impact impacts of the proposal.

Table 23: Sustainability safeguards and management

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
SU1	Sustainability	Sustainability initiatives would be incorporated into the detailed design and construction of the project to support the achievement of the project sustainability objectives.	Project Sustainability Manager	During construction
SU2	Sustainability	25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction would be offset.	Commercial Manager	During construction

6.13 Cumulative impacts

6.13.1 Potential impacts

Cumulative impacts have the potential to arise from the interaction of individual elements of the proposal and the additive effects of the proposal with other external projects. Under Clause 228 (2) of the EP&A Act, TfNSW is required to take into account potential cumulative impacts as a result of the proposal.

The proposal would require temporary use of the worksite from early 2018 to early 2020. Other locally occurring developments that could interact with the proposal were identified through a desktop review of publicly available information and liaison with TfNSW and Viva Energy Australia. The following developments and operations would occur near to and during the delivery of the proposal:

- Viva Energy Australia’s fuel distribution facility which will continue to operate adjacent to the proposed worksite
- Viva Energy Australia’s decommissioning and terminal conversion project which will be undertaken adjacent to and during the delivery of the proposal
- Ferry services along the Parramatta River
- TfNSW’s Parramatta Light Rail which includes a Stabling and Maintenance Facility which is proposed to be located at 6 Grand Avenue. This project is scheduled to commence enabling works in the third quarter of 2018 with construction due to commence at the latter half of the fourth quarter 2018/first quarter of 2019.

No significant cumulative impacts have been identified, however heavy vehicle movements would require consideration as noted in Section 6.1.2. Noise, vibration and air quality impacts associated with the above proposals are expected to be identified and managed at a project level through implementation of appropriate mitigation. Due to the distance between work areas cumulative impacts are not expected.

City of Parramatta Council will be consulted to identify any further developments in the locality.

6.13.2 Safeguards and management measures

Table 24 identifies environmental safeguards and management measures that would be implemented to address potential cumulative impacts of the proposal.

Table 24: Cumulative impacts safeguards and management

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
CI	Cumulative impacts	Ongoing consultation with surrounding projects and developments to: <ul style="list-style-type: none"> a) Increase awareness of construction timeframes and impacts b) Co-ordinate impact mitigation and management 	Construction Manager	During construction

7.0 Environmental management

7.1 Construction Environmental Management Plan

The proposal would be managed under the systems and tools set out in Part B JHCPBG's Construction Environmental Management Plan (CEMP) (SMCSWTSE-JCG-TPW-EM-PLN-002010) including:

- Leadership, accountability and culture
- Governance and planning
- Legal and other compliance monitoring
- Risk and opportunity management
- Change management
- Communication and consultation
- Training and competency
- Subcontractor management
- Incident management
- Emergency planning and response
- Document and record management
- Reporting, auditing, review and improvement

It is noted that Section 5.9 of this CEMP references this REF and that updating the CEMP would not be required to implement the proposal.

The CEMP Sub Plans and Aspect specific management plans referenced in the CEMP would not apply to the proposal as the following site-specific documentation would be prepared to set out required environmental mitigation measures and controls:

- Site Environmental Plan
- Construction Noise and Vibration Impact Statement
- Erosion and Sediment Control Plan
- Construction Traffic Management Plan for road based transport
- Traffic Management Plan(s) and Communication Plan(s) for barging
- Construction Flora and Fauna Management Plan.

7.2 Management and mitigation measures

7.2.1 Construction management

Environmental management measures to be implemented during construction are shown in Table 25.

Table 25: Construction environmental management measures (compiled from Section 6.0 mitigation measures)

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
T1	Construction traffic and transport	<p>A Construction Traffic Management Plan (CTMP) would be developed for road based traffic associated with the worksite. This CTMP would address:</p> <ul style="list-style-type: none"> a) Consideration of methods to minimise peak period traffic disruptions b) Safe provision for vehicles, cyclists and pedestrian traffic c) Implement appropriate operational and other measures to ensure the safety of vulnerable road users. <p>The CTMP would be prepared in consultation with Parramatta Council, endorsed by the Sydney Coordination Office and approved by RMS</p>	Traffic and Transport Manager	Prior to the commencement of construction
T2	Construction traffic and transport	Road safety audits would be undertaken during the development of the CTMP and following completion of site establishment works	Traffic and Transport Manager	Detailed design and construction
T3	Construction traffic and transport	Traffic Management Plan(s) and Communication Plan(s) would be prepared in consultation with RMS and the Harbour Master for the wharf upgrade works and barging operations.	Approvals, Environment and Sustainability Manager	Prior to the commencement of works within Parramatta River
NV1	Construction noise and vibration	Site establishment, operations and decommissioning works would generally be undertaken Mondays to Fridays 7:00am to 6:00pm and Saturdays 8:00am to 1:00pm. There may be a need for works outside of these hours, particularly due to tides or to coordinate with other vessel movements or restrictions on oversize road vehicle movements.	Site Supervisor	During construction
NV2	Construction noise and vibration	A detailed Construction Noise and Vibration Impact Statement (CNVIS) would be prepared following detailed design to confirm the exact mitigation measures to be implemented during site	Project Environment Manager	Prior to the commencement of construction

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
		establishment, operations and decommissioning.		
NV3	Construction noise and vibration	The following noise management measures would be included in the CNVIS: <ul style="list-style-type: none"> a) Community notification b) Site inductions and tool box talks c) Behavioural practices 	Project Environment Manager	Prior to the commencement of construction
NV4	Construction noise and vibration	Undertake attended monitoring during representative noise generating works.	Project Environment Manager	During construction
FF1	Flora and Fauna	Access to the wetland area and surrounding vegetation would be avoided except for environmental mitigation and monitoring purposes.	Project Environment Manager	Pre-construction and construction
FF2	Flora and Fauna	A pre-clearance survey in the Swamp Oak Forest would be undertaken within two weeks prior to construction in order to identify any nests or other features within the construction zone. If nests, hollows or coarse woody debris occur an ecologist would be present during vegetation clearing to manage fauna that may be present.	AMBS	Prior to site establishment works
FF3	Flora and Fauna	A temporary frog-fence would be established along the southern side of the construction area and maintained for the life of the project. Pre-clearance searches for sheltering GGBFs would be undertaken after erection of the fence and prior to construction. This would include diurnal and nocturnal searches and incorporate the easement area and along the KLF waste management facility fence line.	Project Environment Manager AMBS	During site establishment works
FF4	Flora and Fauna	Implement frog hygiene protocols consistent with the <i>Hygiene protocol for the control of disease in frogs</i> (DECC 2008) and erect information signs to prevent non-disinfected vehicles/equipment/people from entering the site.	Project Environment Manager	Pre-construction and construction
FF5	Flora and Fauna	Construct a chytrid fungus (Phytophthora cinnamomi) and weed wash area at the Grand Avenue access. Vehicle wheels, equipment and shoes must be cleaned so that they are free of dirt and debris,	Site supervisor	Pre-construction and construction

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
		then sprayed or washed with solution containing 10% bleach.		
FF6	Flora and Fauna	<p>Site supervisors are to be inducted on Hygiene protocol for the control of disease in frogs (DECC 2008) and frog handling techniques.</p> <p>Workers would be inducted on the location and identification of threatened entities, the importance of the Clyde Wetlands area, and what to do if a frog or other animal is encountered.</p>	Project Environment Manager	Prior to commencing work
FF7	Flora and Fauna	Exclusion zones would be set up at the limit of clearing to protect the adjacent wetland, Swamp Oak Forest and Mangrove Forest Community	Project Environment Manager	During site establishment works
FF8	Flora and Fauna	Any fill to be brought onsite for construction purposes should be clean and tested or processed to ensure no contaminants are present	Construction Manager	During site establishment works
FF9	Flora and Fauna	<p>While work is being undertaken on site conduct daily checks of the following:</p> <ul style="list-style-type: none"> d) Frog exclusion fences e) Monitor the chytrid barrier wash area f) Confirm other sterilisation procedures are being implemented correctly <p>A daily checklist would be prepared to assist in implementation of this requirement.</p>	Site Supervisor	Daily when works are being undertaken
FF10	Flora and Fauna	Timber from native trees removed would be re-used as coarse woody debris in the adjacent woodland, particularly along the northern edge of the wetland, and as advised by AMBS.	Site Supervisors AMBS	During site establishment works
FF11	Flora and Fauna	It is recommended that the area of vegetation cleared for the project is re-vegetated post-development. Revegetation works would be co-ordinated with other bush regeneration and management activities undertaken in the study area and be consistent with UBM (2017)	Project Environment Manager	Post construction
FF12	Flora and Fauna	Weed control and monitoring would be undertaken prior, during and post-construction. Any weeds removed would be undertaken using low impact	Project Environment Manager	During site establishment works

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
		techniques to minimise disturbance and/or destruction of significant flora and fauna, mobilisation of sediments, and pollution by herbicides.		
FF13	Flora and Fauna	Herbicides used must be registered or permitted for aquatic situations and personnel must follow all product label directions.	Project Environment Manager	During site establishment and construction
FF14	Flora and Fauna	Green waste including weeds is to be disposed of responsibly. Seed bearing debris, bulbs, corms, rhizomes and succulents which regenerate from fragments are to be bagged and removed off-site at the end of work sessions (not stockpiled overnight). All green waste must be taken off-site and disposed at an appropriately licenced facility.	Project Environment Manager	During site establishment works
FF15	Flora and Fauna	Any temporary stockpiling of soil that may contain seed of exotic species would be away from adjacent vegetation or stormwater drains where they could be spread during rainfall events	Site supervisor	During site establishment works
FF16	Flora and Fauna	Night-time truck movements would be limited as far as practicable and a speed limit of 20 km/hr at night would be enforced	Site supervisor	During operation
FF17	Flora and Fauna	Light spill into the wetland and surrounding vegetation would be minimised as much as possible. There is to be no additional lighting of the access road and lights on the wharf, truck turning area and site office area would be subdued as much as possible and directed away from the wetland.	Site supervisor	During operation
FF18	Flora and Fauna	Noise such as horns and air brakes would be avoided except during emergencies and noise generally kept to a minimum, particularly along the section of road through the Swamp Oak Forest.	Site supervisor	During operation
FF19	Flora and Fauna	A temporary visual screen would be erected on the southern side of the track between the easement and the section of track running north-east from the easement, to screen truck movements from water birds in the wetland.	Project Environment Manager	During site establishment works
FF20	Flora and Fauna	No chemicals, fuels and / or wastes would be stored within or near any	Site supervisor	During site establishment

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
		natural or stormwater drainage lines or on the foreshore. All such substances are to be contained in sealed vessels of appropriate volumes and, where necessary, stored within bunded areas.		works and operation
FF21	Flora and Fauna	All in-water activities associated with piling would be scheduled to coincide with favourable tidal conditions to ensure that sediment re-suspension and dispersion is minimised, e.g. calm conditions and minimal tidal fluctuation where practicable.	Site supervisor	During site establishment works
FF22	Flora and Fauna	Floating booms, silt curtains or screens would be used during in-stream activities to minimise the mobilisation of sediments and the spread of suspended sediments.	Site supervisor	During site establishment works
FF23	Flora and Fauna	Aquatic habitat would be protected in accordance with Section 3.3.2 <i>Standard precautions and mitigation measures of the Policy and guidelines for fish habitat conservation and management Update 2013</i> (NSW DPI 2013) and <i>NSW control Plan for the Noxious Marine Alga <u>Caulerpa taxifolia</u></i> (I&I NSW 2009)	Project Environment Manager Site supervisor	Prior to and during construction
FF24	Flora and Fauna	If the blocked drain between the wetland and the river is repaired, the drainage upgrades would ensure that the normal water levels of the Parramatta River and Duck River cannot flow into the wetland. The drainage would be one-directional, allowing water to drain from the wetland to the river during overflow events, but not the reverse.	Site supervisor	During site establishment works
SW1	Soil and water	Earthworks would be designed and managed to control and protect the health and safety of people onsite. If contaminated soils are discovered during excavations, they would be separated and managed in accordance with a site specific Contamination and Acid Sulfate Soils Management Procedure	Construction Manager	Prior to and during site establishment
SW2	Soils and water	Monitoring for the presence of ASS in accordance with the monitoring parameters specified in the Acid Sulphate Soils Assessment Guidelines would be undertaken and the site specific Contamination and Acid Sulfate Soils Management Procedure would include management measures for ASS and a	Project Environment Manager	During site establishment

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
		contingency plan to be implemented to manage impacts that have the potential to occur if specified management strategies are unsuccessful.		
SW3	Soils and water	A detailed Erosion and Sediment Control Plan (ESCP) would be prepared in advance of construction to detail mitigation measures and progressively updates as required during site establishment, operations and decommissioning. The ESCP would include measures to minimise opportunities for mobilised sediments to extend into Parramatta and Duck Rivers.	Project Environment Manager	Prior to and during construction
SW4	Soils and water	Erosion and sediment control measures would be implemented in accordance with Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Managing Urban Stormwater: Soils and Construction Volume 2 (Department of Environment and Climate Change, 2008a). Measures would be designed as a minimum for the 80th percentile; 5-day rainfall event.	Project Environment Manager	During construction
SW5	Soils and water	Fuels, oils and other potentially harmful substances would be stored when not in use in a bund sized to be at least 110% of the largest container to be stored.	Project Environment Manager	During construction
SW6	Soils and water	Water quality monitoring upstream and downstream of the worksite would be undertaken during wharf upgrade works at a frequency of at least one sample per fortnight.	Project Environment Manager	During wharf upgrade works
SW7	Soils and water	A site-specific Spill Management Procedure would be developed and implemented. It would identify spill management equipment to be kept onsite and procedures to be implemented in the event of a spill.	Project Environment Manager	Prior to and during construction
WM1	Waste management	A Waste and Recycling Management Procedure would be implemented during construction to correctly classify waste that is produced during construction for reuse, recycling or disposal to an appropriately licenced facility in accordance with EPA Waste Classification Guidelines.	Project Environment Manager	During construction

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
WM2	Waste management	Sewerage waste would be disposed of by a waste contractor in accordance with Sydney Water requirements.	Site Supervisor	During construction
LS1	Land use, property and socio economic	Wharf upgrade works would be designed and planned in consultation with RMS	Construction Manager	Prior to construction
HR1	Hazard and risk	Integrate the risks and indicative mitigation strategies identified in Appendix C into Work Area Plan (WAP) risk assessments and Safe Work Method Statements (SWMS).	Construction Manager	Prior to construction
AQ1	Air quality	The engines of all on-site vehicles and plant would be switched off when not in use for an extended period	Site Supervisor	During construction
AQ2	Air quality	Plant would be well maintained and serviced to minimise emissions. Emissions from plant would be considered as part of pre-acceptance checks.	Site Supervisor	During construction
AQ3	Air quality	Hard surfaces would be regularly cleaned	Site Supervisor	During construction
AQ4	Air quality	Unsealed work areas would be regularly damped down in dry and windy conditions	Site Supervisor	During construction
AQ5	Air quality	All road vehicles and barges carrying loose or potentially dusty material to or from the site would be covered.	Site Supervisor	During construction
AQ6	Air quality	Stockpiles would be managed to minimise dust generation.	Site Supervisor	During construction
HH1	Historic heritage	An Unexpected Finds Protocol would be implemented during construction	Project Environment Manager	During construction
AH1	Aboriginal heritage	An Unexpected Finds Protocol would be implemented during construction	Project Environment Manager	During construction
VI1	Visual impacts	The worksite would be maintained in a clean and tidy condition	Site Supervisor	During construction
SU1	Sustainability	Sustainability initiatives would be incorporated into the detailed design and construction of the project to support the	Project Sustainability Manager	During construction

No.	Impact	Environmental safeguards and management measures	Responsibility	Timing
		achievement of the project sustainability objectives.		
SU2	Sustainability	25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction would be offset.	Commercial Manager	During construction
CI	Cumulative impacts	<p>Ongoing consultation with surrounding projects and developments to:</p> <ul style="list-style-type: none"> c) Increase awareness of construction timeframes and impacts d) Co-ordinate impact mitigation and management 	Construction Manager	During construction

7.2.2 Operational management

The proposal entails the temporary use of the worksite during construction of the TSE Works. Spoil, plant and equipment would arrive at this site by barge. The materials would be transferred to trucks by excavators and self-propelled mobile equipment trailers would be loaded onto trucks. Trucks would transport the materials to approved locations throughout Sydney and NSW using the arterial road network.

The proposal therefore has no operational impacts.

7.3 Licencing and approvals

See Section 4.5 which includes a summary table.

8.0 Justification and conclusion

8.1 Justification

The Project was approved on 9 January 2017 (SSI 15_7400) (Project Planning Approval). Condition E84 requires that opportunities to maximise tunnel spoil removal by non-road methods are investigated to minimise truck movements in town centres and the Sydney Central Business District (CBD).

As set out in Section 2.1, the proposal would support the construction of the TSE Works. To reduce the number of trucks travelling through Sydney's CBD, JHCPBG propose using barges from Barangaroo and Blues Point to transport TBM components and the spoil excavated from the Barangaroo Station and underground structures including the under-harbour tunnel and Blues Point Shaft.

Barging of spoil would remove trucks from constrained streets of Barangaroo and North Sydney. Spoil barging from Barangaroo would remove approximately 20,000 truck arrivals (truck and trailer) over a period of 26 months. Hickson Road is already home to the Barangaroo Development Area with extensive construction works underway and there is also significant truck transport associated with the Overseas Passenger Terminal. As such, spoil barging would greatly assist in reducing traffic conflicts and congestion in this area.

Many community submissions received in response to exhibition of the EIS expressed concerns about the proposed use of Blues Point as a TBM retrieval site, particularly in respect of pedestrian safety and noise from truck movements. Blues Point Road is a relatively narrow and winding road with many street trees and a vibrant restaurant precinct. Spoil barging from Blues Point would remove approximately 1,150 truck arrivals (singles) over a period of three months and would have significant amenity and safety benefits compared to road transport. As a number of community submissions to the EIS recommended that barging be considered for Blues Point, implementing this proposal would be a positive outcome of community consultation.

8.2 Ecologically sustainable development considerations

Ecologically sustainable development (ESD) is development that improves the total quality of life, both now and in the future in a way that maintains the ecological processes on which life depends. The principles of ESD have been an integral consideration for the proposal. This includes the effective integration of economic and environmental considerations in all decision-making processes.

Schedule 2 of the (NSW) *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation), outline the four principles of ecologically sustainable development (ESD). TfNSW is committed to ensuring that its projects are implemented in a manner that is consistent with the principles of ESD, which are:

- Precautionary principle — Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for not implementing mitigation measures or strategies to avoid potential impacts
- Inter-generational equity — The present generation should ensure that the health, diversity and productivity of the environment are equal to or better for the future generations
- Conservation of biological diversity and ecological integrity — Preserving biological diversity and ecological integrity requires that ecosystems, species and genetic diversity within species are maintained

- Improved valuation and pricing of environmental resources — This principle establishes the need to determine economic values for services provided by the natural environment, such as the atmosphere’s ability to receive gaseous emissions, cultural values and visual amenity.

JHCPBG is committed to ensuring that its activities are undertaken in a manner that is consistent with the four principles of ESD. These principles would be incorporated into JHCPBG’s management systems for the proposal (discussed previously in Section 7.0).

Table 26 summarises how the four principles of ESD have been addressed through the proposal’s design and assessment processes.

Table 26: Adherence to the principles of ESD

ESD Principle	Adherence
Precautionary principle	A precautionary approach has been applied throughout the proposal’s development. The options development and assessment, the design development and the REF process have sought to minimise the environmental impact of the proposal. There are no threats of serious or irreversible damage posed by this development. All of the environmental risks have been carefully and thoughtfully considered through the preparation of the REF and would be mitigated through the implementation of the environmental management system and measures set out in Section 7.0.
Intergenerational equity	The proposal would facilitate the construction of the TSE Works which form part of TfNSW’s Sydney Metro City and Southwest Project. This Project will help to ensure that future generations have a safer, more comfortable and more reliable rail transport option, through increased reliability, and more frequent services.
Conservation of biological diversity and ecological integrity	The proposal involves the use of an existing facility and site establish works involve some limited vegetation clearing. Impacts on flora and fauna have been assessed in detail and comprehensive mitigation and management measures set out in Section 7.0.
Improved valuation and pricing of environmental resources	Environmental and social issues were considered in the strategic planning and establishment of the need for the proposal, and in consideration of various proposal options. The value placed on environmental resources is evident in the extent of the planning and environmental investigations and in the design of the proposed mitigation and safeguards.

8.3 Objects of the EP&A Act

Table 27 identifies the objects of the EP&A Act and their relevance to the proposal

Table 27: Summary of Objects of the EP&A Act

Object	Comment
5(a)(i) To encourage the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of	Safeguard measures detailed in this REF would allow for the proper management, development and conservation of natural and artificial resources. The proposal would require minor vegetation removal and ground disturbance.

Object	Comment
promoting the social and economic welfare of the community and a better environment.	Social and economic impacts of the proposal have been assessed and are considered to be minor in nature.
5(a)(ii) To encourage the promotion and coordination of the orderly economic use and development of land.	The proposal allows for the temporary use of land not needed by Viva Energy Australia in the short term.
5(a)(iii) To encourage the protection, provision and co-ordination of communication and utility services.	Not relevant to the proposal
5(a)(iv) To encourage the provision of land for public purposes.	Not relevant to the proposal
5(a)(v) To encourage the provision and coordination of community services and facilities	Not relevant to the proposal
5(a)(vi) To encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats.	The proposal would require minor vegetation removal. Safeguards detailed in this REF would minimise impacts on conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats.
5(a)(vii) To encourage ecologically sustainable development.	Ecologically sustainable development is addressed in Section 8.2
5(a)(viii) To encourage the provision and maintenance of affordable housing.	Not relevant to the proposal
5(b) To promote the sharing of the responsibility for environmental planning between different levels of government in the State.	Not relevant to the proposal
5(c) To provide increased opportunity for public involvement and participation in environmental planning and assessment.	See community consultation strategy in Section 5.

8.4 EP&A Regulation considerations

Clause 228 of the EP&A Regulation states factors that must be taken into account when assessing the impact of an activity on the environment. Table 28 provides a summary checklist of matters that must be considered under Clause 228 of the EP&A Regulation.

Table 28: Clause 228 considerations

Ref	Clause 228 considerations	Impact
a	<p>Any environmental impact on a community?</p> <p>Construction of the proposal would result in some short-term negative impacts on traffic, noise and vibration and flora and fauna.</p>	Short-term, minor, negative

Ref	Clause 228 considerations	Impact
	These impacts would be managed according to the safeguards outlined in Section 7.	
b	Any transformation of a locality? The proposal involves upgrading of an existing access road and wharf. The proposal would not transform the locality	Short term, minor, negative
c	Any environmental impact on the ecosystems of the locality? The proposal would require minor vegetation removal. Safeguards detailed in this REF would minimise impacts on the ecosystems of the locality	Short-term, minor, negative
d	Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality? The proposal is not anticipated to result in reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality.	No impacts
e	Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations? The proposal is not anticipated to result in any substantial effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations.	No impacts
f	Any impact on the habitat of protected fauna (within the meaning of the <i>National Parks and Wildlife Act 1974</i>)? The proposal would require minor vegetation removal. Safeguards detailed in this REF would minimise impacts on the habitat of protected fauna	Short-term, minor, negative
g	Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air? The proposal would require minor vegetation removal. Safeguards detailed in this REF would minimise impacts on species of animal, plant or other form of life, whether living on land, in water or in the air	Short-term, minor, negative
h	Any long-term effects on the environment? The proposal to establish and operate a barging facility adjacent to the Paramatta River at Clyde to enable the transport of plant and equipment and spoil by barge to and from the TSE Barangaroo and Blues Point Worksites is temporary. Future use of the site by Viva Energy Australia would be addressed in separate environmental assessment(s).	No impact
i	Any degradation of the quality of the environment? The proposal has the potential to degrade the quality of the environment as a result of traffic, noise, flora and fauna, water quality and air quality impacts. These impacts would be managed according to the safeguards outlined in Section 7.0.	Short-term, minor, negative

Ref	Clause 228 considerations	Impact
j	<p>Any risk to the safety of the environment?</p> <p>Hazards risk are assessed in Section 6.7. These impacts would be managed according to the safeguards outlined in Section 7.0.</p>	Short-term, minor, negative
k	<p>Any reduction in the range of beneficial uses of the environment?</p> <p>The proposal would be located within an industrial zone that has previously been used to receive barges. The temporary use of the site does not limit the existing surrounding land uses.</p>	No impact
l	<p>Any pollution of the environment?</p> <p>The proposal has the potential to generate pollution as a result of traffic, noise, flora and fauna, water quality and air quality impacts. These impacts would be managed according to the safeguards outlined in Section 7.0.</p>	Short-term, minor, negative
m	<p>Any environmental problems associated with the disposal of waste?</p> <p>The proposal would facilitate the sustainable reuse of spoil from the TSE Works in approved residential and industrial developments in Sydney. Volumes of waste generated by the proposal would be readily managed through the application of standard mitigation measures outlined in Section 7.0.</p>	Long-term, moderate, positive
n	<p>Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply?</p> <p>The proposal would require resources such as aggregate and water, which are common construction materials. The proposal would not create a substantial demand on these resources.</p>	No impact
o	<p>Any cumulative environmental effect with other existing or likely future activities?</p> <p>Operation of the proposal may overlap with other local developments within the area and with the construction of the Light rail. Given the nature of the proposal, cumulative impacts as a result of concurrent development is anticipated to be minor and would be managed according to safeguards outlined in Section 6.13.</p>	Short-term, minor, negative
p	<p>Any impact on coastal processes and coastal hazards, including those under projected climate change conditions?</p> <p>The proposal is temporary and does not involve any clearing of vegetation on the Parramatta River banks and the barge movements would not create significant wash.</p>	Short-term, minor, negative

8.5 Consideration of matters of national environmental significance

Table 29 provides a summary checklist of matters of National Environmental Significance that were considered for the proposal under the EPBC Act.

Table 29: Checklist of EPBC Act Matters

Matter of national environmental significance	Impact
<p>World heritage properties</p> <p>There are no items within the proposal area listed on the World Heritage List.</p>	No impacts
<p>National heritage places</p> <p>There are no items within the proposal area listed on the National Heritage List.</p>	No impact
<p>Wetlands of international importance</p> <p>There are no wetlands of international importance in the proposal site or likely to be affected by the proposal.</p>	No impact
<p>Nationally threatened species and ecological communities</p> <p>The proposal would require minor vegetation removal. Safeguards detailed in this REF would minimise impacts on nationally threatened species and ecological communities</p>	Minor impact
<p>Migratory species</p> <p>The proposal is not anticipated to impact any migratory species</p>	No impact
<p>Commonwealth marine areas</p> <p>Not relevant to the proposal.</p>	No impact
<p>The Great Barrier Reef Marine Park</p> <p>Not relevant to the proposal.</p>	No impact
<p>Nuclear actions (including uranium mining)</p> <p>Not relevant to the proposal.</p>	No impact
<p>A water resource, in relation to coal seam gas development and large coal mining development</p> <p>Not relevant to the proposal.</p>	No impact

8.6 Conclusion

The proposal to establish and operate a barging facility adjacent to the Parramatta River at Clyde to enable the transport of plant, equipment and spoil by barge to and from the TSE Barangaroo and Blues Point worksites is subject to assessment under Part 5 of the EP&A Act.

The potential impacts of the proposal have been considered in accordance with the requirements of Section 111 of the EP&A Act, Clause 228 of the EP&A Regulation and the EPBC Act. Whilst some potentially negative impacts may result from the proposal, these impacts are not considered to be significant, as discussed in Section 6.0 of this REF. Section 7.0 of this REF provides mitigation measures and management strategies that would be implemented to reduce potentially negative impacts and manage environmental impacts.

The proposal would be unlikely to cause a significant impact on the environment. Therefore, it is not necessary for an EIS to be prepared and approval to be sought from the Minister for Planning under Part 5.1 of the EP&A Act. A SIS is not required. The proposal is subject to assessment under Part 5 of the EP&A Act. Consent from Council under Part 4 of the EP&A Act is not required.

The proposal is not likely to have a significant impact on matters of National Environmental significance or the environment of Commonwealth land within the meaning of the EPBC Act. The proposal will be referred to the Australian Department of the Environment and Energy under the EPBC Act to confirm that it is not a controlled action.

9.0 Certification

This REF provides a true and fair review of the proposal in relation to its potential likely effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposal.



Rob Muir
Senior Environment Co-ordinator
JHCPBG

15 December 2017

10.0 References

AECOM, November 2013, Clyde Terminal Conversion Project Environmental Impact Statement, prepared for the Shell Company of Australia, Sydney.

Chapman GA and Murphy CL, 1989, Soil Landscapes of the Sydney 1:100,000 Sheet report. Department of Conservation and Land Management, Sydney.

Chapman GA, Murphy CL, Tille PJ, Atkinson G and Morse RJ, (2009), Soil Landscapes of the Sydney 1:100,000 Sheet map. Ed. 4, Department of Environment, Climate Change and Water, Sydney

Fairfull, S. and Witheridge, G. 2003, Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings. NSW DPI, Cronulla, 16 pp.

Laxton, J. H. and Gittins, R. G. 2003, Water Quality of Upper Parramatta River – Analysis of Data Collected Between 1990 and 2002. Prepared for Upper Parramatta River Catchment Trust.

Parramatta Light Rail Stage 1 Westmead to Carlingford via Camellia Environmental Impact Statement including Technical Paper 1

Murphy CL, December 1997, Acid Sulfate Soil Risk map Prospect / Parramatta River 91 30N3, Department of Land and Water Conservation

Appendix A– Noise and vibration assessment

SYDNEY METRO CHATSWOOD TO SYDENHAM – TSE WORKS

Construction Noise and Vibration Assessment for Barging at Clyde

14 December 2017

John Holland CPB Ghella JV

TH511-02 13F01 REF Noise Assessment (r3).docx

Document details

Detail	Reference
Doc reference:	TH511-02 13F01 REF Noise Assessment (r3).docx
Prepared for:	John Holland CPB Ghella JV
Address:	Level 9, 50 Bridge Street, Sydney NSW 2000
Attention:	Robert Muir

Document control

Date	Revision history	Non-issued revision	Issued revision	Prepared	Instructed	Authorised
28.11.2017	Draft	0	1	HP/CW	CW	
7.12.2017	Final	-	2	HP/CW	CW	CW
14.12.2017	Minor updates	-	3	HP/CW	CW	CW

Important Disclaimer:

The work presented in this document was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

This document is issued subject to review and authorisation by the Team Leader noted by the initials printed in the last column above. If no initials appear, this document shall be considered as preliminary or draft only and no reliance shall be placed upon it other than for information to be verified later.

This document is prepared for the particular requirements of our Client referred to above in the 'Document details' which are based on a specific brief with limitations as agreed to with the Client. It is not intended for and should not be relied upon by a third party and no responsibility is undertaken to any third party without prior consent provided by Renzo Tonin & Associates. The information herein should not be reproduced, presented or reviewed except in full. Prior to passing on to a third party, the Client is to fully inform the third party of the specific brief and limitations associated with the commission.

In preparing this report, we have relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, we have not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

We have derived data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination and re-evaluation of the data, findings, observations and conclusions expressed in this report.

We have prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

The information contained herein is for the purpose of acoustics only. No claims are made and no liability is accepted in respect of design and construction issues falling outside of the specialist field of acoustics engineering including and not limited to structural integrity, fire rating, architectural buildability and fit-for-purpose, waterproofing and the like.

Supplementary professional advice should be sought in respect of these issues.

Contents

1	Introduction	1
2	Project Description	2
2.1	Barging receival site	2
2.2	Receiver locations	3
2.3	Proposed construction works	3
2.3.1	Site establishment	3
2.3.2	Operations	3
2.3.3	Program	4
2.4	Construction Hours	4
3	Existing noise environment	5
3.1	Noise monitoring locations and results	5
3.2	Noise catchment areas and representative L_{A90} noise levels	7
4	Noise and Vibration Criteria	9
4.1	Interim Construction Noise Guideline	9
4.2	Construction Noise Criteria	11
4.3	Human Annoyance Vibration Criteria	11
4.4	Structural Damage Vibration Criteria	13
5	Noise Assessment	16
5.1	Noise Sources	16
5.2	Modelling Methodology	17
5.3	Predicted Noise Levels	18
5.4	Discussion of predicted Noise Levels	18
6	Vibration Assessment	20
6.1	Minimum buffer distances for vibration intensive plant	20
7	Recommendations	21
7.1	Reasonable and feasible noise and vibration mitigation	21
7.1.1	Standard noise and vibration management measures	21
7.1.2	Additional noise and vibration management measures	25
7.1.3	Applying additional management measures - airborne construction noise	26
7.1.4	Applying additional management measures – construction vibration	26
8	Conclusion	27
APPENDIX A	Glossary of Terminology	28
APPENDIX B	Summary of predicted noise levels	30

List of tables

Table 1	Recommended standard hours for construction work (from ICNG)	4
---------	--	---

Table 2	Attended short-term noise monitoring results and observations	6
Table 3	Average L_{A90} background noise levels for noise area categories (from AS1055.2-1997)	7
Table 4	ICNG Noise Management Levels at Residential Receivers, dB(A)	10
Table 5	ICNG Noise Management Level at Commercial Premises, dB(A)	10
Table 6	Summary of Applicable $L_{Aeq,15min}$ Construction Noise Management Levels, dB(A)	11
Table 7	Types of Vibration	11
Table 8	Preferred and Maximum Levels for Human Comfort	13
Table 9	Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)	13
Table 10	Transient vibration guide values - minimal risk of cosmetic damage (BS 7385) - peak component particle velocity	14
Table 11	List of plant and equipment with sound power levels used for noise modelling	16
Table 12	Predicted $L_{Aeq,15min}$ Construction Noise Levels, dB(A)	18
Table 13	Minimum working distances (m) for cosmetic damage (continuous vibration).	20
Table 14	Standard noise and vibration management measures	22
Table 15	Standard noise and vibration source mitigation measures	23
Table 16	Standard noise and vibration receptor mitigation measures	24
Table 17	Additional management measures	25

List of figures

Figure 1	Aerial photo showing location of barge receival site and nearby sensitive receivers	2
Figure 2	Attended short-term measurement locations	6
Figure 3	NCA's and L_{A90} background noise levels	8
Figure 4	Orthogonal Axes for Human Exposure to Vibration	12
Figure 5	Graph of Transient Peak Component Particle Velocity Vibration Guide Values for Cosmetic Damage	15
Figure 6	Additional airborne noise management measures	26

1 Introduction

Renzo Tonin & Associates was engaged by John Holland CPB Ghella (JHCPBG) to prepare a noise and vibration assessment for construction activities associated with proposed barging and spoil removal at Clyde. This noise and vibration report forms part of the Review of Environmental Factors (REF).

The proposed construction activities form part of the Tunnel and Station Excavation (TSE) Works of the Sydney Metro City & Southwest Project (the Project). Spoil associated with tunnelling operations at the Barangaroo and Blues Point TSE sites and plant and equipment is proposed to be barged along the Parramatta River to a barging receival site within land owned by Viva Energy Australia Limited Fuel Storage Terminal at Clyde adjacent to the Parramatta River. The proposed works include upgrading the existing wharf to accommodate barges up to 55 m long and minor upgrades and extension to the existing access road to allow for heavy vehicle movements.

This report provides an assessment of the potential noise and vibration activities associated with the proposal and identifies mitigation measures that are likely to be required to minimise impacts in accordance with the relevant EPA noise guidelines.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Project Description

2.1 Barging receival site

The Barging Receival site is approximately 8,000 m² and is adjacent to the Parramatta River within the former Shell refinery site. An aerial photograph showing the approximately location of the site in relation to nearby sensitive receivers is provided in Figure 1.

The site would be used to:

- Receive laden spoil barges from the Barangaroo and Blues Point TSE Worksites
- Transfer plant and equipment including Tunnel Boring Machine (TBM) components, water treatment plants and other static plant and equipment

The site is accessed via Grand Avenue. The existing access road between Grand Avenue and the wharf (shown in Figure 1) will be upgraded as part of the project. Some oversize plant and equipment may need to be transported to the site through access roads within Viva Energy Australia Limited's facility.

Figure 1 Aerial photo showing location of barge receival site and nearby sensitive receivers



2.2 Receiver locations

The location of the nearest potentially impacted receivers is shown in Figure 1.

Residential receivers in the suburb of Rydalmere (John St, Fallon St, Primrose Ave, Sylvia St, Nowill St and Milton St) are located to the north. The nearest receivers in this area are approximately 320 m from the wharf.

Residential receivers in the suburb of Ermington (River Rd on the east side of Silverwater Rd) are located to the north-west. The nearest receivers in this area are approximately 350 m from the wharf.

Eric Primrose Reserve (passive and active recreation area) is located north of the barging receival site on the northern bank of the Parramatta River (approximately 250 m from the wharf). Silverwater Park (passive and active recreation area) is located east of the barging receival site on the southern bank of the Parramatta River (approximately 175 m from the wharf).

2.3 Proposed construction works

2.3.1 Site establishment

Site establishment works are required at the barging receival site. These are likely to include the following activities which may generate noise and vibration:

- Installing concrete barriers, fencing and environment controls
- Removing some casuarinas along the access road and small stands of trees within the worksite
- Upgrading the access road involving earthworks, and upgrading drainage
- Minor earthworks to level the loading area
- Upgrading the existing wharf to cater for the barges
- Installing a site office, amenities and a weighbridge at the site entry on Grand Avenue.

2.3.2 Operations

- Loading of heavy plant and equipment for the tunnel boring machines is proposed to occur at the wharf so that it can be transported by barge to and from the Barangaroo and Blues Point TSE sites. One barge is proposed to be loaded per day, with approximately 10 to 15 barges in total.
- Unloading of spoil will occur at the wharf once per day over 20 months, with approximately 400 to 667 barges in total, depending on the size of the vessel utilised.

- Approximately 63 truck and trailers will be required per day to remove spoil off-site via Grand Avenue. During peak periods there would be up to 125 truck movements per day.

Some decommissioning works would also be required, and the exact scope would be determined following consultation with the landowners, Viva Energy Australia Limited and Roads and Maritime Services.

2.3.3 Program

Site establishment is proposed to commence in early 2018 and take two months. The facility is proposed to operate from approximately mid 2018 to early 2020.

2.4 Construction Hours

The proposed construction hours (Table 1) are consistent with the recommended standard construction hours outlined in the *Interim Construction Noise Guideline* (ICNG - Department of Environment and Climate Change NSW, 2009).

Table 1 Recommended standard hours for construction work (from ICNG)

Work type	Recommended standard hours of work*
Normal construction	Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays

* The relevant authority (consent, determining or regulatory) may impose more or less stringent construction hours.

There may be a need for works outside of these hours, particularly due to tides or to coordinate with other vessel movements or restrictions on oversize road vehicle movements. Should alternative construction hours be required separate assessment would be required.

3 Existing noise environment

Criteria for the assessment of construction noise are generally derived from the existing noise environment of an area. Fact Sheet B of the NSW EPA 'Noise Policy for Industry' (NPfI) outlines two methods for determining the background noise level of an area, being 'B1 – Determining background noise using long-term noise measurements' and 'B2 – Determining background noise using short-term noise measurements'. This assessment has used a combination of short-term noise monitoring and estimated average background L_{A90} noise levels from Australian Standard AS 1055.2-1997.

As the noise environment of an area almost always varies over time, background and ambient noise levels need to be determined for the periods when construction works are proposed. For example, in a suburban or urban area the noise environment is typically at its minimum at 3 am in the morning and at its maximum during the morning and afternoon traffic peak hours. The NPfI outlines the following standard time periods over which the background and ambient noise levels are to be determined:

- **Day** 7am to 6pm, Monday to Saturday and 8am to 6pm Sundays & Public Holidays
- **Evening** 6pm to 10pm, Monday to Sunday & Public Holidays
- **Night** 10pm to 7am, Monday to Saturday and 10pm to 8am Sundays & Public Holidays

3.1 Noise monitoring locations and results

Noise measurements are ideally carried out at the nearest or potentially most affected locations surrounding the construction site. Furthermore, representative locations may be established in the case of multiple receivers as it is usually impractical to carry out measurements at all locations surrounding a site.

Attended short-term noise measurements were undertaken by Renzo Tonin & Associates at representative receiver locations on 24 November 2017. The purpose of these measurements was to determine the typical L_{Aeq} and L_{A90} noise levels during the daytime period between the morning and afternoon peak periods. The results of the attended noise measurements are summarised in Table 2.

The attended noise measurement locations are illustrated in Figure 2.

Figure 2 Attended short-term measurement locations

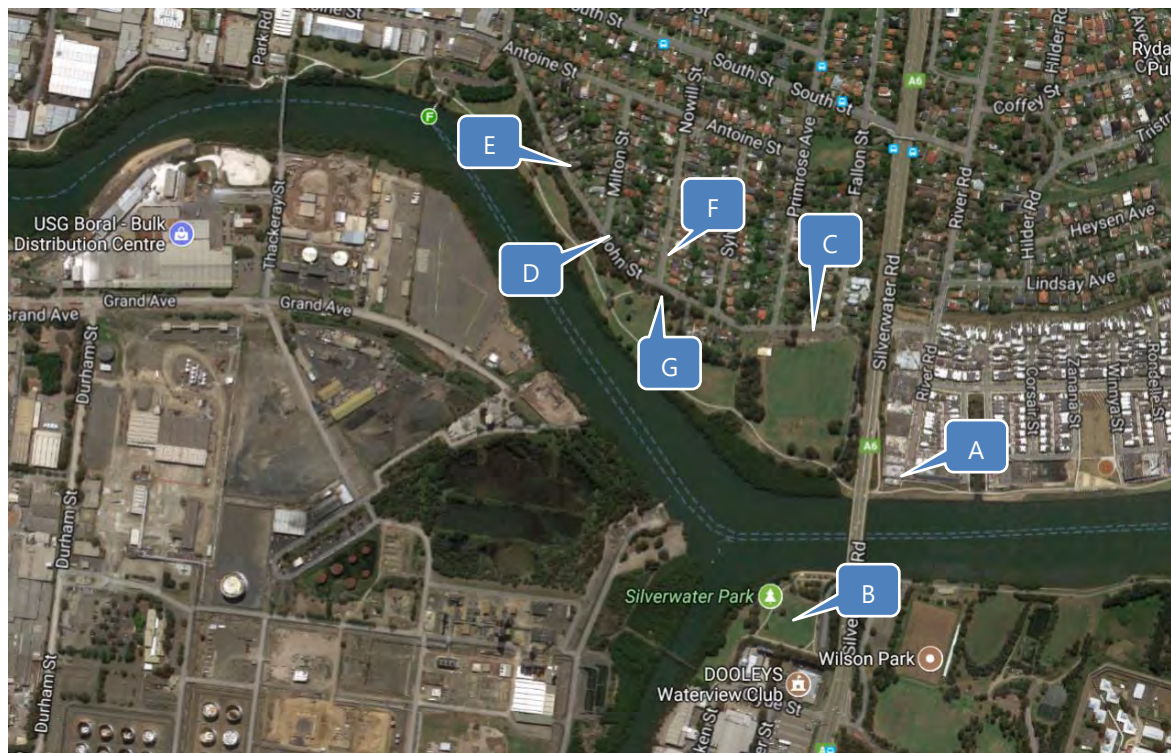


Table 2 Attended short-term noise monitoring results and observations

Location / time of day	Measured 15-minute noise levels, dB(A)		Typical noise sources and associated L _{Amax} noise levels
	L _{Aeq}	L _{A90}	
A - River Road 1:30 pm	57	56	Noise environment controlled by road traffic on Silverwater Road. Typical L _{Amax} noise levels from cars and trucks 63 dB(A) to 65 dB(A)
A - River Road 4:15 pm	59	56	Noise environment controlled by road traffic on Silverwater Road. Typical L _{Amax} noise levels from cars and trucks 63 dB(A) to 65 dB(A)
B - Silverwater Park 1:50 pm	62	58	Noise environment controlled by road traffic on Silverwater Road and industrial noise from adjacent cement factory. Typical L _{Amax} noise levels from cars and trucks 65 dB(A) to 67 dB(A). Steady L _{Aeq} noise from factory 58 dB(A) to 60 dB(A).
B - Silverwater Park 4:35 pm	59	55	Noise environment controlled by road traffic on Silverwater Road. Typical L _{Amax} noise levels from cars and trucks 65 dB(A) to 68 dB(A). Factory noise not audible.
C - Near 53 John Street 2:25 pm	62	58	Noise environment controlled by road traffic on Silverwater Road. Typical L _{Amax} noise levels from cars and trucks 65 dB(A) to 68 dB(A).
D - Near 37 John Street 2:50 pm	56	53	Noise environment controlled by road traffic on Silverwater Road and from construction activities at the Clyde Terminal site opposite. Typical L _{Amax} noise levels from cars and trucks 61 dB(A) to 63 dB(A).
E - Near 25 John Street 3:10 pm	55	50	Noise environment controlled by construction activities on opposite side of river. Typical L _{Amax} noise levels from cars and trucks 65 dB(A) to 68 dB(A).
F - Near 27 Nowill Street 3:45 pm	49	46	Noise environment controlled by natural noise sources and distant road traffic noise. Typical L _{Amax} noise levels from cars and trucks 50 dB(A) to 53 dB(A). Typical L _{Amax} noise levels from birds 66 dB(A) to 68 dB(A).

Location / time of day	Measured 15-minute noise levels, dB(A)		Typical noise sources and associated L_{Amax} noise levels
	L_{Aeq}	L_{A90}	
G - Near corner of John Street and Nowill St 5:00pm	52	48	Noise environment controlled by road traffic on Silverwater Road. Typical L_{Amax} noise levels from cars and trucks 57 dB(A) to 59 dB(A).

Guidance on average background L_{A90} noise levels for various noise category areas is provided in Australian Standard AS1055.2-1997 *Acoustics – Description and measurement of environmental noise Part 2: Application to specific situations*.

The average background L_{A90} noise levels for land use areas applicable to this assessment are summarised in Table 3.

Table 3 Average L_{A90} background noise levels for noise area categories (from AS1055.2-1997)

Noise area category	Description of neighbourhood	Average L_{A90} background noise level, dB(A) Monday to Saturday 7am to 6pm Sundays and Pub Hol 9am to 6pm
R1	Areas with negligible transportation	40
R2	Areas with low density transportation	45
R3	Areas with medium density transportation or some commerce or industry	50
R4	Areas with dense transportation or some commerce or industry	55

3.2 Noise catchment areas and representative L_{A90} noise levels

To assess and manage construction noise impacts, the areas around worksite has been divided into Noise Catchment Areas (NCAs). These are based on each area's similar acoustic environment before construction works start.

Based on the attended noise measurement results in Table 2 and the noise area category descriptions in Table 3, three NCA's have been established. These areas are illustrated in Figure 3.

Figure 3 NCA's and L_{A90} background noise levels

Review of the measurement results in Table 2 indicates measured L_{A90} noise levels of 55 dB(A) to 58 dB(A) at Locations A to C (close to Silverwater Road). These levels are consistent with the average L_{A90} noise levels for noise area category R4 in Table 3. For noise assessment purposes, this area (see Figure 3) has been split into NCA's CLD_01 and CLD_02. The representative L_{A90} background noise level for these areas are assumed to be 55 dB(A) during the daytime period.

Review of the measurement results in Table 2 indicates measured L_{A90} noise levels of 46 dB(A) to 53 dB(A) at Locations D to G (away from Silverwater Road). These levels are consistent with the average L_{A90} noise levels for noise area category R2 and R3 in Table 3. For noise assessment purposes, this area (see Figure 3) is referred to as CLD_03. The representative L_{A90} background noise level for this area is assumed to be 45 dB(A) during the daytime period.

4 Noise and Vibration Criteria

In the absence of any specific construction noise criteria applicable to this site, noise emissions have been assessed against the NSW 'Interim Construction Noise Guideline' (ICNG, 2009). Vibration impacts have been assessed using the NSW 'Assessing Vibration; a technical guideline' and British Standard 7385: Part 2-1993 *Evaluation and measurement of vibration in buildings*.

4.1 Interim Construction Noise Guideline

The NSW 'Interim Construction Noise Guideline' (ICNG, 2009) provides guidelines for assessing noise generated during the construction phase of developments.

The key components of the guideline that are incorporated into this assessment include:

- Use of L_{Aeq} as the descriptor for measuring and assessing construction noise.

NSW noise policies, including the NPfI, Road Noise Policy and Rail Infrastructure Noise Guideline have moved to the primary use of L_{Aeq} over any other descriptor. As an energy average, L_{Aeq} provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the L_{A10} descriptor.

- Application of reasonable and feasible noise mitigation measures

As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints.

Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

The ICNG provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria. A qualitative assessment is recommended for small projects of duration less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

Given the scale of the barging receipt and spoil removal works, a quantitative assessment is carried out herein, consistent with the ICNG requirements.

Table 4, reproduced from the ICNG, sets out the noise management levels and how they are to be applied for residential receivers.

Table 4 ICNG Noise Management Levels at Residential Receivers, dB(A)

Time of Day	Management Level L _{Aeq} (15 min) *	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured L _{Aeq} (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: <ul style="list-style-type: none"> • times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) • if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 <i>[of the ICNG]</i> .

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

As identified for residential receivers, a 'highly affected' noise objective of L_{Aeq(15min)} 75dB(A) is adopted for all noise sensitive residential receivers, with exceedances addressed as described in Table 4.

In addition to the above, Table 5 sets out the ICNG noise management levels for commercial receivers, and passive/active recreation areas.

Table 5 ICNG Noise Management Level at Commercial Premises, dB(A)

Land Use	Where Objective Applies	Management Level L _{Aeq} (15 min)
Commercial premises	External noise level	70 dB(A)
Industrial premises	External noise level	75 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level	65 dB(A)

Land Use	Where Objective Applies	Management Level L_{Aeq} (15 min)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level	60 dB(A)

Notes: Noise management levels apply when receivers are in use.

4.2 Construction Noise Criteria

The proposed construction works are proposed to be undertaken only during standard construction hours. As such, the Noise Management Levels at residential receivers are based on the RBL + 10 dB. A summary of the applicable construction noise management level for each receiver location are presented in Table 6 below.

Table 6 Summary of Applicable $L_{Aeq,15min}$ Construction Noise Management Levels, dB(A)

NCA/Receiver ID	Description	Receiver Type	Noise Management Level
CLD_01	Residences east of Silverwater Road	Residential	65 ¹
CLD_02	Residences west of Silverwater Road	Residential	65 ¹
CLD_03	Northern residences - away from Silverwater Road	Residential	55 ²
OSR -160	Eric Primrose Reserve	Passive recreation	60
OSR -161	Eric Primrose Reserve (playing fields)	Active recreation	65
OSR -162	Silverwater park	Passive recreation	60

Notes: 1. Based on background noise level of 55 dB(A) during the daytime period (7am to 6pm) from Saturday to Sunday as detailed in Section 3.2
2. Based on background noise level of 45 dB(A) during the daytime period (7am to 6pm) from Saturday to Sunday as detailed in Section 3.2

4.3 Human Annoyance Vibration Criteria

Assessment of potential disturbance from vibration on human occupants of buildings is made in accordance with the NSW 'Assessing Vibration; a technical guideline'. This document provides criteria which are based on the British Standard BS 6472-1992 'Evaluation of human exposure to vibration in buildings (1-80Hz)'.

Vibration sources are defined as continuous, impulsive, or intermittent. Table 7 provides a definition and examples of each type of vibration, reproduced from the NSW 'Assessing Vibration; a technical guideline'.

Table 7 Types of Vibration

Type of Vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).

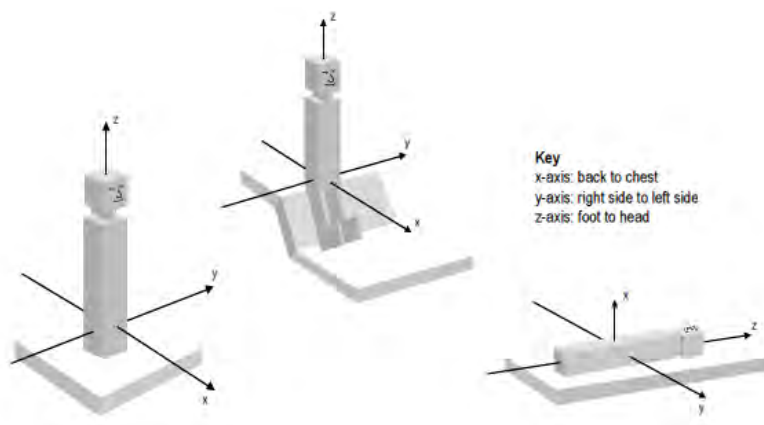
Type of Vibration	Definition	Examples
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than two seconds	Infrequent: Activities that create up to three distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

The vibration criteria are defined as a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

“Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).”

When applying the criteria, it is important to note that the three directional axes are referenced to the human body, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). Vibration may enter the body along different orthogonal axes and affect it in different ways. Therefore, application of the criteria requires consideration of the position of the people being assessed, as illustrated in Figure 4. For example, vibration measured in the horizontal plane is compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z- axis criteria if the concern is for people in the lateral position.

Figure 4 Orthogonal Axes for Human Exposure to Vibration



The preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced in Table 8.

Table 8 Preferred and Maximum Levels for Human Comfort

Location	Assessment Period ¹	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration (weighted RMS acceleration, m/s², 1-80Hz)					
Critical areas ²	Day or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night-time	0.020	0.014	0.040	0.028
Workshops	Day or night-time	0.04	0.029	0.080	0.058
Impulsive vibration (weighted RMS acceleration, m/s², 1-80Hz)					
Critical areas ²	Day or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night-time	0.64	0.46	1.28	0.92
Workshops	Day or night-time	0.64	0.46	1.28	0.92

- Notes:
1. Daytime is 7am to 10pm and night-time is 10pm to 7am
 2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to (BS 6472-1992).

The acceptable vibration dose values (VDV) for intermittent vibration are defined in Table 2.4 of the guideline and are reproduced in Table 9.

Table 9 Acceptable Vibration Dose Values for Intermittent Vibration (m/s^{1.75})

Location	Daytime ¹		Night-time ¹	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical areas ²	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

- Notes:
1. Daytime is 7am to 10pm and night-time is 10pm to 7am
 2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas (BS 6472-1992).

4.4 Structural Damage Vibration Criteria

Potential structural damage of buildings due to vibration is typically managed by ensuring vibration induced into the structure does not exceed certain limits and standards, such as British Standard 7385 Part 2. Currently there is no existing Australian Standard for assessment of structural building damage caused by vibration energy.

BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur. The cosmetic damage levels set by BS 7385 are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular building types. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls. 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

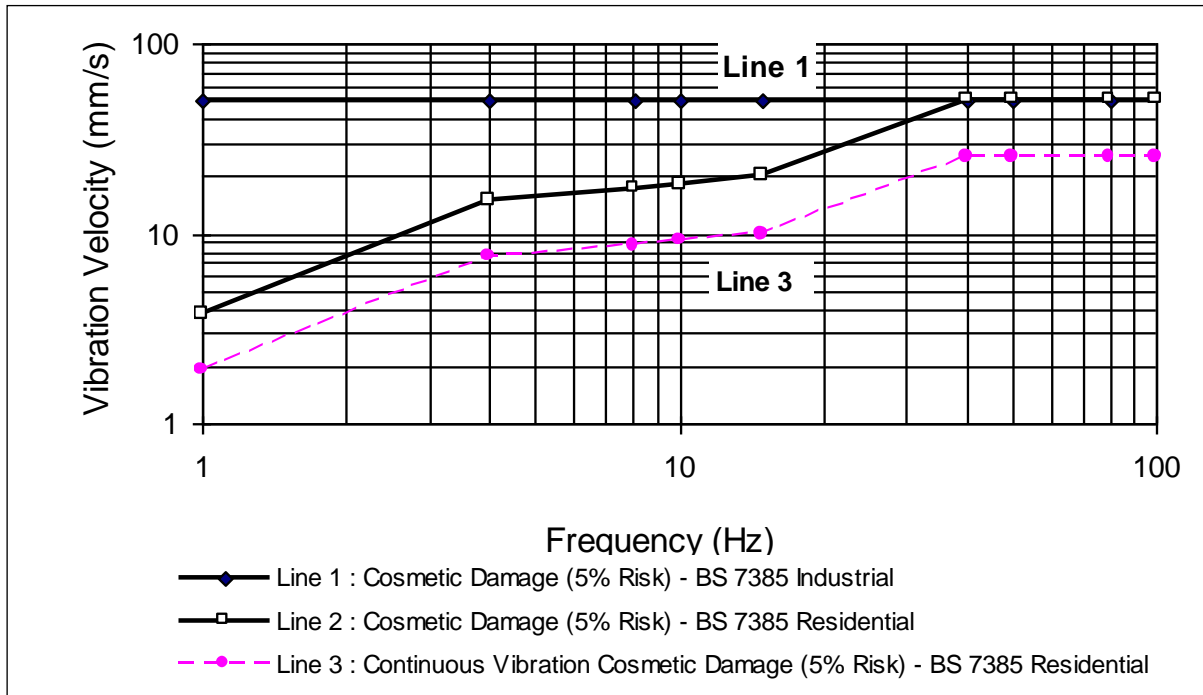
Table 10 sets out the recommended limits from BS7385 for transient vibration to ensure minimal risk of cosmetic damage to residential, commercial and industrial buildings. This is shown graphically in Figure 5.

Table 10 Transient vibration guide values - minimal risk of cosmetic damage (BS 7385) - peak component particle velocity

Line	Type of structure	Frequency range 4 to 15 Hz	Frequency range 15 to 40 Hz	Frequency range 40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s	50 mm/s	50 mm/s
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4Hz, increasing to 20 mm/s at 15Hz	20 mm/s at 15Hz, increasing to 50 mm/s at 40Hz	50 mm/s

BS7385 states that the guide values in Table 10 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 10 may need to be reduced by up to 50%, as shown by Line 3 of Figure 5 for residential buildings.

Figure 5 Graph of Transient Peak Component Particle Velocity Vibration Guide Values for Cosmetic Damage



5 Noise Assessment

This section identifies the noise sources to be used on site, describes the methodology for predicting noise levels at the nearest receivers and presents the results of the assessment.

5.1 Noise Sources

Noise generating equipment to be used for key construction scenarios has been identified by JHCBPG. A list of the equipment and corresponding sound power levels used as inputs for the noise modelling is provided in Table 11.

In Table 11, construction of the wharf, loading area and site access road would occur in parallel. However, since not all plant / equipment would operate at the same time, these works have been split into two scenarios for modelling and assessment purposes.

Prior to spoil removal (construction scenario V03), loading of barges with plant / equipment for the Barangaroo and Blues Point TSE sites would occur. The below construction scenarios are representative of the noise and vibration impacts of the proposed works. Noise emissions for barge loading activities will be less than for the spoil removal activities and have therefore not been specifically modelled. Similarly, decommissioning works would have similar noise impacts to site establishment and have therefore not been specifically modelled.

Table 11 List of plant and equipment with sound power levels used for noise modelling

Construction Scenario	Activities	Timing	Plant/ Equipment	Number of plant	Sound Power Level (Lw re: 1pW) L _{Aeq} , dB(A)	Notes	
V01	Construct wharf and loading area	Mar 18 to May 18	Light vehicle	5 per hour	89	Busy on shift changes only	
			Road truck deliveries	3 per day	108		
			Compressor	2	70		
			Hand tools	3	107		
			Piling rig (Bauer BG36)	1	114 + 5dB penalty		For wharf construction
			Franna crane	1	99		
V02	Upgrade / construct site access road	Mar 18 to May 18	Light vehicle	5 per hour	89	Busy on shift changes only	
			Truck & Dog (DGB delivery)	5 per hour	108		
			Compressor	2	70		
			Hand tools	3	107		
			Excavator	1	103		
			Grader	1	114		
			Compact Roller	1	112		

Construction Scenario	Activities	Timing	Plant/ Equipment	Number of plant	Sound Power Level (L _w re: 1pW) L _{Aeq} , dB(A)	Notes
			Concrete truck	1	108	
V03	Spoil removal	June 18 to Jan 20	Truck & Dog (spoil haulage)	10 per hour	108	Approximately 63 trucks per day along site access road (and up to 100 during peak periods)
			Loader on Barge	1	103	Loading trucks
			Excavator w bucket on land	1	103	Loading trucks
			Tugs 25m long Pedro 1 – 2 Tugs/barge	2 per day	97	up to 2 barges delivered and unloaded per day

5.2 Modelling Methodology

Modelling and assessment of airborne noise impacts has been undertaken using a Cadna-A computer noise model developed for this project. The model calculates the contribution of each noise source at identified receiver locations and allows for the prediction of the total noise from a site for the various stages of the works.

The noise prediction model considers:

- Location of noise sources and receiver locations;
- Height of sources and receivers referenced to one metre digital ground contours for the site area and surrounding area;
- Sound Power Levels (L_w) of plant and equipment likely to be used during the various construction activities;
- Separation distances between sources and receivers;
- Ground type between sources and receivers; and
- Attenuation from barriers (natural and purpose built).

For this assessment the stages of construction activities as presented in Table 11 have been modelled. It is noted that a +5dB penalty has been applied to the noise levels from any stages involving "highly annoying" activities, as defined in Section 4.5 of the ICNG. This penalty has been applied to scenario V01 which includes piling.

5.3 Predicted Noise Levels

Noise levels at the surrounding receivers have been calculated for each of the construction stages identified in Table 11. Predicted noise results for the assessment against the ICNG noise management levels are presented in Table 12 below and summarised in graphical form in APPENDIX B.

The predicted noise levels represent a worst-case scenario in which the most noise intensive plant and equipment for that construction stage are operating concurrently.

The colours in the table indicate whether or not receivers comply with the noise management levels and, where exceedance of the noise management level occurs, the perceived impact of the exceedance.

The impacts presented are as follow for **Standard Hours**:

- XX Complies with NML
- **XX** < 10dB(A) above NML - construction noise clearly audible
- **XX** > 10dB(A) above NML - construction noise clearly moderately intrusive
- **XX** > 75dB(A) - highly noise affected residence

Table 12 Predicted $L_{Aeq,15min}$ Construction Noise Levels, dB(A)

Receiver ID	$L_{Aeq(15minute)}$ noise level, dB(A) - Day (7:00 am to 6:00 pm)						
	NML	V01 min	V01 max	V02 min	V02 max	V03 min	V03 max
CLD_01	65	31	61	27	50	26	51
CLD_02	65	51	60	40	51	42	51
CLD_03	55	40	63	34	54	35	54
Industrial Receivers	75	47	67	37	66	38	66
Eric Primrose Reserve	60	n/a	66	n/a	56	n/a	56
Eric Primrose Reserve (playing fields)	65	n/a	64	n/a	53	n/a	54
Silverwater Park	60	n/a	67	n/a	54	n/a	56

Note: Min and Max refer to the minimum and maximum predicted noise levels at representative receivers within the noise catchment area

5.4 Discussion of predicted Noise Levels

The noise levels in Table 12 indicate that piling activities (for wharf construction) are predicted to cause exceedances of the noise management levels of up to 8 dB(A) at residential receivers in NCA CLD_03 (northern residences – away from Silverwater Road). At receiver locations closer to Silverwater Road, with higher ambient noise levels (NCA CLD_01 and NCA CLD_02), noise levels are predicted to comply with the noise management levels.

Noise management levels at the passive recreational spaces in Silverwater Park and Eric Primrose Reserve are predicted to be exceeded by up to 7 dB(A) during piling activities.

The piling works will be undertaken intermittently during the site establishment period (over approximately two months) and limited to standard daytime construction periods. For the remaining construction activities, including construction of the access road, loading of barges and spoil removal, noise levels are predicted to comply with the noise objectives.

To assist in management the potential impact of construction noise during piling activities, further guidance on feasible and reasonable mitigation and management measures is provided in Section 7.

6 Vibration Assessment

6.1 Minimum buffer distances for vibration intensive plant

From the plant and equipment listed in Table 11 the dominant vibration generating plant and equipment include:

- Bored piling rig
- Compacting roller

Potential vibration generated to receivers is dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration, and the receiver structure.

The recommended minimum working distances for vibration intensive plant are presented in Table 13. These distances are conservatively based on excavation of hard rock. Site specific buffer distances for vibration significant plant items must be measured on site where plant and equipment is likely to operate close to or within the minimum working distances for cosmetic damage (Table 13).

Unlike noise, vibration cannot be readily predicted. There are many variables from site to site, for example soil type and conditions, sub surface rock, building types and foundations, and actual plant on site. The data relied upon in this assessment (tabulated below) is taken from a database of vibration levels measured at various sites or obtained from other sources (e.g. BS5228-2:2009). They are not specific to this project as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver.

Table 13 Minimum working distances (m) for cosmetic damage (continuous vibration).

Plant item	Minimum working distance (m)		
	Reinforced or framed structures (e.g. commercial buildings) ¹	Unreinforced or light framed structures (e.g. residential buildings) ¹	Sensitive structures (e.g. heritage structures) ²
Screw piling rig	5 ³	5 ³	5 ³
Bored piling rig	5 ³	5 ³	5 ³
Compacting roller	5	10	20

Note 1: Initial screening test criteria reduced by 50% due to potential dynamic magnification in accordance with BS7385.

Note 2: A site inspection should be undertaken to determine whether a heritage structure is structurally unsound.

Note 3: Minimum working distances are in 5m increments only to account for the intrinsic uncertainty of this screening method. Bored piling rigs are likely to have minimum working distances smaller than 5 m (e.g. 2m in accordance with TfNSW CNS).

Prior to the commencement of construction activities, a detailed site survey should be undertaken to determine if there are any sensitive structures and/or buried pipework within the minimum working distances in Table 13. If any such structures are identified, detailed assessment is required to establish safe vibration levels and a proposed monitoring plan to ensure that vibration levels comply with the appropriate criterion.

7 Recommendations

As noted in Section 5.4, the predicted noise levels exceed the noise management objectives at the nearest residential receivers to the north (away from Silverwater Road) and at passive recreation areas in Silverwater Park and Eric Primrose Reserve. These exceedances are up to 8 dB(A) and are predicted to occur during piling activities at the wharf which would be undertaken intermittently over a two-month period.

Noise levels during the remaining construction activities are predicted to comply with the noise management levels at the nearest residential and other sensitive receivers.

Where the predicted $L_{Aeq(15\text{minute})}$ noise levels are greater than the noise management levels, the ICNG identifies that the following measures are to be applied to minimise potential impacts:

- JHCPBG should apply all feasible and reasonable work practices to meet the noise management level
- JHCPBG should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

The following sections provide guidance on indicative noise control measures that are proposed to be implemented to reduce noise impacts to surrounding receivers. A detailed Construction Noise and Vibration Impact Statement will be prepared following detailed design to confirm the exact mitigation measures to be implemented during site establishment and operations.

7.1 Reasonable and feasible noise and vibration mitigation

7.1.1 Standard noise and vibration management measures

An indicative list of standard noise and vibration mitigation measures to be implemented for the construction of the TSE Works to reduce construction noise and vibration is provided in the tables that follow.

- Table 14, which identifies standard noise and vibration management measures
- Table 15, which lists standard noise and vibration source mitigation measures
- Table 16, which sets out standard noise and vibration receptor mitigation measures.

Table 14 Standard noise and vibration management measures

Action required	Details	Estimated noise benefit	Comments on feasibility/ reasonableness	Preferred action?
Implement community consultation or notification measures	<p>Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night period, any operational noise benefits from the works (where applicable) and contact telephone number.</p> <p>Notification should be a minimum of seven calendar days prior to the start of works. For this project, more advanced consultation or notification should be adopted, including:</p> <ul style="list-style-type: none"> Website (if required) Contact telephone number for community Email distribution list (if required) 	<p>Ensures stakeholders know what to expect and keeps stakeholders informed of the likely impact.</p> <p>Community may identify solution to assist in managing impacts.</p>	N/A	Yes
Register of Noise Sensitive Receivers	<p>A register of all noise and vibration sensitive receivers (NSRs) would be kept. The register would include the following details for each NSR:</p> <ul style="list-style-type: none"> Address of receiver Category of receiver (e.g. Residential/Commercial etc.) Contact name and phone number 	<p>N/A</p> <p>Ensures worksites can contact NSRs.</p>	N/A	Yes
Site inductions	<p>All employees, contractors and subcontractors are to receive an environment and community induction. The induction must at least include:</p> <ul style="list-style-type: none"> • all site specific and relevant standard noise and vibration mitigation measures • relevant licence and approval conditions • community consultation and notification requirements • permissible hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times (including deliveries) • community contact protocols • complaints management requirements. 	<p>Keeps construction workforce informed of actions required to minimise noise and vibration impact.</p>	N/A	Yes
Behavioural practices	<p>No swearing or unnecessary shouting or loud stereos/radios on site.</p> <p>No dropping of materials from height where practicable, throwing of metal items and slamming of doors.</p> <p>No excessive revving of plant and vehicle engines</p> <p>Controlled release of compressed air.</p>	<p>0-20dB reduction</p> <p>Reduce annoyance + sleep disturbance.</p>	<p>Reasonable cost, limited noise reduction, reduced overall impact.</p>	Yes
Verification	<p>A noise verification program is to be carried out for the duration of the works in accordance with the Environment Protection Licence conditions.</p> <p>Ongoing noise monitoring during construction at sensitive receivers during critical periods (i.e. times when noise emissions are expected to be at their highest - e.g. piling and hammering) to identify and assist in managing high risk noise events.</p>	<p>0dB reduction</p> <p>Minimises noise and vibration impact.</p>	<p>Reasonable cost, limited noise/vibration reduction, reduced overall impact.</p>	Yes

Action required	Details	Estimated noise benefit	Comments on feasibility/ reasonableness	Preferred action?
Attended vibration measurements	Attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels satisfy the criteria for that vibration generating activity. Where there is potential for exceedances of the criteria further vibration investigations would be undertaken to determine the site-specific safe working distances for that vibration generating activity. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the applicable safe-working distances.	Reduces vibration impact + risk of structure damage.	Reasonable cost, and consideration of refinement of operations to reduce overall impact.	Yes

Table 15 Standard noise and vibration source mitigation measures

Action required	Details	Estimated noise benefit	Comments on feasibility/ reasonableness	Preferred action?
Construction hours and scheduling	Construction is proposed to be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels would be scheduled during less sensitive time periods.	Minimise high noise impact and reduce risk of annoyance.	N/A	Where reasonable and Feasible
Construction respite period - standard hours	High noise generating activities near receivers should be carried out in blocks that do not exceed three hours each, with a minimum respite period of one hour between each block. The duration of each block of work and respite should be flexible to accommodate the usage and amenity at nearby receivers.	Minimise noise and vibration impact and reduce risk of annoyance.	Reasonable cost, limited noise/vibration reduction, reduced overall impact.	Yes
Consider vibration in selecting plant and equipment	Use quieter and less vibration emitting construction methods where feasible and reasonable.	0-20dB reduction depending on selected equipment	Reasonable cost, limited noise reduction, reduced overall impact.	Where reasonable and feasible
Construction methodology/ Equipment selection	Use quieter and less noise emitting construction methods where feasible and reasonable, especially where they can replace high noise or vibration impact works.	0-20dB reduction/ less vibration impact + risk of annoyance.	Variable noise/vibration reduction, reduced overall impact, cost varies. Reasonableness and feasibility needs to be determined on a case by case basis.	Where reasonable and feasible
Maximum noise levels	The noise levels of plant and equipment must have operating Sound Power Levels compliant with the maximum noise levels in Table 11 of the Sydney Metro City and Southwest Construction Noise and Vibration Strategy Regular compliance checks on the noise emissions of all plant and machinery used for the project would indicate whether noise emissions from plant items were higher than predicted. This also identifies defective silencing equipment on the items of plant.	Varies depending on plant sound power level	Reasonable cost, variable noise reduction, minimum requirement.	Yes

Rental plant and equipment	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the maximum noise levels in Table 11 of the Sydney Metro City and Southwest Construction Noise and Vibration Strategy.	Varies depending on plant sound power level	Reasonable cost, variable noise reduction, minimum requirement.	Yes
Plan worksites and activities to minimise noise and vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.	Reduce noise/ vibration impact + risk of annoyance.	Reasonable cost, variable noise/vibration reduction, reduced overall impact.	Where reasonable and feasible
Switch off plant not in use	Avoid the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers to reduce noise to NSRs.	3-6dB reduction	Reasonable cost, medium reduction, where practicable	Where reasonable and feasible
Non-tonal reversing alarms	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Whilst the use of non-tonal reversing alarms is suggested to ensure noise impacts are minimised, it is noted that OH&S requirements must also be fully satisfied.	5-10dB reduction + reduce vibration	Reasonable cost, medium noise reduction	Yes
Engine silencing	The minimising of noise emissions from mobile plant by fitting residential grade mufflers on all mobile plant regularly used at worksites. Ensure plant including the silencer is well maintained. Heavy vehicle vehicles using the sites should have RMS compliant mufflers to control engine braking noise.	0-20dB reduction Reduce annoyance + sleep disturbance.	Medium cost of install, moderate to high noise reduction.	Where reasonable and feasible
Air brake silencing	Air brake silencers should be installed and fully operational for any heavy regularly used at worksite.	5-10dB LAmax reduction	Reasonable cost, medium noise reduction	Where reasonable and feasible
Engine compression braking	Ensure vehicles are fitted with a maintained Original Equipment Manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.	5-20dB reduction	Reasonable cost, medium noise reduction	Yes

Table 16 Standard noise and vibration receptor mitigation measures

Action required	Details	Estimated noise benefit	Comments on feasibility/ reasonableness	Preferred action?
Building condition surveys	Undertake infrastructure surveys on all buildings assessed as being at risk of property damage prior to commencement of activities with the potential to cause property damage.	Limits infrastructure damage.	Reasonable cost, limited vibration reduction, reduced overall impact.	Yes
vibration monitoring	At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.	Limits damage to infrastructure.	Reasonable cost, limited vibration reduction, reduced overall impact.	Where reasonable and feasible

7.1.2 Additional noise and vibration management measures

During the proposed construction works there will be circumstances where after application of the all reasonable and feasible mitigation measures identified in Table 14 to Table 16, the construction noise and vibration objectives (refer Section 4) will be exceeded. In these instances, and consistent with the Sydney Metro Construction Noise and Vibration Strategy (CNVS), additional noise and vibration management may be applicable, taking into consideration when works are being undertaken and the level of exceedance.

Additional management measures to be applied when mitigating and managing construction impacts are described in Table 17.

Table 17 Additional management measures

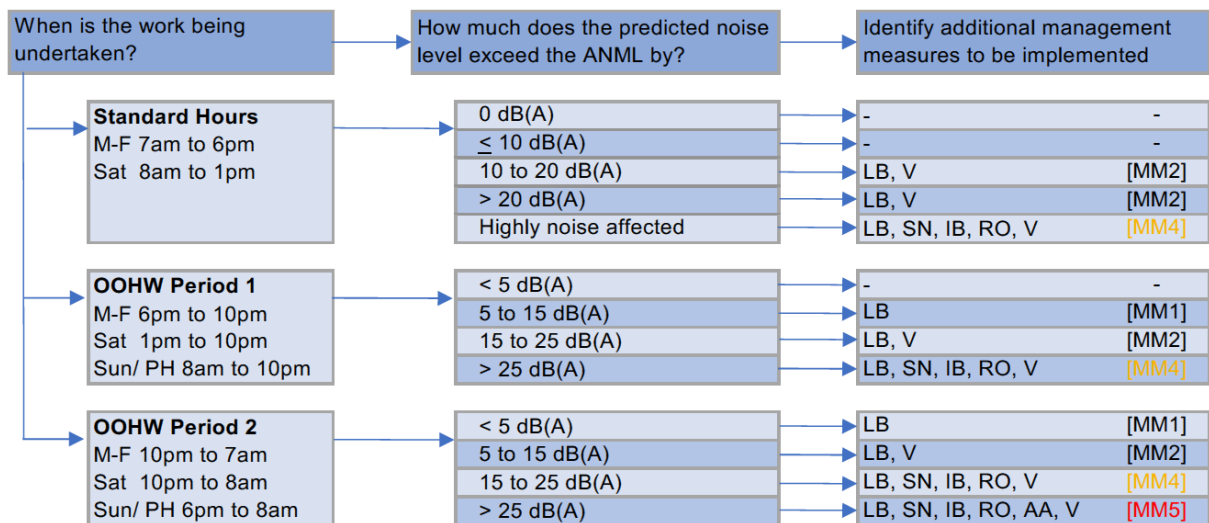
Measure	Description	Abbreviation
Letter box drops	The Sydney Metro TSE will prepare newsletters to be distributed to the local community via letterbox drop and the project email list. The newsletters will provide an overview of current and upcoming works across the TSE Worksites and other topics of interest and/or provide advanced warning of high noise impact activities during the day or potentially audible OOHV. The objective is to engage and inform and provide project-specific messages. The newsletter will disseminate TSE Works information to interested stakeholders. The newsletter will be distributed monthly.	LB
Verification monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, noise or vibration monitoring may be conducted at the affected receiver(s) or a nominated representative location (typically the nearest receiver where more than one receiver have been identified). Monitoring can be in the form of either unattended logging or operator attended surveys. The purpose of monitoring is to inform the relevant personnel when the noise or vibration goal has been exceeded so that additional management measures may be considered implemented.	V
Specific notification	Specific notifications are given to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advise of unscheduled works. Specific notification may be in the form of personalised letter delivered or hand distributed; phone call; and/or email.	SN
Individual briefing	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the TSE Works.	IB
Project specific respite offer	The purpose of a TSE Works specific respite offer is to provide respite to residents subjected to lengthy periods of noise or vibration from an ongoing impact. This may be in the form of rescheduling works to better suit sensitive receivers (where reasonable/ feasible). Alternatively, TSE Works specific respite offer may include pre-purchased movie tickets, coffee or meal vouchers. Respite offers will be determined on a case-by-case basis.	RO
Alternative accommodation	Alternative accommodation options may be offered to residents living near construction works that are likely to incur unreasonably high impacts over an extended period. Alternative accommodation will be determined on a case-by-case basis.	AA

7.1.3 Applying additional management measures - airborne construction noise

In circumstances where, after application of all reasonable and feasible mitigation measures, the $L_{Aeq(15\text{minute})}$ airborne construction noise levels are still predicted to exceed the NMLs, additional airborne noise management measures can be applied to further limit the risk of annoyance from construction noise. This requirement is supplemental to the basic requirements in the ICNG.

The steps to be carried out to determine the additional management measures to be implemented are identified in Figure 6.

Figure 6 Additional airborne noise management measures



Notes: Use the abbreviation codes in the table above to confirm management measures required
Code in square brackets [] refers to noise management code for affected receivers identified in each CNVIS

7.1.4 Applying additional management measures – construction vibration

If the predicted ground-borne vibration levels exceed the structural damage objectives in Section 4.4, a different construction method with lower source vibration levels should be considered. Attended measurements should be undertaken at the commencement of all high vibration generating activities. If there is any risk of exceedance of the structural damage objective, a permanent vibration monitoring system should be installed, to warn plant operators (via flashing light, audible alarm, SMS, etc.) when vibration levels are approaching the structural damage objective.

8 Conclusion

Renzo Tonin & Associates has completed an assessment of the environmental noise and vibration impact from the proposed barge receival and spoil removal site at Clyde.

Noise impacts from each construction activity upon the potentially most affected noise sensitive receivers has been quantified and compared to the noise management levels (NML) set by the NSW ICNG and human comfort vibration levels in Assessing vibration – a technical guideline.

Exceedances of the relevant noise management levels of up to 8 dB(A) are predicted during piling works required for the site establishment phase of the works. Compliance with the relevant noise management levels are predicted during the barge receival and spoil removal stage.

Indicative noise management measures (consistent with other TSE construction sites) are recommended to aid in reducing noise impacts at nearby sensitive receivers. A detailed Construction Noise and Vibration Impact Statement will be prepared following detailed design to confirm the exact mitigation measures to be implemented during site establishment and operations.

APPENDIX A Glossary of Terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0 dB The faintest sound we can hear 30 dB A quiet library or in a quiet location in the country 45 dB Typical office space. Ambience in the city at night 60 dB CBD mall at lunch time 70 dB The sound of a car passing on the street 80 dB Loud music played at home 90 dB The sound of a truck passing on the street 100 dB The sound of a rock band 115 dB Limit of sound permitted in industry 120 dB Deafening
dB(A)	A-weighted decibels. The A-weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L _{Max}	The maximum sound pressure level measured over a given period.
L _{Min}	The minimum sound pressure level measured over a given period.

L ₁	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L ₁₀	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L ₉₀	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L _{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B **Summary of predicted noise levels**

Appendix B– Terrestrial and marine flora and fauna assessment



Clyde Barging Receiving Site: Ecological Assessment

Prepared by AMBS Ecology & Heritage Pty Ltd
for JHCPBG JV

Final Report

December 2017

AMBS Reference: 16316

Document Information

Citation:	AMBS Ecology & Heritage 2017, Clyde Spoil Reveal Site: Ecological Assessment. Consultancy report to John Holland Pty Ltd, CPB Contractors Pty Ltd and Ghella Pty Ltd Joint Venture.
AMBS Reference:	16316
Versions:	Version 1: Preliminary Draft issued 3 December 2017 Version 2: Draft Report issued 8 December 2017 Version 3: Final Report issued 8 December 2017 Version 4: Final Report v2 issued 11 December 2017 Version 5: Final Report v3 issued 11 December 2017
Recipient:	Robert Muir
Authors:	Glenn Muir, Dr Alison Hunt (AH Ecology), Belinda Pellow
Approved by:	Glenn Muir

Contents

1	Introduction	1
1.1	Background	1
1.2	Objectives and Scope	1
1.3	Site Description	2
1.4	Proposed Development	2
1.5	Statutory Framework	4
2	Methods	1
2.1	Study Area	1
2.2	Information Review	1
2.3	Field Surveys – Previous Studies	2
2.4	Field Surveys – This Study	3
2.5	Limitations	4
3	Results - Terrestrial	5
3.1	Information Review	5
3.2	Plant Communities and Fauna Habitat	9
4	Results - Aquatic	17
4.1	Existing Environment	17
4.2	Site & Study Area	18
5	Conservation Significance	21
5.1	Estuarine and Marine Environment	21
5.2	Wetlands of International Significance	21
5.3	DPI Key Fish Habitat	21
5.4	Estuarine Habitat	21
5.5	Riparian and Estuarine Vegetation	21
5.6	Threatened Plants	23
5.7	Threatened Ecological Communities	24
5.8	Threatened Fauna	24
5.9	Connectivity	26
5.10	Foreshore Vegetation Guidelines	27
6	Impact Assessment	28
6.1	Potential Impacts	28
6.2	Marine Vegetation	28
6.3	Disturbance of Sediments	28
6.4	Potential Indirect Impacts on the Aquatic Environment	29
6.5	Impacts on Aquatic Species, Populations and Communities of Conservation Significance	30
6.6	Threatened Plants	31
6.7	Endangered Ecological Communities	31
6.8	Threatened and Migratory Fauna	33
6.9	Corridor Values	37
6.10	Cumulative Impacts	37
7	Management and Mitigation	38
7.1	Terrestrial	38
7.2	Aquatic	40
7.3	Summary Table	1
8	Conclusion	1
	Bibliography	2
	Appendix A: Threatened Flora Likelihood of Occurrence	5
	Appendix B: Threatened Fauna Likelihood of Occurrence	7

Appendix C: Plant Species Recorded During Survey.....11
Appendix D: Fauna Recorded During Survey13
Appendix E: Assessments of Significance14

Tables

Table 1.1: Movement of equipment and spoil over the course of the project.3
Table 2.1: Field sampling conditions.3
Table 3.1: Plant communities previously mapped in the study area.....9
Table 5.1: Aquatic species of conservation significance relevant to this proposal.....25
Table 6.1: Aquatic communities, populations and guilds of species listed under the threatened species legislation for which Assessments of Significance have been undertaken.....30

Figures

Figure 1.1: Location of proposed development..... 1
Figure 1.2: Layout of proposed development.....2
Figure 3.1: BioNet records of threatened and migratory fauna.6
Figure 3.2: BioNet records of threatened flora.....7
Figure 3.3: UBM (2017) vegetation map of the wetland and surrounds9
Figure 3.4: AMBS vegetation map of the subject site and surrounds.10
Figure 5.1: Parramatta Council Vegetation Significance map.....26
Figure 6.1: Approximate extent of development if it is within a 7-metre corridor.32
Figure 7.1: Table of mitigation measures. 1

1 Introduction

1.1 Background

AMBS Ecology & Heritage Pty Ltd (AMBS) was commissioned by John Holland Pty Ltd, CPB Contractors Pty Ltd and Ghella Pty Ltd Joint Venture (JHCPB JV) to undertake an ecological assessment of potential impacts in relation to a proposed development at the Viva Energy fuel storage terminal at Clyde (the 'Clyde Facility'). The proposed development involves the upgrade of an existing wharf and the upgrade of an existing road between the wharf and the existing public road network. The wharf is located on the Parramatta River, approximately 15 km west of the Sydney central business district (Figure 1.1).

The purpose of the proposed development will be to facilitate the transfer of equipment and spoil for the approved Sydney Metro Tunnel and Station Excavation (Sydney Metro TSE) project works, which are being undertaken by JHCPB JV for Transport for New South Wales (TfNSW). In relation to the development proposal at the Clyde Facility, TfNSW is the proponent and the determining authority under Part 5 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act). This biodiversity impact assessment forms part of the Review of Environmental Factors (REF) being prepared for the proposal.

AMBS commissioned Alison Hunt & Associates Pty Ltd (AH Ecology) to undertake the assessment of impacts on aquatic environments in relation to the project and the results are incorporated into this report.

1.2 Objectives and Scope

The purpose of this study was to assess the potential direct and indirect impacts of the proposed development on terrestrial flora and fauna, and estuarine and marine biodiversity, of the site, immediate surrounds and locality, especially in relation to threatened species, populations and ecological communities. Specific tasks were to:

- Assess the potential for threatened species, populations and ecological communities (or their habitats) listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) to occur;
- Assess the presence or potential for threatened ecological communities, populations, species and / or their habitat listed under the NSW *Fisheries Management Act 1994* (FM Act) to occur on the site and within the locality;
- Assess the presence or potential presence of mangroves and 'certain other marine vegetation' as described by the FM Act;
- Assess the potential for any relevant Matters of National Environmental Significance listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to occur;
- Consider the potential impacts of the proposed works on biodiversity, especially in relation to the BC Act, FM Act and EPBC Act;
- Prepare recommendations for the avoidance of impacts and management or mitigation options; and
- Assess the significance of the potential impacts of the proposed works on threatened species, populations and ecological communities.

This report is focussed on biodiversity and does not address heritage, acid sulphate soils, flooding, zoning or contamination.

1.3 Site Description

The Clyde Facility is set within the Camellia Industrial Estate which is home to a range of businesses, including recycling services, building products, waste services, gas supplies and product transport (AECOM 2013). It was previously a crude oil refinery (operating from 1928 until 2012) and is now a fuel storage terminal which receives, stores and distributes fuel products (e.g. diesel, jet fuel, gasoline), which are transferred from Gore Bay Terminal via an existing pipeline. Fuel products are then distributed via an existing pipeline to the Parramatta Terminal road gantry and then via road transport across NSW. Fuel is also supplied from Clyde Terminal to Sydney Airport via existing pipeline infrastructure (AECOM 2013).

The Clyde Facility is located between industrial development to the west, Duck River to the east and south, and Parramatta River to the north. Parramatta River forms the northern boundary of the site and Duck River the eastern boundary. The existing wharf is located near the confluence of Parramatta River and Duck River, approximately 200 m upstream of the Silverwater Bridge (Figure 1.2). Opposite the Clyde Facility, the northern bank of the Parramatta River is bordered by mangroves, fronting parkland and the residential suburb of Rydalmere.

One of the features of the Clyde Facility is a constructed wetland, which is situated between the refinery area and the Parramatta River, west of the wharf (Figure 1.2). The wetland is surrounded by a band of varying width of mostly planted terrestrial vegetation. The wetland and vegetated surrounds (together the “Clyde Wetlands area”) are bordered to the north by a Hymix Concrete facility, a KLF waste recycling centre and the Parramatta River. An existing road bordering the Clyde Wetlands follows the boundary between the vegetated area and the Hymix and KLF waste facility, then passes through the vegetated area south of the Parramatta River to the wharf. An existing easement is located between the Hymix and KLF facilities.

1.4 Proposed Development

The Clyde Facility would be used as a transfer station for equipment and materials required for the Sydney Metro TSE works and for spoil generated from TSE excavation works at Barangaroo and Blues Point. Equipment would be brought in by road to the Clyde Facility and transferred to a barge via the road and upgraded wharf, for transport down Parramatta River. Spoil would be brought up river on a barge from Barangaroo and/or Blues Point and loaded onto trucks at the upgraded wharf.

The existing wharf extends along the riverbank of the Parramatta River for approximately 35 m and is used intermittently to load and unload materials from vessels. It comprises a mixture of wooden piers and metal sheet piles, many of which are in disrepair, and at the southern end an area of large rubble borders the river. Fill comprised of ballast and building rubble has been packed in behind the piers and sheet piles and this fill has slumped and eroded.

The existing 35m wharf may be extended in length, likely to the south and/or extended over the river to east to accommodate barges (up to 2,000 tonne) up to 55 metres. Construction will involve the piling of permanent piles hard up against the riverside of the existing degraded sheet piling. A concrete capping deck would be installed over the piles to the existing wharf to allow for a stable working platform, with fenders installed along the riverside to allow for barge docking. An additional pile will be installed at the northern end of the existing wharf approximately 10 m from the wharf to allow a barge to be tied-off and for additional protection of the existing Gore Bay pipeline.

The wharf would be constructed using a land-based piling rig along the existing wharf. Where the wharf needs to be extended to the south, a piling rig would be located on a barge which will be used to install the piles prior to a deck being installed from the land side. Erosion and sediment

control would be installed prior to the clearing of two isolated stands of trees and the minor earthworks which are required to level the Site (less than 1 m). Concrete barriers will be installed to protect the Gore Bay Pipeline.

An existing packed gravel / concrete hardstand area located adjacent to the wharf will be used as the truck turning / loading area. Trucks will travel to and from the truck turning area to the western end of Grand Avenue via the route of an existing road. The eastern part of the road will follow the line of the existing road along the southern foreshore of Parramatta River, to the KLF building waste recycling centre, where it turns south-east and runs along the KLF boundary fence to an existing easement, where it turns east and follows the easement to Grand Avenue (Figure 1.2).

The existing single-lane road will be upgraded to provide for two-way movements where feasible or alternatively temporary traffic signals or a passing bay may be used. This will require widening the existing road to approximately 7 metres and may require raising the level of the road. Minor earthworks would be required to extend the access road through the easement to Grand Avenue. The upgraded access road would be treated with a spray seal. Existing drainage lines would be upgraded and erosion and sediment controls would be installed. A gate house, weigh bridge and vehicle hygiene facility will be installed at the entrance to Grand Avenue.

Earthworks required in the hardstand truck turning area would include some levelling (less than 1 metre), and on the approaches to an existing bridge over a water main, to reduce gradients to allow for heavy vehicle passage. Earthworks will also be required for the new section of road at end of Grand Avenue.

Site offices and amenities would be located within the current easement at the end of Grand Avenue.

Site establishment would commence in early 2018 and take approximately two months. The facility would operate for approximately 20 months from approximately mid 2018 to early 2020.

The site would generally be operated during standard construction hours i.e. Mondays to Fridays 7:00am to 6:00pm and Saturdays 8:00am to 1:00pm. There may be a need for works outside of these hours, particularly due to tides or to coordinate with other vessel movements.

A barge laden with spoil would be brought to the Clyde facility from the Sydney Metro TSE work site at either Barangaroo or Blues Point guided by two tugs. The two tugs would then perform a changeover of the barges at the wharf and return the empty barge to Barangaroo or Blues Point. The loading and unloading movements at the wharf are expected over the course of the Project (Table 1.1).

Table 1.1: Movement of equipment and spoil over the course of the project.

Activity	Frequency	Total Number of Movements
Plant and Equipment	Intermittently	10 barges
Spoil	1 per day over 20 months	350 barges
Truck & dogs	62 per day when barge delivered	21,875 truck & dogs

The barge will be unloaded via one land-based long-reach 80 tonne excavators which will load out spoil into truck and dogs. The excavators will be operated so that they will not slew over open water when they are loading trucks. Spoil will be held contained on the barge via 2.5 m hungry boards around the perimeter of the barge with a water tight bund on the outside of the hungry board to prevent any sediment laden water from escaping. Tarping will be placed over the spoil to prevent dust generation.

To prevent material from falling between the barge and the wharf while unloading, rubber matting secured on the wharf side and extending for the length of the wharf would be laid between the wharf and the barge where it will also be secured. The rubber matting would be inspected for spoil and swept prior to it being retracted.

1.5 Statutory Framework

The proposed development will be addressed under relevant biodiversity and threatened species legislation. These may include, but not necessarily be limited to the below.

1.5.1 Commonwealth

EPBC Act

The EPBC Act provides for the assessment of impacts on matters of national environmental significance (MNES). MNES that are relevant to this study include nationally threatened species and ecological communities and migratory species. There are no wetlands of international importance in or near the study area; impacts on world heritage properties and national heritage places are not within the scope of this assessment; there are no likely impacts on the Great Barrier Reef Marine Park; the proposed action is not a nuclear action; and the proposed action is not a coal seam gas development or a large coal mining development.

A proponent must not take an action that has, will have or is likely to have a significant impact on a matters of environmental significance without approval from the Australian Government Minister for the Environment and Energy (the Minister). The Australian Government has released guidelines for the purpose of determining whether or not a proposed action will have a significant impact; these include the *Matters of National Environmental Significance - Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999* and, in some cases, additional guidelines for specific species or communities, including the *Significant impact guidelines for the vulnerable green and golden bell frog (Litoria aurea)*.

If a significant impact on an MNES is considered likely, the proponent must refer the project to the Department.

Other policies of relevance include the *Threat Abatement Plan for Disease in Natural Ecosystems caused by Phytophthora cinnamomi* and the *Draft Threat Abatement Plan for Infection of Amphibians with Chytrid Fungus resulting in Chytridiomycosis*.

1.5.2 State

BC Act

The primary mechanism for biodiversity protection and planning in NSW is the BC Act, although a number of transitional arrangements are currently in place in relation to the repealed *Threatened Species Conservation Act 1995* (TSC Act). It is understood by AMBS that the proposed development will be assessed and approved under Part 5 of the EP&A Act. For the purposes of Part 5 of the EP&A Act, an activity is to be regarded as an activity likely to significantly affect the environment if it is likely to significantly affect threatened species.

Development or an activity is "likely to significantly affect threatened species" if:

- (a) it is likely to significantly affect threatened species or ecological communities, or their habitats, according to the test in section 7.3 of the Act (the "5-part test"), or
- (b) the development exceeds the biodiversity offsets scheme threshold if the biodiversity offsets scheme applies to the impacts of the development on biodiversity values, or
- (c) it is carried out in a declared area of outstanding biodiversity value.

In relation to the above:

- (a) where relevant, impacts on threatened species or ecological communities, or their habitats, are assessed in this study according to the test in section 7.3 of the Act (the “5-part test”);
- (b) subsection (b) does not apply to development that is an activity subject to environmental impact assessment under Part 5 of the EP&A Act;
- (c) the study area is not a declared area of outstanding biodiversity value.

Fisheries Management Act (FM Act)

The FM Act aims ‘to conserve, develop and share the fishery resources of the State for the benefit of present and future generations’ and, in particular, to:

- Conserve fish stocks and key fish habitats;
- Conserve threatened species, populations and ecological communities of fish and marine vegetation;
- Promote ecologically sustainable development, including the conservation of biological diversity, and, consistently with those objectives;
- Promote viable commercial fishing and aquaculture industries;
- Promote quality recreational fishing opportunities;
- Appropriately share fisheries resources between the users of those resources; and
- Provide social and economic benefits for the wider community of New South Wales.

To meet these objectives, Part 7 of the FM Act outlines legislative provisions to protect fish habitat and Part 7A outlines provisions to conserve threatened species of fish and marine vegetation and their habitat.

Under the FM Act, fish means “marine, estuarine or freshwater fish or other aquatic animal life at any stage of their life history (whether alive or dead)” and includes oysters and other aquatic molluscs, crustaceans, echinoderms and beachworms and other aquatic polychaetes. The definition also includes any part of a fish, but does not include whales, other mammals, reptiles, birds, amphibians or other things excluded from the definition by the regulations.

State Environmental Planning Policies (SEPPs)

SEPPs deal with matters of State or regional environmental planning significance. They are made by the Governor on the recommendation of the Minister for Planning and may be exhibited in draft form for public comment before being published as a legal document. SEPPs that are considered relevant to this biodiversity study are discussed below.

State Environmental Planning Policy No 44—Koala Habitat Protection

The study area is not Core Koala Habitat; none of the previous studies of the study area and surrounds have described it as Potential Koala Habitat; and the Koala is highly unlikely to occur anywhere within the study area or in the surrounding landscape.

State Environmental Planning Policy No 19—Bushland in Urban Areas

The study area is not zoned or reserved for public open space purposes and, as private land, the requirements of the SEPP do not specifically apply to the Clyde Wetlands.

State Environmental Planning Policy No 26—Littoral Rainforests

Littoral rainforest does not occur within the study area.

State Environmental Planning Policy No 14—Coastal Wetlands

There are no SEPP 14 wetlands within the study area.

1.5.3 Region

The *Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005* (REP) (DPI 2005) covers all the waterways of Sydney Harbour, the foreshores and the entire catchment. The REP establishes a set of planning principles for the preparation of planning instruments for the hydrological catchment of Sydney Harbour and zones the waterways into nine different zones to suit the differing environmental characteristics and land uses of the harbour and its tributaries.



Figure 1.1: Location of proposed development.



Figure 1.2: Layout of proposed development.

2 Methods

2.1 Study Area

The “subject site” was defined as the area that will be directly affected by the proposed development (the development “footprint”), including any areas required to be temporarily cleared for construction purposes. This included the proposed wharf upgrade, the truck loading/turning area next to the wharf, and the road between the turning area and the eastern end of Grand Avenue.

The “study area” was defined as the subject site and areas that might be affected by indirect impacts from the proposed development, including the wetland area south of the road and the vegetation surrounding the wetland.

Potential impacts on aquatic environments, in particular the marine environment around the wharf and mangrove and saltmarsh habitats along the Parramatta and Duck rivers, are included in the study.

2.2 Information Review

A number of recent studies regarding flora and fauna at the Clyde Facility have been undertaken. If available, these reports were reviewed in order to gather background information regarding the flora and fauna of the site. In addition, records of threatened species, populations and ecological communities from the locality (5 km radius) were obtained via database searches. A full list of reference materials is provided in the “References” section. Key information sources included:

- *Conservation of Green and Golden Bell frogs, Shell Site, Clyde* (Biosphere 2013a);
- *Plan of Management – Restoration of Green and Golden Bell Frog Habitat – Clyde* (Biosphere 2013b);
- *Plan of Management – Restoration of Green and Golden Bell Frog Habitat – Clyde* (Biosphere 2014);
- *Flora and Fauna Survey of a Wetland within the Shell Refinery, Rosehill* (UBMC 2006);
- *Revised Wetland Management Plan for the Clyde Wetlands – Clyde Terminal, Rosehill, NSW* (UBM 2017);
- *Ecological Assessment – Clyde Terminal Conversion* (AECOM 2013);
- *Shell Clyde Refinery – Bats* (Ecological 2012);
- *Parramatta Light Rail – Duck River Crossing – Biodiversity Review* (redacted version) (Jacobs 2016);
- *Shell Clyde Refinery Wetland – Environmental Statement and Plan of Management* (Gunninah 1990).

Additional searches of the following databases and maps were also undertaken:

- a search of the NSW Office of Environment and Heritage *BioNet Atlas* database for records of threatened fauna and flora in the locality (5 km radius for terrestrial and 10 km for aquatic species) (OEH 2017);
- a search of the Commonwealth Department of the Environment and Energy *Protected Matters* database for records of matters of national environmental significance in the locality (5 km radius for terrestrial and 10 km for aquatic matters) (DotEE 2017);
- a search of the NSW Department of Primary Industries (NSW DPI) – Fisheries ‘What is Currently Listed’ online resource (accessed October 2017);
- broad vegetation maps of the study area and surrounds produced by OEH (2016);
- Parramatta Council’s “Vegetation Significance” map.

2.3 Field Surveys – Previous Studies

Gunninah (1990) undertook flora and fauna surveys of the Clyde Wetlands area. The vegetation was surveyed in a single site traverse. Fauna surveys involved direct observation, predominantly in the afternoon and early evenings, “on a number of occasions”.

UBMC (2006) undertook flora and fauna surveys of the Clyde Wetlands area in 2005. Fauna surveys were undertaken on 22 November 2005, 30 November 2005, 8 December 2005 and 15 December 2005 and included a range of techniques, including spotlighting, ultrasonic call detection for microbats, hand searches, hair tubes, scat analysis, call-playback for the GGBF, direct observation and habitat assessment. Flora surveys were undertaken for about 14 person-hours on 24 November 2005. The study area was traversed, with search efforts targeting sites that had the highest potential to support plant species, populations or communities of conservation significance. Approximately 14 hours were spent actively surveying the study area. All areas of vegetation within the study area were traversed on foot using the Random Meander method described by Cropper (1993).

NGH Environmental undertook surveys across a broader area in 2008, which included a bird survey at the remnant wetland. Their report was not available to AMBS; however, AECOM (2013) discuss this study and its results.

AECOM (2013) undertook site investigations at the Clyde Facility on 20 September 2012, including the Wetland and surrounds. The investigations comprised ground-truthing of vegetation mapping (where access was permissible) and habitat assessment. Habitat assessment was aimed at identifying all known and potential areas of GGBF habitat, including “each area where OEH’s Atlas of Wildlife returned records for the species as well as additional drainage and bunded areas, which have water holding capacity, and the foreshore of Duck and Parramatta Rivers”. Where possible, areas containing potential shelter habitat and aquatic vegetation were searched for sheltering and basking frogs and tadpoles.

AECOM (2013) also undertook nocturnal surveys for the GGBF on 10 and 11 October 2012, using a combination of call detection, call playback and spotlighting for eye shine, in all areas of potential GGBF habitat.

Jacobs (2016) undertook site assessments at eight terrestrial and four aquatic sites along the Parramatta and Duck rivers from 30-31 March, 4-5 April and 22 April 2016, within a broader study area. The field surveys included a terrestrial site within the Wetland area and another along the Duck River adjacent to the subject site. These site assessments included “Vegetation and flora field survey”, “Terrestrial fauna survey” and “Habitat assessment”. Specific survey techniques and effort were not documented.

UBM (2017) undertook field investigations of the Clyde Wetlands in June-July 2017 to confirm and update data from previous reports (Gunninah 1990, UBMC 2006, UBMC 2007) and identify specific issues or problems relevant to the Revised Wetland Management Plan (UBM 2017). All parts of the area were traversed on foot, using the Random Meander method described by Cropper (1993). The investigations included:

- targeted searches for the threatened Downy Wattle (*Acacia pubescens*) and Narrow-leafed *Wilsonia* (*Wilsonia backhousei*);
- opportunistic observations of any other flora listed on the TSC Act or EPBC Act;
- opportunistic sightings of fauna in and adjacent to the area;
- discussions with the National Trust bush regeneration team regarding their fauna sightings in recent years;
- habitat assessment;

- assessment of the value of the area as a local wildlife corridor or vegetation link;
- identification and mapping the boundaries and locations of weeds.

2.4 Field Surveys – This Study

A field inspection was undertaken on 6 October 2017 by Belinda Pellow, Glenn Muir and Dr Alison Hunt, to ascertain the current condition of the subject site and study area and the presence, or likely presence, of threatened or protected species, populations and communities. This was undertaken in the afternoon to coincide with low tide (Table 2.1).

Table 2.1: Field sampling conditions.

Date	Time (hours)	Tide	Weather
5 October 2017	1200-1600	Low tide 0.31 m @ 1542 hours	Partly cloudy, calm, 15.5-28.7 °C. No rain.

Site assessments included:

- Habitat assessments undertaken to identify aquatic habitats present, their quality and the overall health of the site. During this assessment the following were noted:
 - Type and distribution of macrophytes, seaweeds and algae; and
 - Type and distribution of fauna habitat including a visual inspection of the banks for burrowing activity, shell remnants and fragments of crayfish or molluscs. Debris was overturned and macrophytes and emergent vegetation were also searched for the presence of invertebrate fauna.
- The potential for the Site to provide habitat for species, populations and communities, and in particular those listed under the FM Act, BC Act and EPBC Act, was determined through integrating known records of aquatic species within the locality and the types of habitat present.

The field inspection included a flora survey of the area where the proposed road works will be undertaken and in the vicinity of the proposed wharf upgrade. The study area was traversed to examine the type and condition of the vegetation and to record the plant species present. The structure of the vegetation, its location within the landscape and the substrate on which it occurred were noted. The location and extent of Threatened Ecological Communities (TECs) previously recorded within the Clyde Wetlands area (UBMC 2007, AECOM 2013, UBM 2017, OEH 2016), the location and extent of these was confirmed.

Searches for threatened plant species were made using a random meander method. A list of weed species was also compiled. Particular focus was on weeds that are listed as Priority Weeds in the City of Parramatta LGA.

The field inspection included a detailed assessment of the fauna habitat present in the area proposed for the road works and in the vicinity of the proposed wharf upgrade. The structure and condition of the vegetation was examined and a search was made for tree hollows and any other habitat features that might be used by threatened species. Every tree within the area of the proposed works footprint was examined for hollows. Outside of the footprint, a brief inspection of the fauna habitat present was made in the woodland areas around the wetland.

The field inspection also included an examination of the wetland area from a number of angles and a brief survey for the Green and Golden Bell Frog (GGBF). The GGBF survey included a diurnal call-playback and a brief search for basking animals at three points around the wetland and a search for sheltering animals along the northern shore of the wetland.

2.5 Limitations

The aquatic site assessment was aimed at providing an overall broad assessment of the ecological values of the site and environs, with particular emphasis on the likely presence of threatened species or other ecological matters of interest, through integration of data from a number of sources. It was not designed to identify all species, whether resident or transitory to the site, and it is likely that a number of species not mentioned in this report would utilise the resources of the site from time to time.

In relation to terrestrial flora and fauna, the study area has been the subject of a number of previous studies and the presence of a number of threatened species and ecological communities in the wetland and/or its surrounds are already known. The GGBF and the wetlands and surrounds are already the subject of management plans that have been prepared for the Clyde Facility (UBMC 2007, 2017; Biosphere 2013a, 2013b, 2014). Detailed field surveys were undertaken by UBMC (2006). In addition, some field surveys were undertaken by Gunninah (1990), AECOM (2013) and Jacobs (2016).

Accordingly, this study was focussed on ground-truthing and updating existing information, rather than undertaking detailed surveys. The field component of the study was undertaken on one day in spring and the fauna component largely involved habitat assessment. It was not the intention of the study to document every plant and animal on the site and there are likely to be many species that utilise the site that were not recorded during this study.

Limitations described by AECOM (2013) in respect of their field surveys were that access was restricted to some areas and use of field equipment on one of the two nights was limited by WH&S requirements. However, AECOM was able to establish the presence of the GGBF in areas with suitable habitat.

3 Results - Terrestrial

3.1 Information Review

The study area has been the subject of a number of previous studies including Gunninah 1990; UBMC 2006 and 2007, and UBM 2017; AECOM 2013; Biosphere 2013a, 2013b, 2014; and Jacobs 2016. A range of information provided in Gunninah 1990, UBMC 2006 and UBMC 2007, was captured and updated in UBM 2017.

The results of the database searches undertaken for this study are presented in Appendix A (flora) and Appendix B (fauna), together with assessment of the likelihood of occurrence based on existing information and the field survey. BioNet records are shown on Figures 3.1 and 3.2.

3.1.1 History of the Clyde Wetlands area

The UBM 2017 report was focussed on the Clyde Wetlands area and as such, provides some detailed information on the history of the site and the flora and fauna recorded within it. This report indicates that the area that is now the Clyde Facility would have once been a small refinery, some light industrial buildings and grazing land. The Clyde Wetlands area would “originally have been covered with dense vegetation (probably Mangroves), with extensive salt flats occurring along the foreshores of the Parramatta River. Low-lying areas between the grazing lands and the Mangroves would at that time, have been tidal in nature, and may have been submerged at high tide”.

UBM 2017 reported that the Clyde Wetlands area was extensively disturbed and modified over the past 50 years and was extensively upgraded and the surroundings landscaped in the early 1970s. A series of earthen mounds or levees were raised around the east, west and southern sides of the Wetlands and planted with a range of generally Australian native trees, shrubs and ground covers. A Butyl Barrier was installed in 1972-73 due to concern about inflow of chromates and other pollutants from adjacent contaminated land (Gunninah 1990). A polypipe irrigation system was also installed and two viewing platforms and a walking track were constructed.

UBM 2017 reported that photographs from the 1970's indicate the trees had been cleared and a shallow depression formed, which filled with water after heavy rains. By 1978, the wetland consisted of three pools, possibly ephemeral, and had filled with water and were being maintained in roughly their current size and form by 1980. Until the Millennium drought, the wetlands existed as a shallow (1-2 metres) open brackish lagoon, about four hectares in size, and filled with a variety of native and introduced plants, including a number of species regarded as 'Environmental Weeds' in the Sydney Region.

In 2007, UBMC described the wetlands as consisting of two large basins, which were substantially dry at the time, along with five smaller ponds which did retain some water at that time. The large northern pool had existed just prior to 2007 as a wide mudflat, but was observed at that time to be largely overgrown by native reeds (including Cumbungi [*Typha* sp.] and *Phragmites australis*). Drains and ponds were observed to be filled with silt and were being colonised by terrestrial vegetation.



Legend

Threatened Fauna Records

- + Common Sandpiper (*Actitis hypoleucos*)
- + Sharp-tailed Sandpiper (*Calidris acuminata*)
- + Latham's Snipe (*Gallinago hardwickii*)
- + White-bellied Sea-eagle (*Haliaeetus leucogaster*)
- + Caspian Tern (*Hydroprogne caspia*)
- + Green and Golden Bell Frog (*Litoria aurea*)
- + Grey-headed Flying-fox (*Pteropus poliocephalus*)

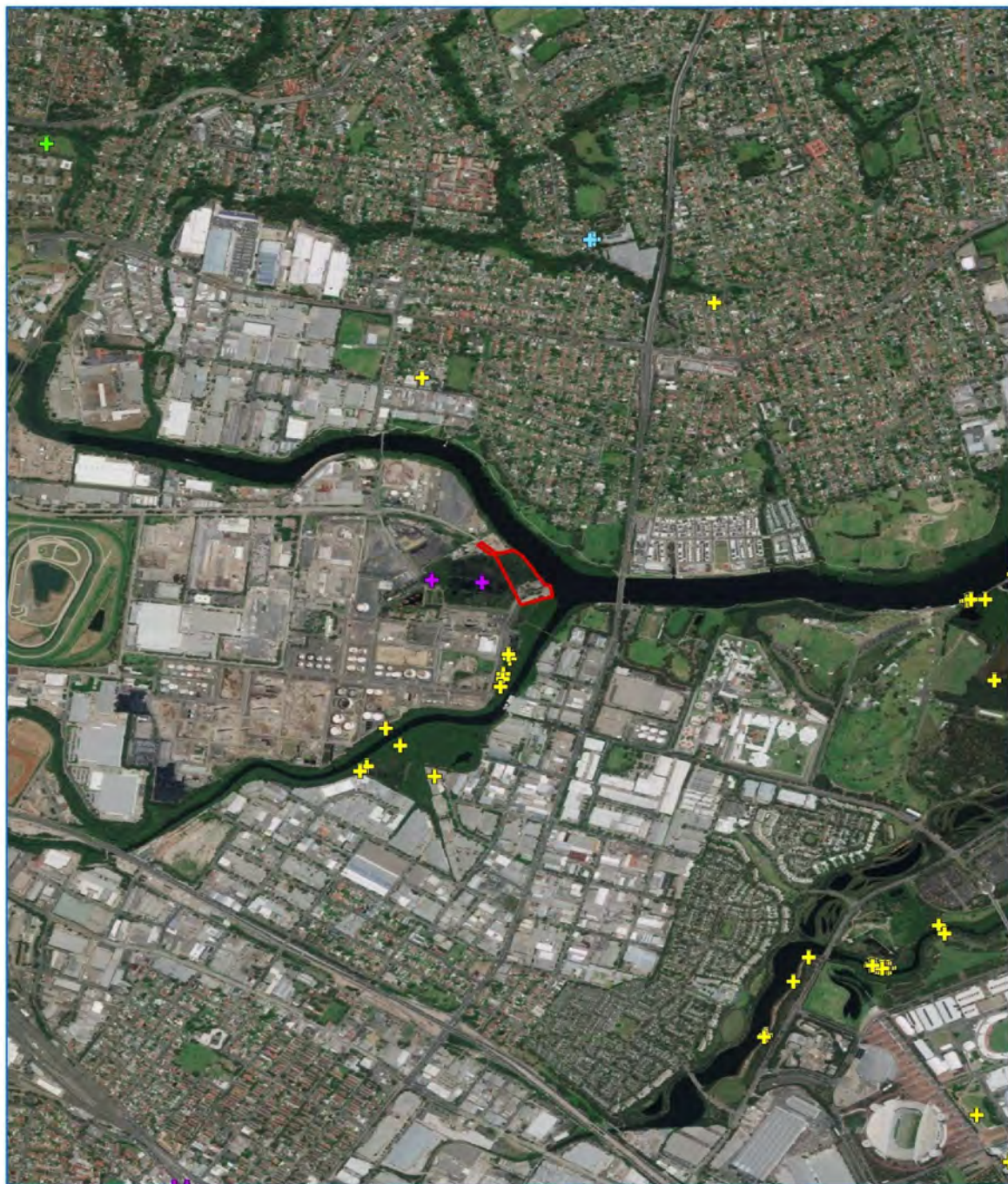
Study Area



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community; Site boundary drawn by AMBS.








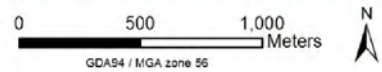
Figure 3.1: BioNet records of threatened and migratory fauna.



Legend

Threatened Flora

-  *Acacia pubescens*
-  *Pomaderris prunifolia*
-  *Syzygium paniculatum*
-  *Wilsonia backhousei*
-  Study Area



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community; Site boundary drawn by AMBS.



Figure 3.2: BioNet records of threatened flora.

3.1.2 Plant Communities

A range of vegetation maps incorporating the study area have been produced and there are some differences between these in both the plant communities identified and in nomenclature (Table 1). In addition, the extent of some of the communities has changed over time. All studies report the presence of a brackish or freshwater wetland area and a form of Swamp Oak Forest, with some reports indicating areas of planted woodland adjacent to the wetland, although the nomenclature of the map units differs between reports. All reports that extend to the Parramatta and Duck Rivers report the presence of a Mangrove community lining both and Estuarine Saltmarsh to the south of the study area along the Duck River.

UBM (2017) reported three plant communities in the Clyde Wetlands area, namely Sydney Freshwater Wetland (the wetland), patches of Swamp Oak Floodplain Forest (SOFF) around the wetland and “Low Woodland” elsewhere (the latter comprising a mixture of planted trees) (Figure 3.3). UBM (2017) also noted that the areas of SOFF had expanded considerably since their previous report (i.e. UBMC 2007). Jacobs (2016) also divided the vegetation around the wetland into two map units, being Estuarine Swamp Oak Forest (mainly between the Parramatta River and the wetland) and “Urban Exotic / Native”. The Jacobs report labelled the wetland as “Estuarine Reedland”.

Both OEH (2016) and AECOM (2013) (the latter being based on OEH mapping from 2010) map most of the UBM SOFF and Low Woodland areas as one map unit, being Estuarine Swamp Oak Forest (OEH) and “Estuarine Fringe Forest – Swamp Oak floodplain forest” (AECOM). OEH (2016) map parts of the wetland as “Estuarine Saltmarsh”, while AECOM map this as “Estuarine saltmarsh - brackish wetland”. Both reports have large unmapped areas within the wetland (possibly areas that were formerly open water or mudflats).

The AMBS survey found the vegetation to be most consistent with the map units described by UBM (2017); i.e. a freshwater wetland area surrounded by areas of Swamp Oak Forest and areas of planted woodland. The Estuarine Saltmarsh mapped by OEH and AECOM was not observed during the AMBS survey. It appears unlikely to occur in that part of the area, due to the lack of tidal flows and the invasion of mud flats by *Casuarina glauca*, *Typha orientalis* and *Juncus acutus*.

A small area at the northern tip of the wetland near the Hymix and KLF facilities has been variously mapped as Estuarine Reedland (OEH 2016), Weeds and Exotics (Jacobs 2017), and Estuarine saltmarsh - *Phragmites* reedland (AECOM 2013). The area found by AMBS to contain mainly *Phragmites australis* and weeds. It was found by AMBS to be consistent with the description of coastal freshwater lagoons and has been included by AMBS with the map unit Plant Community Type (PCT) 781, rather than as a separate unit of Estuarine Reedlands as mapped by OEH (2016).

The vegetation within the hardstand area next to the wharf (the proposed truck turning / loading area) has been variously mapped as “Urban Exotic / Native” (Jacobs 2016), “Estuarine fringe forest - Swamp Oak floodplain forest (EEC)” (AECOM 2013) and “Estuarine Swamp Oak Forest” (OEH 2016). AMBS found this area to be most consistent with Jacobs (2016), as it contained a range of planted trees and other landscape plants in an otherwise bare area, and assigned a separate map unit “Planted Trees over Hard Surface”.

Table 3.1: Plant communities previously mapped in the study area.

Report	Plant Community	Comments
UBMC 2007	Planted Swamp Oak; <i>Juncus acutus</i> (Sharp Rush); Mudflats covered with <i>Typha orientalis</i> ; Planted Low Woodland.	Mapping in detail, but primarily to inform restoration activities.
AECOM 2013	Estuarine Mangroves; Estuarine Fringing Forest; Estuarine Saltmarsh; Planted Vegetation.	Based on broad scale mapping of the Sydney Metropolitan CMA (SMCMA) by OEH in 2010.
OEH 2016	Estuarine Swamp Oak Forest; Estuarine Reedlands; Estuarine Mangroves; Estuarine Saltmarsh; Urban Exotic/Native; Weeds and Exotics	Broad scale SMCMA mapping updated by OEH in 2016
Jacobs 2016	Estuarine Mangrove Forest; Estuarine Reedland; Estuarine Swamp Oak Forest; Urban Exotic/Native; Weeds and Exotics	
UBM 2017	Low Woodland; Swamp Oak Floodplain Forest; Sydney Freshwater Wetlands (Figure 3.3).	Detailed vegetation mapping of the Clyde Wetlands

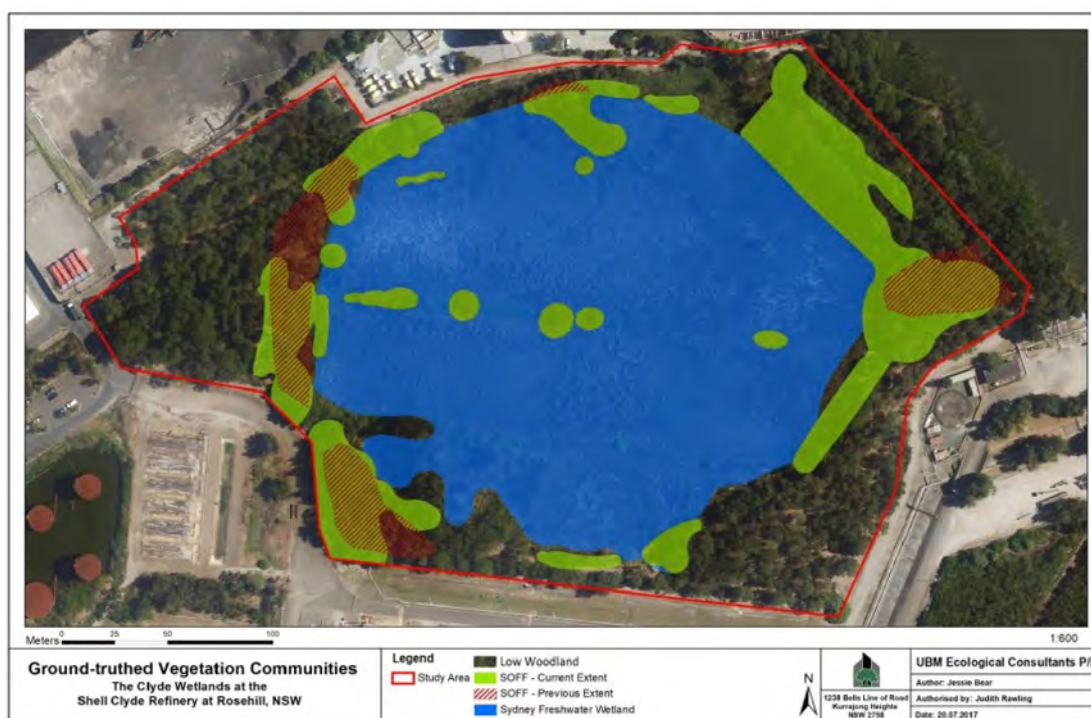


Figure 3.3: UBM (2017) vegetation map of the wetland and surrounds

3.2 Plant Communities and Fauna Habitat

3.2.1 Overview

The AMBS survey found five plant communities and six habitat types within the study area (Figure 3.4):

1. Mangroves;
2. Freshwater Wetland;
3. Swamp Oak Forest;
4. Planted Trees over Hard Surface;
5. Easement;
6. Planted Woodland*.

*N.B. the area of “Planted Woodland” occurs within the study area, but outside of the subject site and its extent was not confirmed or mapped by AMBS. It is consistent with the UBM (2017) area of “Low Woodland”.



Figure 3.4: AMBS vegetation map of the subject site and surrounds.

3.2.2 Mangroves

Plant Community: PCT 920 - Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion

Keith Formation: KF_CH10 Saline Wetlands

Keith Class: Mangrove Swamps

PCT 920 was found as a narrow strip of trees growing along the edge of the Parramatta River. *Avicennia marina* (Grey mangrove) occurs here on narrow mudflats with no understorey.

3.2.3 Freshwater Wetland

Plant Community: PCT781 - Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion

Keith Formation: KF_CH8 Freshwater Wetlands

Keith Class: Coastal Freshwater Lagoons

The majority of the wetland area consists of man-made depressions that hold water for extensive periods. It has been extensively described by UBM (2017).

A section of this wetland, where the existing road meets the easement, occurs within the footprint of the proposed road upgrade. In this location wetland species have established including the invasive Rush *Juncus acutus* (Sharp Rush), which covers large parts of the wetland. *Typha orientalis* (Broadleaf Cumbungi) currently covers the majority of the wetland where suitable water depth occurs. On the northern edge of the study area the native rush *Phragmites australis* occurs. Other native species included *Paspalum distichum* (Water Couch), *Ludwigia peploides* subsp. *montevidensis* (Water Primrose) *Bolboschoenus caldwellii*, and exotic species such as *Hydrocotyle bonariensis* and *Cyperus eragrostis* (Umbrella Sedge).

Fauna habitat within the wetland was divided into two broad sections. The southern half of the wetland, furthest from the proposed road, contained large stretches of open water surrounded by rushes. Several species of waterbird were present here at the time of the survey. Conversely, the northern half, closest to the proposed road, contained extensive areas of dense reeds with very little open water present.

UBM (2017) report that the extent of vegetation cover in this community has increased considerably since 2007, covering much of the area that was previously open water with Cumbungi and Spiny Rush.

The freshwater wetland area provides known and potential habitat for the GGBF and a range of other fauna, in particular other frogs, waterbirds, and reptiles such as the Eastern Water Skink and Red-bellied Black Snake. Both UBMC (2006) and Gunninah (1990) regarded the area as being of high regional significance. However, UBM (2017) report that the expansion of emergent aquatic vegetation has resulted in the loss of large open expanses of water and mudflats, which were valuable foraging and sheltering sites previously available to wetland birds such as the Black-winged Stilt (*Himantopus himantopus*) (UBMC 2006 & 2007). UBMC (2007) also noted that shrubs and trees were also invading the Wetlands, with Swamp Oak invading from the margins, and other species (Wattles, Lantana, Privet) colonizing what were formerly large pools of open water.



Plate 3.1: Southern half of the wetland.



Plate 3.2: Northern half of the wetland.

3.2.4 Swamp Oak Forest

Plant Community: PCT1234 - Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South-East Corner Bioregion

Keith Formation: KF_CH9 Forested Wetlands

Keith Class: Coastal Floodplain Wetlands

An area of Swamp Oak Forest has established over time and has been augmented with species that can occur in swamp oak forest, as well as other species associated with other plant communities that occur in similar locations adjacent to rivers and creeks. Much of the vegetation has been planted. Re-plantings were mature and it was difficult to establish a boundary between planted and naturally occurring trees. In this context the whole area was classified as Swamp Oak Forest, because *Casuarina glauca* (Swamp Oak) was the dominant species across most of the area and species in the ground layer can be associated with this plant community type.

Previous reports have assigned this PCT to the area between the wetland and the Parramatta River (UBMC 2007, AECOM 2013, UBM 2017, OEH 2016) and comment on its expansion over time into surrounding land (UBM 2017). *Eucalyptus* species have been planted in various locations including on mounds of soil and in one location a stand of *Eucalyptus robusta* (Swamp Mahogany) occurs. Other planted trees include *Eucalyptus tereticornis*, *Eucalyptus amplifolia*, *Eucalyptus crebra*, and *Melaleuca quinquenervia*. The ground layer is deeply shaded and native sparsely distributed including *Oplismenus aemulus* (Australian Basket Grass), *Microlaena stipoides* var. *stipoides* (Weeping Grass), *Commelina cyanea*, *Carex appressus* (Tall Sedge), *Alternanthera denticulata* (Lesser Joyweed). Planted species may include *Lomandra longifolia* (Spiny-headed Mat-rush), *Dianella revoluta* (Blueberry Lily), *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Melaleuca quinquenervia* (Broad-leaved Paperbark).

The understorey of this community has many, woody weed species including *Olea europaea* subsp. *cuspidata* (African Olive), *Lantana camara* (Lantana), *Ligustrum lucidum* (Large leaved Privet), *Ligustrum sinense* (Small leaved Privet), *Cotoneaster* sp. (Cotoneaster). Herbaceous weeds include *Hydrocotyle bonariensis*, *Chrysanthoside's monilifera* (Boneseed), *Chloris gayana* (Rhodes Grass), *Ehrharta erecta* (Panic Veldtgrass) *Ageratina adenophora* (Crofton Weed) and *Cardiospermum grandifolium* (Balloon Vine).

Fauna habitat within most of the Swamp Oak Forest was relatively limited, particularly south of the boundary fence along the Parramatta River. North of the fence, the vegetation included dense areas of understorey, albeit mainly weeds such as Lantana. South of the fence, the understorey was sparse and coarse woody debris was scarce. Around the eastern end of the road, the vegetation was mostly relatively young Casuarinas approximately 10 m high, with a few older specimens present. There was little understorey in this part of the area. Around the central part of the road the habitat was a little more diverse, with a number of planted Eucalypts as well as *Casuarina* present, and some understorey plantings (e.g. *Lomandra longifolia*).

No tree hollows were observed within the area proposed for the road upgrade, with the possible exception of one Eucalyptus that could be definitively assessed from the ground. A single small stick-nest was observed in one of the trees.

Notwithstanding the above, and as noted by UBM (2017), the Swamp Oak Forest provides a buffer from the noise and light pollution created by the surrounding industry, adds to the range of habitats available within the study area and also provides a corridor along the northern boundary of the wetland.



Plate 3.3: PCT 1234 showing a mix of *Casuarina glauca* and planted *Eucalyptus robusta*.



Plate 3.4: PCT 1234 either side of the existing road.

3.2.5 Planted Trees over Hard Surface

The eastern end of the study area comprised a hard surface area that has been landscaped with native trees and shrubs. These plantings were mature and included *Eucalyptus crebra* (Narrow-leaved Ironbark), *Corymbia maculata* (Spotted Gum), *Melaleuca styphelioides* (Prickly-leaved Tea Tree) and *Callistemon viminalis* (Weeping Bottlebrush). *Casuarina glauca* (Swamp Oak) also occurred as planted or possibly regenerating trees as well as the woody weed *Olea europaea* subsp. *cuspidata* (Africa Olive).

Fauna habitat within this area was limited. No tree hollows were observed. Its main value is that it adds an element of permeability to the barrier between the Clyde Wetland area and the Duck River.



Plate 3.5: Planted trees over hard surface.

3.2.6 Easement

At the western end of the study area the proposed route of the road upgrade passes through an existing easement between the KLF building waste recycling centre and a Hymix concrete facility. The easement was largely clear of vegetation except for low grasses and some shrubs on the southern side. A wall of rubble associated with the KLF facility formed the northern border of the area and some debris (old tyres etc.) was present within the easement. The site was characterised by the level of moisture present; most of the ground was wet and a pool of water had formed at the low end, resulting from sprinklers in the adjacent KLF facility. Runoff from this area enters the northern part of the wetland.

In general, the easement area is of low value as fauna habitat. However, it is effectively irrigated by sprinklers from the KLF facility, it contains shelter for ground-dwelling species in the form of rubbish and low vegetation, and the adjacent KLF “rubble wall” contained many holes and crevices.

As such the easement could provide shelter habitat for ground-dwelling reptiles and frogs including the GGBF.



Plate 3.6: Easement.

3.2.7 Planted Woodland

Much of the area around the wetland contains areas of planted woodland. These areas are outside of the subject site, and have been described by UBM (2017) (as the “Low Woodland” map unit), and were not examined in detail by AMBS.

Our observations were that the Planted Woodland areas were generally consistent with the description provided by UBM (2017). Although most trees were still relatively young and lacking hollows, the area has many features that provide good fauna habitat. A range of species including small birds that are rare in heavily urbanised environments were observed.

4 Results - Aquatic

4.1 Existing Environment

4.1.1 Sydney Harbour, Parramatta and Duck Rivers

Sydney Harbour opens into Port Jackson and three main branches including Lane Cover River, Middle Harbour and Parramatta River, all of which are tidal estuarine branches of Sydney Harbour. Parramatta River is tidal up to the Charles Street Weir at Parramatta CBD, which is located 19 km upstream of the commencement of Parramatta River at Balmain and approximately 27 km upstream of the entrance to Sydney Harbour. The Parramatta River Subcatchment has a total catchment area of 252.4 km², estuary area of 13.7 km², volume of 69,700 ML and an average depth of 5.1 m (Montoya 2015). Duck River is one of the main tributaries of the Parramatta River. Its total catchment area includes approximately 42 km² and incorporates parts of the Auburn, Bankstown, Holroyd and Parramatta Local Government Areas (LGAs), with the lower Duck River catchment totalling approximately 17 km². It is piped and contained in concrete-lined channels along the majority of its length until the lower Duck River catchment area, where it becomes wider with Mangroves lining the semi-natural banks (i.e. unlined). The confluence of the Parramatta River and Duck River occurs on the eastern boundary of the Site, which is located within the Parramatta LGA.

Sydney Harbour, and specifically the Parramatta River, has a long history of development along the shoreline. European settlement resulted in reclamation and it is estimated that 77 km of the original 322 km of shoreline and around 22% of the estuary have been lost, the majority upstream of the Sydney Harbour Bridge. It is estimated that approximated 80% of the Sydney Harbour catchment area (480.5 km²) has been urbanised or industrialised. Sydney Harbour and its tributaries and catchment areas were polluted within years of European settlement, starting at Darling Harbour in the 1800s and spreading along the southern shoreline of the Parramatta River.

Parramatta River in particular has undergone significant modification with substantial dredging and infilling to allow the river to be more amenable to industrial activities. It is estimated that approximately 2.9 km² of the Parramatta River has been reclaimed, including the largest reclamation project in Sydney Harbour at Homebush Bay, where land was reclaimed for industrial purposes using materials from a variety of sources, including waste materials. Pollutants entering the river during the 1920s to 1960s, either through direct means and / or via leachate from land, included heavy metals, petroleum hydrocarbons, asbestos, chlorinated pesticides, chlorinated benzenes, polycyclic aromatic hydrocarbons and dioxins. Heavy metal concentrations in the sediment of Parramatta River reached maximum levels in the 1970s (Montoya 2015).

AECOM (2010) reported that the Parramatta River Estuary supports approximately 135 km of foreshore with approximately 55% of this being 'natural' shoreline typically comprising beaches, rock platforms, vegetated and non-vegetated shoreline. The majority of this natural shoreline is located west of the Silverwater Bridge and is characterised by a narrowing of the channel, shallow water and mangroves. AECOM (2010) estimated that 13 km of this shoreline has been subject to shoreline erosion. AECOM (2010) also reported several sections of natural foreshore in poor condition and note that erosion is particularly severe upstream of the Silverwater Bridge, which is thought to be attributable to the narrow channel width and shallow depth combined with the size of vessels operating along this stretch of the river (i.e. RiverCats). However, other factors apart from vessel wash are known to cause episodic erosion of natural foreshores (e.g. storms, flooding, high tides, loss of riparian vegetation and informal public access destabilising banks). Longer term recession or accretion of the shoreline can be caused by changes to mean sea level, sediment

availability and changes to river hydrodynamics due to foreshore and channel realignment and dredging.

Erosion of riverbanks is known to have a detrimental effect on biodiversity, including benthic infauna through disturbance of sediments, encrusting fauna through the loss of habitat or mechanical disturbance, and the loss of seagrass beds, mangroves and macrophytes as a result of smothering and loss of substrate (Bishop 2003).

4.2 Site & Study Area

4.2.1 Clyde Facility Description

The proposed site of the upgrade currently supports a wharf area used intermittently to load and unload materials from vessels. The current facility extends along the riverbank of the Parramatta River approximately 35 m. At the northern end, the Gore Bay pipeline enters the Site from the Parramatta River. Protective metal and wooden infrastructure surrounds the pipeline at this point. Extending south is a mixture of wooden piers and metal sheet piles, many of which are in disrepair, and at the southern end an area of large rubble borders the river. Fill comprised of ballast and building rubble has been packed in behind the piers and sheet piles and this fill has slumped and eroded (Plate 4.1).



Plate 4.1: Current wharf with Gore Bay pipeline in the background.

Extending to the west, is a packed gravel / concrete hardstand area which is used by vehicles during loading and unloading from the wharf (Plate 4.2). The hardstand area is fenced with a 2 m high weldmesh fence. Apart from scattered *Casuarina glauca* (Swamp Oak) the hardstand is largely devoid of vegetation. Two small Eucalypt trees have opportunistically established in the fill material behind the piers and sheet piles. At the southern end of the Site is a small group of Grey Mangrove (*Avicennia marina* subsp. *australasica*). To the south beyond the hardstand area, is a forest of Grey Mangroves which extends along Duck River.



Plate 4.2: Hardstand area and Gore Bay pipeline adjacent to the wharf.

From the northern point of the Site the hardstand area extends west to a set of wooden steps and wooden piers to a boatshed and wooden jetty. Beyond this to the north is a set of old wooden piers extending above the low tide water level. This area then extends further north to a stretch of 'natural' bank which supports Grey Mangroves. Severe undercutting of the banks along this stretch is evident and the sandy / muddy substrate is littered with building rubble, rubbish and wooden piers (Plate 4.3). This area backs onto Estuarine fringe forest – Swamp Oak floodplain forest (AECOM 2013) and an extensive wetland.



Plate 4.3 Undercutting and erosion of natural banks to the north of the wharf

4.2.2 Estuarine Ecology

The natural estuarine habitat provided by areas of unvegetated sandy / muddy substrate to the north of the current wharf had a low level of bioturbation from the burrowing activities of invertebrate fauna. The artificial habitats of the piers and sheet piles, provided habitat for encrusting turfing green filamentous alga and a low density of Sydney Rock Oysters (*Saccostrea glomerata*). There was no evidence of seagrass and this is consistent with the closest records of seagrass occurring 5 km downstream of the Site. The narrow-band of Grey Mangroves which extend around the margins of the Study Area extend into larger areas of Estuarine Mangrove Forest. Coastal Saltmarsh does not occur across the Site, although there are considerable expanses of this community within the wetland to the north-west of the Site and on the margins of the Estuarine Mangroves which occur along Duck River (AECOM 2013).

Soft-sediment infauna assemblages of the Parramatta River and the broader Sydney Harbour have been shown to exhibit significant spatial and temporal variation. Whilst some of this variation is in response to factors such as sediment type, flows, position within the ecosystem, other components are in response to sediment contamination and change in water flows and erosion flows within the ecosystem (e.g. Stark 1998, Cardno Ecology Lab 2009, Alison Hunt & Associates Pty Ltd 2016). The soft sediments adjacent to the wharf are likely to support an array of infauna taxa that may vary spatially and temporally across the area. A variety of mobile fish and invertebrates would also live in the water column above these sediments. Six species of fish were recorded at several sites within Duck River and at sites near its confluence with Parramatta River in studies undertaken in April 2016 (Jacobs 2016) and these included: Flathead Gudgeon (*Philypnodon* sp.), Glass Goby (*Gobiopterus semivestitus*), Port Jackson Glassfish (*Ambassis jacksoniensis*), Sea Mullet (*Mugil cephalus*), Toadfish (*Tetractenos* sp.) and the introduced Eastern Gambusia (*Gambusia holbrooki*). Large quantities of shrimp (*Palaemoninae* sp.) were also recorded at the Parramatta River sites and it was noted that the Mussel (*Xenostrobus pulex*) was also present. All of these are common species found in the estuarine habitats of the Parramatta River.

5 Conservation Significance

5.1 Estuarine and Marine Environment

Despite massive modification of the Parramatta River catchment and subcatchments, the river and its estuarine habitats still support significant environmental biodiversity, including Important Wetlands at Bicentennial Park and Newington Wetlands, Endangered Ecological Communities listed under the BC Act and EPBC Act, threatened species listed under the FM Act, seagrass populations, mangrove forests and other marine vegetation and habitats protected under the FM Act. A number of these features occur, or have the potential to occur, within the locality. A brief outline is provided below, with relevant species being considered in more detail in Section 6: Impact Assessment.

5.2 Wetlands of International Significance

There are no RAMSAR listed wetlands within the Parramatta River estuary catchment.

5.3 DPI Key Fish Habitat

The entirety of the Sydney Harbour and Parramatta and Duck Rivers are considered to be *Key Fish Habitat* which is defined as *aquatic habitat that is important to the sustainability of the recreational and commercial fishing industries, the maintenance of fish populations generally and the survival and recovery of threatened aquatic species.*

5.4 Estuarine Habitat

AECOM (2010) reviewed estuarine habitat mapping which has been undertaken for Sydney Harbour (e.g. West et al. 1985, 2004; West & Williams 2008) and documented the extent of estuarine vegetation within the Parramatta River, including tributaries, as a part of the Parramatta River Estuary Processes Study. Estuarine vegetation communities within the locality included seagrasses, mangroves, saltmarsh and Swamp-oak Forest. AECOM (2010) found that seagrasses were only found downstream of Concord Road, Ryde Bridge (approximately 5 km downstream of the Site) and these tended to comprise *Halophila* spp. with *Zostera* spp. being less abundant. *Posidonia australis* was not recorded. Mangrove communities were dominated by Grey Mangrove (*Avicennia marina*) with River Mangrove (*Aegiceras corniculatum*) occurring less frequently and saltmarsh communities were patchily distributed.

5.5 Riparian and Estuarine Vegetation

There are a number of estuarine vegetation communities which have been mapped (AECOM 2013) in the study area. Those EEC that are considered here are Estuarine Mangrove Forests, Estuarine Saltmarsh and Seagrass Meadows.

All marine vegetation is protected under the FM Act, including seagrass, mangroves and seaweed due to their importance as species-rich habitats which provide shelter to numerous species of fish and invertebrates, especially as juveniles. This includes the Mangrove Forest Community bordering the Site and extending into Duck River and surrounds.

5.5.1 Estuarine Mangrove Forest

Common Name	Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion
Plant Community Type	920
BC Act Name	Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (part).
BC Act Status	Endangered Ecological Community
EPBC Act Name	Subtropical and Temperate Coastal Saltmarsh
EPBC Act Status	Vulnerable

Estuarine Mangrove Forest occurs as stands of low closed to open forest on mudflats in Sydney Harbour, river coves and estuaries. Grey Mangrove (*Avicennia marina*) is often seen in pure stands. Stands of this species comprise very few species other than the canopy, with the understorey mostly an open mudflat sometimes with scattered saltmarsh herbs. The River Mangrove (*Aegiceras corniculatum*) is also found scattered amongst swathes of grey mangrove or along upper reaches of coastal riverbanks. It occurs where freshwater influences from runoff or rivers cause lower salinity levels. The distribution of mangrove appears dynamic. Estuaries have been extensively cleared and infilled for industrial and urban development. There is evidence that mangroves have colonised areas formerly occupied by saltmarsh (Williams et al. 2004) and have established on sites of recent sediment accumulation. Estuarine Mangroves are a key feature of the landscape surrounding the Site. Several small Grey Mangrove (*Avicennia marina*) trees occur on the southern end of the area of the wharf upgrade. Substantial stands of Grey Mangroves are found along Duck River and the Parramatta River adjacent to the Site.

In NSW parts of the Estuarine Mangrove Communities meet the requirement as the EEC, *Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*, which is listed under the TSC Act. It is also listed as *Subtropical and Temperate Coastal Saltmarsh*, a Vulnerable community under the EPBC Act. Coastal Saltmarsh communities are generally treeless plant communities dominated by a low mosaic of succulent herbs, salt tolerant grasses and sedges. On occasion scattered emergent mangrove species may occur (DECC 2007). The majority of the Estuarine Mangrove Communities of the Study Area would not qualify as Coastal Saltmarsh EEC as they are dominated by dense stands of Grey Mangrove with absent understorey and groundcover.

5.5.2 Estuarine Saltmarsh

Common Name	Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion
Plant Community Type	1126
TSC Act Name	Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
TSC Act Status	Endangered Ecological Community
EPBC Act Name	Subtropical and Temperate Coastal Saltmarsh
EPBC Act Status	Vulnerable

Saltmarshes consist of low succulent herbs and rushes on tidally inundated land that adjoin open water and mangroves. Throughout the marsh salinity varies greatly according to tidal influence, evaporation and fresh water accumulation. Chenopod species dominate areas more frequently inundated by the tides, while Sea Rush (*Juncus kraussii*) occupies the more elevated terrestrial

margin (OEH 2017). Local scalds occur in small depressions where intensely saline deposits accumulate from the evaporation of tidal waters preventing the growth of any plants at all (Keith 2004). Like many estuarine vegetation communities, large areas have been reclaimed for industrial, recreational and urban land use. Many examples that remain in Sydney are small in size, highly fragmented and patchy in distribution. Historical photographs taken in 1943 across much of the Sydney area (LPI 2013) clearly indicates that some former saltmarshes and mud flats are now colonised by dense stands of mangroves and this is particularly visible along the Georges and Parramatta Rivers (Williams et al. 2004). This community has not been recorded on the Site of the wharf upgrade but considerable occurrences are found within the adjacent wetlands and on the margins of Estuarine Mangroves which occur along Duck River.

This community forms part of the EEC, *Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*, which is listed under the TSC Act. It is also listed as *Subtropical and Temperate Coastal Saltmarsh*, a Vulnerable community under the EPBC Act.

5.5.3 Seagrass Meadows

Common Name	Seagrass meadows of the estuaries and lagoons of the New South Wales coast
Plant Community Type	1913
TSC Act Name	Not listed
TSC Act Status	Not listed
EPBC Act Name	Not listed
EPBC Act Status	Not listed
FM Act	Protected

Seagrass Meadows are marine vegetation in estuaries and lagoons. *Zostera capricorni* is the most common seagrass in Sydney Harbour and Parramatta River while *Posidonia australis* has a more restricted distribution. It prefers the lower reaches of river systems where there is large tidal exchange (West et al. 1985). *Halophila* spp. are often recorded with *Zostera* spp. Seagrass Meadows are found on estuaries and lagoons of the Hacking, Georges and Parramatta Rivers.

Seagrass meadows are spatially and temporally variable. These changes may be caused by natural processes such as storm and flood-induced erosion. Human-induced losses can be caused by:

- Poor water quality (increased turbidity levels, suspended solids, nutrient levels, introduction of pest species);
- Dredging and reclamation;
- Water-based recreational activities and commercial practices (damage from trawling, boat propellers, boat launching, wash and wake, fishing and bait collection); and
- Development of the foreshore environment (e.g. seawalls, bridges, marinas).

Seagrass have been recorded within the locality but beds are not found upstream of the Ryde Bridge which is 5 km downstream of the Site.

5.6 Threatened Plants

The highly modified nature of the Parramatta River means that there is less potential for threatened aquatic species, communities and / or populations of conservation significance to occur upstream of Silverwater Bridge. However, the mobile nature of many marine fauna species does mean that there is the potential for fauna to move and / or forage across the Study Area at least occasionally. Threatened aquatic species listed under the BC Act and FM Act that have been

recorded within the locality (i.e. 10 km radius) and species for which potential habitat may occur as predicted under the EPBC Act are detailed at Appendix A.

The threatened plant *Acacia pubescens* (Downy Wattle) has been recorded in previous studies at three locations within the Clyde Wetlands (UBMC 2006; UBM 2017). During the current survey one specimen of *Acacia pubescens* was located in the study area. Given the degree of disturbance and the location of the study area it seems unlikely that these plants are naturally occurring. It was often planted in landscaping projects and these occurrences are likely to be the result of previous landscaping works.

The saltmarsh species *Wilsonia backhousei* was reported by Jacobs (2016) in a number of locations along the Duck River to the south of the study area, where it was found as a component of saltmarsh communities. They did not record the species from the subject site or the Wetland area, where it appears unlikely to occur, although it may have been present in the past. UBM (2017) report that this species was recorded by Gunninah Consultants (1990), and was said to be located on saline fill soils on the eastern side of the Wetlands. However, it was not located during surveys of the Wetland by UBMC in 2006, 2007, and UBM in 2017, nor was recorded during the current (AMBS) survey. Habitat for this species is unlikely to occur in the Wetland area at this time, given the lack of tidal flows into the wetland and the invasion of mud flats by *Casuarina glauca*, *Typha orientalis* and *Juncus acutus*. Potential habitat may occur on the narrow mud flats adjacent to the Parramatta River, but these are continuously impacted by wash from boat movements on the River and *Wilsonia backhousei* does not tolerate this type of disturbance, being a species that requires long periods between inundation.

Zannichellia palustris is a species found in stationery or slow flowing water. It was not recorded by AMBS within the subject site, or by UBM (2017) within the Wetland and surrounds. Jacobs (2016) report that this species has “potential to occur in the upper reaches of Duck River” and there are reports of the species from Sydney Olympic Park.

The most recent field investigations (UBM 2017) also recorded *Eucalyptus scoparia* (Wallangarra White Gum), which is a threatened species not indigenous to the Locality and has been planted within the Study Area.

5.7 Threatened Ecological Communities

PCT781 (the wetland) is equivalent to Freshwater Wetlands on Coastal Floodplains of the NSW North Coast Sydney Basin and South East Corner Bioregions, an Endangered Ecological Community (EEC) listed under the BC Act. It is not listed under the EPBC Act.

PCT1234 swamp oak forest fringing estuaries in the Sydney Basin Bioregion is equivalent to Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions, an EEC listed under the BC Act. It is not listed under the EPBC Act.

The potential for Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions to be impacted by the project is considered in the aquatic assessment.

5.8 Threatened Fauna

5.8.1 Aquatic

Sydney Harbour and its tributaries are known, or predicted habitat, for a number of fish species, reptiles, sharks, cetaceans and other marine mammals, and in sections is important as nursery habitat for commercially important species due to the extant seagrass and mangrove communities

throughout the area. Those matters of conservation significance considered to have relevance to this proposal are listed in Table 5.1.

Five species of turtle (i.e. Loggerhead Turtle (*Caretta caretta*), Green Turtle (*Chelonia mydas*), Leatherback Turtle (*Dermochelys coriacea*), Hawksbill Turtle (*Eretmochelys imbricate*), and Flatback Turtle (*Natator depressus*)), have been recorded, or are predicted to occur within 10 km of the Site. It is unlikely that any of these species would forage at or near the Site, as these species tend to favour more open waters. None have been recorded within the Parramatta River.

Three threatened species of shark have been recorded within 10 km of the Site and these are the Grey Nurse Shark (*Carcharias taurus*), Great Hammerhead Shark (*Sphyrna mokarran*) and White Shark (*Carcharodon carcharias*). Whilst all of these species are likely to be found on occasion within Sydney Harbour, none are likely to forage upstream into the shallow, estuarine habitats of the Site as they favour deeper coastal waters. The Mackerel Shark (*Lamna nasus*), Reef Manta Ray (*Manta alfredi*) and Giant Manta Ray (*Manta birostris*) are all migratory species predicted to occur within 10 km of the Site. These are unlikely to occur at or near the Site, as they tend to inhabit oceanic waters and areas around the edge of the continental shelf with only occasional movements into coastal waters.

One species of bony fish has been recorded within the locality and it is listed as Vulnerable under the FM Act. The Black Cod (*Epinephelus daemeli*) is a large, reef-dwelling species belonging to the grouper family, which is found in warm temperate and subtropical parts of the south-western Pacific. They generally inhabit near-shore rocky and offshore coral reefs at depths down to 50 m. Recently settled juvenile black cod (i.e. individuals that have recently completed the pelagic, drifting larval stage) are often found in coastal rock pools while slightly older juvenile black cod are often found in estuary systems. Juveniles of this species have some potential to be found in the Study Area.

Table 5.1: Aquatic species of conservation significance relevant to this proposal.

Species / Community	Status	Habitat	Likelihood of occurrence
Fishes			
Black Cod (<i>Epinephelus daemeli</i>)	V-FM	A large, reef-dwelling, carnivorous grouper species usually found in caves, gutters and beneath bomboras on rocky reefs.	Adults are unlikely to forage this high in Parramatta River although there is potential habitat in the Study Area for juveniles.
Note: FM = NSW Fisheries Management Act 1994, V = Vulnerable.			

5.8.2 Terrestrial

Threatened fauna that have been recorded within the study area include:

- the GGBF (*Litoria aurea*) is listed as Endangered on the BC Act and Vulnerable on the EPBC Act, and has been recorded at a number of locations in the Clyde Facility, including the Clyde Wetlands;
- the Common Sandpiper (*Actitis hypoleucos*) is a listed migratory species on the EPBC Act and has been recorded in the Clyde Wetlands;

- the Black-winged Stilt (*Himantopus himantopus*) is a listed migratory species on the EPBC Act and recorded by UBMC in the Clyde Wetlands;
- the Dusky Woodswallow (*Artamus cyanopterus*) listed as vulnerable on the BC Act and was recorded by Gunninah (1990) using woodland around the wetland area;
- the Grey-headed Flying-fox (*Pteropus poliocephalus*), as a camp of this species is located about 600 metres to the south along the Duck River and the species has been reported foraging in the woodlands around the wetland.

A 2008 NGH Environmental survey assessed the suitability of the broader AECOM Project Area to provide habitat for migratory shorebirds. This investigation found that the freshwater wetlands, mangroves and saltmarshes within and surrounding their broader Project Area provide important foraging, roosting and breeding habitat for a diverse range of bird species.

Other threatened fauna of consideration include microbat species that have been recorded in the nearby Sydney Olympic Park (the Eastern Bent-wing Bat and Southern Myotis).

5.9 Connectivity

Parramatta Council’s Biodiversity Strategy (Parramatta City Council 2015) provides a map of vegetation significance, which regards the riparian zones along the Parramatta River and Duck River as a Primary Corridor. The study area is located at the confluence of the Parramatta and Duck Rivers and the Primary Corridor area includes the woodland and mangrove area around the wetland. The planted woodland on the western side of the wetland is considered as “Core Vegetation” (Figure 4.1).

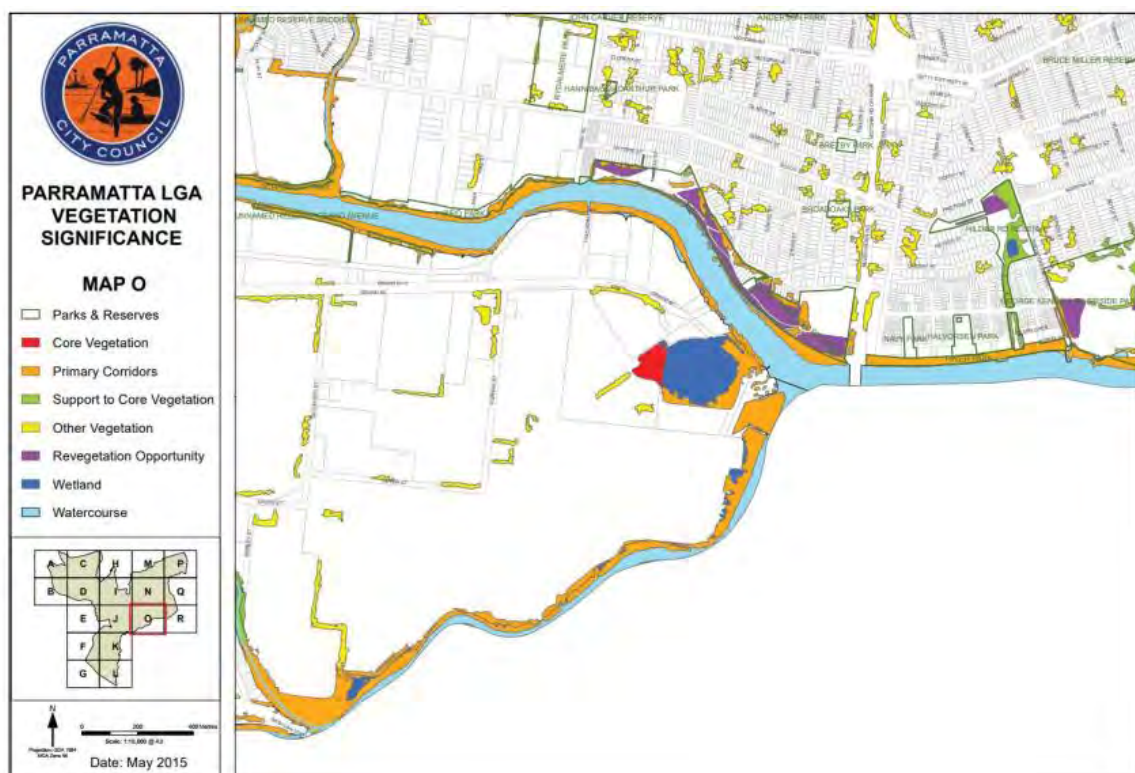


Figure 5.1: Parramatta Council Vegetation Significance map.

Although separated by the Duck River, for some relatively mobile species (e.g. microbats, waterbirds) the study area has potential value as an “extension” of the wetland and woodland areas in Sydney Olympic Park, located to the east.

Notwithstanding the above, apart from the riparian connectivity along the river edges, which mainly comprises a strip of mangroves, the study area is highly isolated in the landscape, being surrounded on three sides by heavy industry and on the fourth by broad estuarine rivers.

5.10 Foreshore Vegetation Guidelines

The subject site is located within 40 metres of the Parramatta River, which constitutes “waterfront land” under the Water Management Act (WM Act). Section 91E(1) of the WM Act states that it is an offence to carry out a controlled activity in, on or under waterfront land:

- without holding a controlled activity approval for that activity
- in a manner that doesn't comply with the terms and conditions of a controlled activity approval
- when a controlled activity approval is suspended.

A number of exemptions apply in relation to Public Authorities, in some cases a third party, carrying out works on behalf of a public authority.

6 Impact Assessment

6.1 Potential Impacts

Potential impacts of the proposed development include:

- Removal of vegetation and habitat, including part of the EEC Swamp Oak Forest, possibly part of the EEC Freshwater Wetlands, and part of the terrestrial habitat within 200 metres of a known GGBF site;
- Harm to marine vegetation;
- Disturbance of sediments;
- Noise, vibration and light;
- Providing a potential vector for weeds and pathogens;
- Introduction/increase in noise and activity near an area of potential habitat for migratory birds;
- Introduction of a saline influence to the wetland from the Parramatta River;
- Pollution, erosion and sedimentation, particularly potential impacts on water quality in the wetland and the Parramatta and Duck Rivers;
- Dust.

6.2 Marine Vegetation

Marine vegetation (i.e. saltmarsh, mangroves, seagrasses and macroalgae) provides shelter and nursery areas for estuarine fauna and habitat for a range of both terrestrial and aquatic fauna, including predators (NSW DPI 2017b), and is an essential component of the estuarine and coastal ecosystems.

The definition of "harm", in relation to marine vegetation, means "gather, cut, pull up, destroy, poison, dig up, remove, injure, prevent light from reaching or otherwise harm the marine vegetation, or any part of it." A permit issued under Part 7 of the FM Act would be required to harm marine vegetation.

The information provided to AMBS is that the extension of the wharf to the south will not require the removal of the mangroves. The extension will be a series of piles in front of the mangroves, which will be spaced to allow both water and light to reach the mangroves. The piles will prevent the barge from coming in contact with the unprotected shore line.

It is unlikely that any other marine vegetation would be removed as the wharf site did not support seagrass communities or areas of saltmarsh.

6.3 Disturbance of Sediments

The upgrade would involve the piling of permanent piles hard up against the riverside of the existing degraded sheet piling and the installation of an additional pile at the northern end of the wharf. This would involve the disturbance of sediments and result in the temporary disruption of infauna from adjacent area. These impacts are unlikely to result in long-term impacts to infauna communities as it is likely that fauna would readily recolonise these areas at the completion of piling works. The installation of additional piles would however provide additional hard substrates for encrusting organisms (e.g. Sydney Rock Oyster, turfing green filamentous alga).

6.4 Potential Indirect Impacts on the Aquatic Environment

6.4.1 Mobilisation of Sediments

The risks associated with potential indirect impacts on neighbouring areas of conservation value could occur during upgrading of the wharf, construction of the access road and the truck movements across the Site (i.e. truck movements along the access road and truck turning area). Sensitive receptors potentially at risk from the proposal include:

- Sydney Harbour;
- Parramatta River and Duck River catchments;
- Adjacent wetland;
- Grey Mangrove forests; and
- Coastal Saltmarsh communities.

Activities across the Site that involve the removal of vegetation and excavation of soils and truck movements could result in the mobilisation of sediments into the adjacent wetland, Mangrove Forest Community, Parramatta and Duck Rivers and the wider Sydney Harbour area. Potential indirect impacts on these areas of conservation value include:

- Smothering of vegetation and an increase in light attenuation which can decrease the productivity of vegetation and increase mortality;
- An increase in nutrients which can cause eutrophication;
- Infill of habitat refugia and smothering of spawning habitat;
- Decrease in growth rates and increased mortality of marine fauna due to obstruction of gills and feeding structures by suspended particles; and
- Changes to habitat for estuarine fauna including marine species and migratory waders.

6.4.2 Noise, Vibration and Light

Noise, vibration and light associated with construction and operational activities have the potential to disrupt estuarine fauna as disturbance of fauna can result in changes to the behaviour and patterns of usage of resources by some fauna species. Given that the site is located in a largely peri-urban environment it is likely that fauna is conditioned to noise, vibration and light and hence indirect impacts are expected to be minimal and could be managed with commonly used management techniques.

6.4.3 Threatening Processes

Key threatening processes for threatened and protected matters relevant to this proposal include:

- Degradation of native riparian vegetation along New South Wales water courses (FM Act);
- In the absence of mitigation measures this proposal could result in the degradation of the Mangrove Forest and Saltmarsh Communities adjacent to the Site and within the locality. A CEMP, OEMP and ESCP would be prepared to ensure that the potential for impacts is minimised and that these communities are protected and conserved;
- Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands – Habitat loss / change (BC Act); Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams (FM Act). Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands (EPBC Act). This proposal is likely to result in the temporary change to flow regimes during instream construction activities at the wharf upgrade Site. These changes are likely to be temporary as flow regimes would be reinstated at the completion of construction;
- Introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales. (FM Act).

This proposal could assist the spread of *Caulerpa taxifolia* via equipment used in the channel during construction and movement of vessels during operation. This species is listed as a marine pest and is easily spread to areas where it can smother marine habitats and displace naturally occurring species. To reduce the risk equipment should be thoroughly cleaned if moved from areas that are infested with *C. taxifolia*. It is recommended that management of *C. taxifolia* be addressed in the CEMP and ESCP so as to minimise the risk of invasive species establishment and that these measures be in line with the *NSW control Plan for the Noxious Marine Alga Caulerpa taxifolia* (I&I NSW 2009).

6.5 Impacts on Aquatic Species, Populations and Communities of Conservation Significance

Direct impacts on species, populations and communities of conservation significance are unlikely to occur as a consequence of this proposal. However, in the absence of mitigation measures there is the potential for indirect impacts to off-site biodiversity and these are discussed below. Species and communities with the potential to be impacted by this proposal are listed in Table 6.1.

Table 6.1: Aquatic communities, populations and guilds of species listed under the threatened species legislation for which Assessments of Significance have been undertaken.

Scientific Name	Common Name	Conservation Ranking and Relevant Act
Endangered Ecological Communities		
Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions		EEC-BC
Marine Fishes		
<i>Epinephelus daemeli</i>	Black Rockcod	V-FM
Note: FM Act = NSW Fisheries Management Act 1994, BC = NSW Biodiversity Conservation Act 2016, EEC = Endangered Ecological Community, V = Vulnerable. Source: DPI Fisheries (2016), OEH (2016).		

6.5.1 Commonwealth EPBC Act Assessments

There were nine threatened ecological communities, 74 listed threatened species and 52 listed migratory species listed under the EPBC Act as occurring or with the potential to occur within the locality. However, none of the marine species, populations or communities for the purposes of Part 3 of the EPBC Act were considered to be relevant to this proposal as the site and study area are located in the upper reaches of the Parramatta River away from the more suitable habitat offered within the lower reaches of the catchment and Sydney Harbour. Hence it is considered that no further assessment under the EPBC Act is required.

6.5.2 NSW BC Act Assessments

Assessments of the likely impacts on species, populations and communities listed under the BC Act were undertaken. The *Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions* was the only matter listed under the BC Act considered to potentially be at risk from this proposal (Table 6.1). An Assessment of Significance for this community is provided at Appendix E. It concluded that the risks to the Coastal Saltmarsh community could be managed with commonly applied measures that would be documented within the Construction Environmental Management Plan (CEMP), Operational Environmental Management Plan (OEMP) and Erosion and Sediment Control Plan (ESCP). Therefore it is unlikely that this proposal would cause significant impacts and hence the preparation of a Species Impact Statement is not required.

6.5.3 NSW FM Act Assessments

Assessments of the likely impacts on species, populations and communities listed under the FM Act were undertaken for those matters considered to be at potential risk from this proposal. The Black Rockcod (*Epinephelus daemeli*) was the only species considered to be at minor risk from this proposal. An Assessment of Significance for this species is provided at Appendix E. It concluded that the risks to the Black Rockcod are minimal and could be managed with commonly applied measures that would be documented within the CEMP, OEMP and ESCP. Therefore, it is unlikely that this proposal would cause significant impacts to this species, and hence the preparation of a Species Impact Statement is not required.

6.6 Threatened Plants

The project will have no direct impacts on threatened plant species if the area containing *Acacia pubescens* is fenced off and avoided. Appropriate measures to remove and control weeds and pathogens during construction and operation will minimise the potential for indirect impacts. Weed control techniques should be consistent with those recommended in UBM (2017).

Wilsonia backhousei is located in saltmarsh south of the study area. Provided the recommendations in this report are implemented this species should not be significantly impacted.

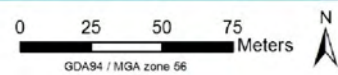
6.7 Endangered Ecological Communities

The project will remove a strip of approximately 0.15 ha of Swamp Oak Forest next to an existing road, which represents approximately 15% of this community within the study area. However, much of this community has been planted and the remainder has colonised or spread throughout the area. UBM (2017) indicate that this community is likely to continue to expand within the study area unless controlled. Thus, the removal of the strip along the existing road is not likely to substantially or permanently affect the viability of the remaining Swamp Oak Forest within the study area, provided that potential indirect impacts such as weeds are controlled.


The likely extent of the subject site if the road is 7 metres wide is shown in Figure 5.1.

The SOFF of the study area is highly modified with planted native trees and shrubs and exotic shrubs introduced by birds. Widening the road will allow more light to penetrate below the currently dense canopy and this will encourage the growth of exotic species particularly along the road edge. As well, road works may introduce propagules from exotic species that will further degrade the SOFF. Dust from many truck movements will coat the leaves of plants adjacent to the road and well into the remnant. Mitigation measures such as sealing the road surface, adequate control of runoff from the road to direct it away from the SOFF, machinery hygiene measures and weed control along the road prior to, during and post construction activities, should be undertaken to prevent further degradation and modification of the SOFF.

The likely significance of impacts on the Swamp Oak Forest was assessed using the “5-part test” of significance criteria in the BC Act. The outcome was that, provided the measures outlined in Section 6 are implemented, the proposed development would be unlikely to have a significant impact on this community.





Legend


 Proposed Access Track


 Study Area


Vegetation Community


 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion

 781 Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion

 920 Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion

 Planted trees over hard surface

 Buildings and hard surfaces

 Easement

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community; Site boundary drawn by AMBS.



Figure 6.1: Approximate extent of development if it is within a 7-metre corridor.

The project may have a minor direct impact on the Freshwater Wetland community, depending on how much area will be required for the road upgrade in the vicinity of the easement. It is estimated that approximately 0.01 ha of this community would be removed. This is less than 1% of the community within the study area and is in an area heavily weed infested and affected by runoff from the Hymix and KLF facilities. Accordingly, the project is not considered likely to have a significant impact on the community, provided that indirect impacts are avoided and minimised in accordance with the recommendations in Section 6.

It is recommended that the area of vegetation cleared for the project is re-vegetated post-development. Revegetation works should be co-ordinated with other bush regeneration and management activities undertaken in the study area and be consistent with UBM (2017) and any updates to UBM (2017).

6.8 Threatened and Migratory Fauna

6.8.1 Green and Golden Bell Frog (*Litoria aurea*)

The Clyde Facility forms a large component of the area supporting the “Clyde/Rosehill key population” of the GGBF. The species has been detected at a number of locations in the Clyde Facility, including several “tankfarms” within the industrial part of the facility, in the Clyde Wetlands area and in runoff containment tanks near the Duck River (pers. obs.). Within the Clyde Wetlands area, the species was recorded on the western side of the northern main pond during surveys by UBMC in 2006 and AECOM in 2012, and on the eastern side of the southern main pond during surveys by AECOM in 2012 and Jacobs in 2016. There are no records of the species from within the subject site (i.e. the proposed development footprint).

The key area of habitat for the GGBF within the study area is the wetland itself, which provides a large area of potential breeding, foraging and shelter habitat and contains water for long periods of time. The Planted Woodland areas to the west, south and east are also likely to provide a resource for the population, in particular the areas with an abundance of potential diurnal and overwinter shelter such as litter and woody debris. Much of the Swamp Oak Forest to north of the wetland has little ground layer vegetation or woody debris and would have limited value in providing diurnal shelter or overwintering sites for the species, except along the edges of the wetland. The main value of the Swamp Oak Forest to the GGBF would be to serve as a barrier between the wetland and the Parramatta River.

Biosphere (2013) supports this view regarding the Swamp Oak Forest and indicates that the expansion of the Swamp Oak Forest over time (reported by Biosphere [2013a] and UBM [2017]) has reduced areas surrounding the wetlands that were once open woodland with grassy understory that would have provided foraging areas for the GGBF. The report states that the areas around the wetland have become “overgrown with Grey She-oak and a range of understorey weeds” and that “Grassy areas no longer exist around the wetland and it is highly likely that the only foraging areas that remain are those around the margins of the wetland.” The GGBF management plan for the Clyde Wetlands area (Biosphere 2013b) recommends that a large number of *Casuarina glauca* be removed and grasses re-established.

Outside of the Clyde Facility, a large population of the GGBF occurs in Sydney Olympic Park and extends across an area including the Brickpit, the Newington Wetlands, Blaxland Riverside Park and Wilson Park (pers. obs.), the latter being located just a few hundred metres from the Clyde/Rosehill population, but across the Duck River. There is also a population in Merrylands to the south-west, near a tributary of the Duck River. There are no nearby records of the GGBF to the north-west of the study area reported by AECOM (2013), Jacobs (2017) or on the BioNet database. However, the Green and Golden Bell Frog Parramatta Key Population Management Plan (DECC

2008) indicates two locations where the species has been recorded to the north-west of the subject site, both of which appear to be on the south bank of the Parramatta River (one at the end of Thackeray Street and one opposite Subiaco Street). The source of these records is unclear.

The Clyde/Rosehill population is therefore relatively isolated, with the most likely potential interaction with other populations being via individual dispersal to or from the Sydney Olympic Park population the east, across the Duck River. Biosphere (2013b) suggested that GGBFs could potentially cross the Duck River at low tide after rain and have made recommendations regarding the establishment of corridor habitat south from the wetland area along the Duck River, behind the mangroves.

The direct impact of the proposed development in relation to the GGBF will be the removal of approximately 0.15 ha of terrestrial habitat comprising an approximately 7-10 metre wide strip to the north of the wetland. The majority of this area is located approximately 30-40 m from the edge of the wetland and comprises either the existing road or Swamp Oak Forest, which is of limited value to the GGBF; indeed, Biosphere (2013b) recommends the removal of a large number of Swamp Oaks and their replacement with grassland. At the western end, where the road meets the easement, the road is much closer to the wetland and widening this section may in fact encroach upon the edge of the wetland itself. The vegetation in this part of the study area contains planted trees and a drainage line with Phragmites, is currently affected by runoff from the Hymix and KLF facilities, and is heavily weed-infested. It was mapped as "Weeds and Exotics" by Jacobs (2017), "Interface Zone" by UBM (2017), and "Swamp Oak Forest" by this study.

It is also possible that construction of a road through the easement area would remove a few potential shelter sites (mainly rubbish, old tyres etc.) located outside of the Clyde Wetlands area. It is therefore recommended that a pre-clearance survey be undertaken of this area, including diurnal searches for sheltering frogs and nocturnal searches for animals that may be using the KLF rubble wall.

The proposed development will not have any substantial impact on existing connectivity between the Clyde/Rosehill population and other GGBF populations. The wetland is currently separated from the Duck River "corridor" by pipelines and a road. The existing hardstand area that will be used for the truck turning and loading area is located at the northern end of the river and will not be substantially altered, although a temporary frog-fence will be erected to exclude for the duration of the project.

Given the above, the main potential impacts on the GGBF and its habitat are considered to be potential indirect impacts, in particular, habitat degradation through pollutants, sedimentation or saline water entering the wetland; noise, lights and activity at night; and the potential for road or road traffic to provide a vector for Key Threatening Processes (KTPs) that are relevant to this species. KTPs relevant to the project could include:

- Infection of frogs by amphibian chytrid causing the disease chytridiomycosis;
- Invasion and establishment of the Cane Toad (*Bufo marinus*);
- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. lat);
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants;
- Predation by *Gambusia holbrooki* Girard, 1859 (Plague Minnow or Mosquito Fish) (as described in the final determination of the Scientific Committee to list the threatening process).

Construction of the road upgrade and operation of the road will require best practice erosion and sediment controls to be put in place, particularly in the area near the easement which is closest to

the wetland. There is an opportunity to improve the current situation in this location, given that the area near the easement is currently affected by runoff from both the Hymix and KLF facilities.

If the drain between the wetland and the Parramatta River is re-opened, the drain should be one-directional, i.e. allow outflow from the wetland to the river but not the reverse, consistent with the recommendations of Biosphere (2013b). However, it should be noted that investigations of the wetland system are currently being undertaken by the UNSW Water Research Laboratory and some of the recommendations of Biosphere (2013b) could be updated as a result.

The area is already affected to some extent by noise, lights and activity from the surrounding industry; indeed, AECOM noted that “adjacent industrial operations contributed significant background noise on the evening of 10 October 2012” and that call play-back in some areas was not possible on that evening (N.B. AECOM were surveying within overall the Clyde Facility, not just the wetland). However, much of the wetland is set away from these disturbances, particularly on the northern side, and there is currently a woodland buffer surrounding it.

The majority of noise and activity disturbance is expected to be during the day and, apart from a small area near the easement, set away from the wetland by about 30 metres. In order to minimise light disturbance, it is recommended that no additional lighting be installed between the easement and the truck turning area and that lighting provided for the truck turning area, site offices etc is subdued as much as possible and directed away from the wetland. Light spill into the wetland area should be minimised as much as possible.

In order to eliminate or minimise the risk of amphibian chytrid, Cane Toads, plant material and Plague Minnow entering the environment via the road, it is proposed to construct a wash area at the Grand Avenue entrance to the site. It should be noted that Plague Minnow are already present in the wetland. It is unknown whether the Clyde/Rosehill GGBF population is already affected by chytrid (Biosphere 2013); however, the disease is known to be present in the nearby GGBF population at Sydney Olympic Park.

In order to minimise the risk of further spread of Lantana and other weeds that are already present within the study area, weed control prior to, during and post construction and operation is proposed.

The significance of the likely impacts on the GGBF as a result of the proposed development were tested by application of the “5-part test” criteria listed in the BC Act and the “Significant Impact Criteria” listed for the EPBC Act (Appendix E). The outcome of the tests was that impacts on the GGBF are not likely to be significant, provided that that appropriate control mechanisms for KTPs such as chytrid and weeds are in place.

Notwithstanding the above, the EPBC *significant impact guidelines for the green and golden bell frog* state the following:

“There is a possibility of a significant impact on the green and golden bell frog, and a referral under the EPBC Act should be considered, if the action results in:

- 1. the removal or degradation of aquatic or ephemeral habitat either where the green and golden bell frog has been recorded since 1995 or habitat that has been assessed as being suitable according to these guidelines. This can include impacts from chytrid, Gambusia originating off-site*
- 2. the removal or degradation of terrestrial habitat within 200 metres of habitat identified in threshold 1*

3. *breaking the continuity of vegetation fringing ephemeral or permanent waterways or other vegetated corridors linking habitats meeting the criteria in threshold 1."*

6.8.2 Grey-headed Flying-fox (*Pteropus poliocephalus*)

A Grey-headed Flying-fox (GHFF) camp is located on the Duck River about 600 metres to the south of the Clyde Wetlands area. This species was recorded by UBMC (2006) in the Planted Woodland area west of the wetland and is likely to forage in other parts of the Planted Woodland. However, the habitat to be removed by the proposed development comprises mainly Swamp Oak Forest dominated by *Casuarina glauca*, which is of limited value to the species. Impacts are likely to be limited to the loss of a few planted eucalypts that may occur within the footprint. There may be some limited disturbance to individuals foraging at night; however, the majority of truck movements are expected to be during the day.

For the reasons given above, potential impacts on the Grey-headed Flying-fox are expected to be limited and the species is not considered further in this assessment.

6.8.3 Microbats

No threatened microchiropteran bat species have previously been recorded in the study area. Potential breeding and roosting habitat for microbats was limited or absent in the subject site. However, the Clyde Wetlands area undoubtedly provides foraging habitat for a range of microbat species and three species, the Eastern Horseshoe Bat (*Rhinolophus megaphyllus*), Gould's Wattled Bat (*Chalinolobus gouldii*) and White-striped Freetail Bat (*Nyctinomus australis*) were recorded by UBMC (2006). Two species listed as Vulnerable on the BC have been reported from the nearby Sydney Olympic Park; the Eastern Bent-wing-bat (*Miniopterus schreibersii oceanensis*) and the Southern Myotis (*Myotis macropus*). The study area could provide foraging habitat for both species, although the Myotis is most likely to forage over the open water areas in the southern main pond. The Eastern Bent-wing-bat could potentially use the existing road as a flyway.

Impacts on threatened microbat species are considered likely to be limited to the removal of a small area of potential foraging for the Eastern Bent-wing-bat (*Miniopterus schreibersii oceanensis*) (and possibly some other species known from the locality) and some disturbance during activity at night. There may be some potential for mortality of individuals foraging along the road if they encounter a truck. However, the majority of noise and activity disturbance is expected to be during the day and, apart from a small area near the easement, set away from the wetland by about 30 metres. The potential for vehicle strike would be minimised by introducing a speed limit of 20 km/h on truck movements at dawn, dusk and at night.

Given that no threatened microbat species have previously been recorded in the study area, no potential breeding or roosting sites will be removed, and that most of the activity from the proposed development will be during the day, it is considered that potential impacts on threatened microbat species are likely to be limited and these species are not considered further in this assessment.

6.8.4 Waterbirds and Listed Migratory Species

The Clyde Wetlands area clearly provides habitat for a number of waterbirds and several species have been reported during investigations over the years, including herons, ibis, ducks, teal, swamphen, swans and spoonbills. In addition, the area along the Parramatta and Duck Rivers provides potential habitat for a range of species such as cormorants and possibly migratory wading birds. Two of the waterbird species reported by UBMC (2006) are listed as migratory species on the EPBC Act; the Common Sandpiper (*Actitis hypoleucos*) and Black-winged Stilt (*Himantopus*

himantopus). Several species of migratory wading birds are known to occur in the nearby Sydney Olympic Park and other threatened and/or migratory species recorded in the Park include Latham's Snipe, Glossy Ibis, and White-bellied Sea-eagle, all of which could potentially utilise the study area on occasion. A single individual Shining Bronze-cuckoo (*Chalcides lucidus*) (listed as a "marine" species) was observed during the survey in the western part of the Planted Woodland area.

Gunninah (1990) also recorded the Vulnerable Dusky Woodswallow (*Artamus cyanopterus*) in vegetation around the wetland. This species does not appear to have been recorded in any of the more recent studies, but has recorded at Sydney Olympic Park and may occur in the study area on occasion.

The direct impact of the proposed development in relation to these species will be the removal of 0.15 ha of terrestrial habitat comprising an approximately 7-10 metre wide strip to the north of the wetland. The majority of this area is located approximately 30-40 m from the edge of the wetland and comprises either the existing road or Swamp Oak Forest, which is of limited value to these species.

The main impacts of the project on wetland and migratory species is disturbance from noise and activity, particularly truck movement. However, the wetland is screened to some extent from the road by the area of Swamp Oak Forest, except in the north-eastern corner near the easement. The road is close to the Parramatta River foreshore habitat; however, the habitat along this part of the river is marginal, with much better areas being located nearby along the Duck River. The impacts of noise and activity could be minimised by screening of the road on both sites between the easement and the truck turning area.

6.9 Corridor Values

The project in its current form will temporarily reduce the level of connectivity across the northern part of the study area, but will not remove it altogether. Connectivity along the riparian (mangrove) area will be maintained, as will connectivity across the wetland, the woodland to the south of the wetland and an approximately 25-30 metre band of vegetation between the wetland and the road.

This proposal is unlikely to disrupt aquatic connectivity within the locality as proposed instream activities are relatively minor and the instream construction activities and the operation of the facility would be temporary (approximately 2 year period).

6.10 Cumulative Impacts

Cumulative impacts are those that add to the transformation of the ecological values of a site or locality and generally occur when habitat is removed or altered and / or the natural hydrology of the area is altered through an accumulation and interaction of impacts from past, present and future proposals. The proposed project is relatively minor in terms of construction and operational impacts and it is considered that it is unlikely to substantially add to the cumulative impacts within the locality, especially given that operational impacts would cease after the completion of the Sydney Metro TSE.

7 Management and Mitigation

7.1 Terrestrial

The purpose of the BC Act as stated in the legislation is to “maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future, consistent with the principles of ecologically sustainable development”, and in particular:

“(k) to establish a framework to avoid, minimise and offset the impacts of proposed development and land use change on biodiversity”.

The best way to avoid impacts on the biodiversity of the study area, including threatened and migratory species, would be to provide access between the public road network and the wharf area via a route that utilises the existing roads to the west, south and east of the wetland area. This would avoid the need to remove part of an area of Swamp Oak Forest, would relocate the noise and disturbance to an area outside of the Clyde Wetlands area, and would to a large extent remove the risk of indirect impacts. However, it is understood that the development proponent does not own the land upon which the development is to proceed and that directing the traffic around the wetland area is not possible.

For the proposed route, i.e. along the easement and the existing road between the Parramatta River and the wetland, the best way to minimise direct impacts is to minimise the area of vegetation clearing. This will be achieved to some extent by using of the existing road area. The proponent should consider maintaining the existing road as a single-lane road and avoid or limit road widening, if possible. If that is not possible we recommend that the road widening works, including temporary works during construction, be limited to a 7-10 metre corridor that includes all structures associated with the project (i.e. fences, stormwater controls etc.).

Recommendations for minimising and managing actual and potential indirect impacts are described below.

The project should avoid or minimise the potential impacts of runoff, erosion, sedimentation and pollutants entering the wetland, the Parramatta River and the Swamp Oak Forest through the installation of best-practice control measures. These should be documented in relevant construction management plans and be consistent with procedures outlined in the *Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004)* and *Managing Urban Stormwater: Soils and Construction Volume 2 (Department of Environment and Climate Change, 2008)*. The installed measures should be maintained and monitored throughout the life of the project.

N.B. The study area is zoned “IN3 – Heavy Industrial” with Class 3 Acid Sulfate Soils (UBM 2017) and is subject to flooding (Molino Stewart 2012), and this will need to be considered in road construction and control mechanisms.

If the blocked drain between the wetland and the river is repaired, the drainage upgrades should ensure that the normal water levels of the Parramatta River and Duck River cannot flow into the wetland; i.e. the drainage should be one-directional, allowing water to drain from the wetland to the river during overflow events, but not the reverse. N.B. The water regime within the wetland is currently being investigated by UNSW and this recommendation may change in future.

Access to the wetland area and surrounding vegetation should be avoided (except for environmental mitigation and monitoring) and inadvertent damage to vegetation avoided. Exclusion zones should be set up at the limit of clearing.

A temporary frog-fence should be established along the southern side of the construction area. Pre-clearance searches for sheltering GGBFs should be undertaken after erection of the fence and prior to construction. This should include diurnal and nocturnal searches and incorporate the easement area and along the KLF fenceline.

A pre-clearance survey in the Swamp Oak Forest should also be undertaken within two weeks prior to construction in order to identify any nests or other features within the construction zone. If nests, hollows or coarse woody debris occur an ecologist should be present during vegetation clearing to manage fauna that may be present. The construction management plan should include an appropriate clearing and grubbing procedure.

Timber from native trees removed should be re-used as coarse woody debris in the adjacent woodland, particularly along the northern edge of the wetland, and as directed by the project ecologist.

Construct a chytrid, dieback (*Phytophthora cinnamomi*) and weed wash area at the Grand Avenue interface. Vehicle wheels, equipment and shoes must be cleaned so that they are free of dirt and debris, then sprayed or washed with solution containing 10% bleach. Implement frog hygiene protocols consistent with the DECC guideline “hygiene protocol for the control of disease in frogs” (as updated by the Australian Government Threat Abatement Plan (2016)). Additionally, erect information signs to prevent non-disinfected vehicles/equipment/people from entering the site.

Site supervisors are to be inducted by the project herpetologist/ecologist on: Frog Hygiene Protocol (DECC 2008); frog handling techniques; procedures for the erection and daily checking of frog exclusion fences; and are to monitor the chytrid barrier wash area and other sterilisation procedures, to ensure all personnel are utilising these practices correctly. Workers should be inducted on the location and identification of threatened entities, the importance of the Clyde Wetlands area, and what to do if a frog or other animal is encountered.

Weed control and monitoring should be undertaken prior, during and post-construction, consistent with procedures and requirements specified in UBM 2017:

- Ideally, all weeds and invasive native vegetation would be removed using low impact techniques to minimise disturbance and/or destruction of significant flora and fauna, mobilisation of sediments, and pollution by herbicides.
- Herbicides used must be registered or permitted for aquatic situations and contractors must follow all product label directions. The contractor must obtain a permit from the Australian Pesticides & Veterinary Medicines Authority if an off-label application is indicated.
- Plant biomass is to be disposed of responsibly. Seed bearing debris, bulbs, corms, rhizomes and succulents which regenerate from fragments are to be bagged and removed off-site at the end of work sessions (not stockpiled). All such weed debris must be taken off-site to a designated landfill depot.

It is recommended that the area of vegetation cleared for the project is re-vegetated post-development. Revegetation works should be co-ordinated with other bush regeneration and management activities undertaken in the study area and be consistent with UBM (2017) and any updates to UBM (2017).

In order to reduce the impacts of noise and activity it is recommended that:

- screening of the road on both sides should be considered;
- speed should be limited to 20 km/hr at night;
- there should be no additional lighting of the road;
- lights on the wharf, truck turning area and site office area should be subdued as much as possible and directed away from the wetland. Light spill into the wetland and surrounding vegetation should be minimised as much as possible;
- night-time truck movements should be limited to 7 nights per month if possible;
- noise such as horns and air brakes should be avoided except for emergencies and noise generally kept to a minimum, particularly along the section of road through the Swamp Oak Forest.

Any fill to be brought onsite should be clean and tested or processed to ensure no contaminants and seeds. N.B. Biosphere (2014) requires that “Soils, composts or other materials that may potentially harbour Chytrid are to be heat treated before being accepted on site.”

7.2 Aquatic

In the absence of mitigation measures, the proposal has the potential to indirectly impact on sensitive receptors within the locality, including a range of matters of conservation significance. Consequently, a number of management and mitigation measures should be incorporated into plans for the wharf upgrade. The goals of environmental management are outlined below along with specific considerations for this project.

7.2.1 Goals

Effective measures would be established with the aim of achieving the following goals:

- Minimisation of impacts on biodiversity values of the Site, Parramatta River catchment, locality and Sydney Harbour;
- Protection of biodiversity values across the locality and Sydney Harbour; and
- Protection of the values of the adjacent Estuarine Forest.

7.2.2 General Principles

The goals would be achieved through implementation of the following general principles:

- Avoidance of impacts;
- Minimisation of impacts where avoidance is not possible; and
- Mitigation measures.

These goals and principles should form the basis for environmental management across the Site. Considerations specific to this location are detailed in Table 7.1 and Section 7.2.3 below.

7.2.3 Specific Considerations

Specific consideration should be given to the following issues:

Construction Activities

- The protection of the adjacent wetland and Mangrove Forest Community should be given the highest priority. Disturbance and / or decline of these communities could impact the adjacent areas of conservation value;
- All in-water activities associated with piling should be scheduled to coincide with favourable hydrodynamic conditions to ensure that sediment re-suspension and dispersion is minimised, e.g. calm conditions and minimal tidal fluctuation; and
- Floating booms, silt curtains or screens should be used during in-stream activities to minimise the mobilisation of sediments and the spread of suspended sediments.

Erosion and Sedimentation Controls

The following measures should be implemented:

- Implement an ESCP to minimise opportunities for mobilised sediments to extend into Parramatta and Duck Rivers and ultimately Sydney Harbour;
- Installation of sediment detention devices prior to construction to prevent untreated run-off and sediment entering waterways;
- Place all stockpiles away from stormwater drains and drainage lines;
- Piling of soil that may contain seed of exotic species should be away from adjacent vegetation or stormwater drains where they could be spread during rainfall events;
- Excavated materials should be removed off-site as soon as practicable to minimise risk of run-off into adjacent areas;
- Rubbish and debris should be collected and removed off-site to prevent it entering the waterway and causing harm; and
- No chemicals, fuels and / or wastes would be stored within or near any natural or stormwater drainage lines or on the foreshore. All such substances are to be contained in sealed vessels of appropriate volumes and, where necessary, stored within bunded areas.

Offsets

Given that this proposal will not result in the removal of native vegetation communities and that the disturbance to fauna habitat would be minimal it is considered that a biodiversity offset strategy for marine and estuarine ecosystems is not required.

7.3 Summary Table

Relevant mitigation measures that will be implemented are listed in Table 7.1.

Figure 7.1: Table of mitigation measures.

Environmental safeguards and management measures
Access to the wetland area and surrounding vegetation would be avoided except for environmental mitigation and monitoring purposes.
A pre-clearance survey in the Swamp Oak Forest would be undertaken within two weeks prior to construction in order to identify any nests or other features within the construction zone. If nests, hollows or coarse woody debris occur an ecologist would be present during vegetation clearing to manage fauna that may be present.
A temporary frog-fence would be established along the southern side of the construction area and maintained for the life of the project. Pre-clearance searches for sheltering GGBFs would be undertaken after erection of the fence and prior to construction. This would include diurnal and nocturnal searches and incorporate the easement area and along the KLF waste management facility fence line.
Implement frog hygiene protocols consistent with the <i>Hygiene protocol for the control of disease in frogs</i> (DECC 2008) and erect information signs to prevent non-disinfected vehicles/equipment/people from entering the site.
Construct a chytrid fungus, <i>Phytophthora cinnamomi</i> and weed wash area at the Grand Avenue access. Vehicle wheels, equipment and shoes must be cleaned so that they are free of dirt and debris, then sprayed or washed with solution containing 10% bleach.
Site supervisors are to be inducted on Hygiene protocol for the control of disease in frogs (DECC 2008) and frog handling techniques. Workers would be inducted on the location and identification of threatened entities, the importance of the Clyde Wetlands area, and what to do if a frog or other animal is encountered.
Exclusion zones would be set up at the limit of clearing to protect the adjacent wetland, Swamp Oak Forest and Mangrove Forest Community
Any fill to be brought onsite for construction purposes should be clean and tested or processed to ensure no contaminants are present
While work is being undertaken on site conduct daily checks of the following: <ul style="list-style-type: none"> a) Frog exclusion fences b) Monitor the chytrid barrier wash area c) Confirm other sterilisation procedures are being implemented correctly A daily checklist will be prepared to assist in implementation of this requirement.
Timber from native trees removed would be re-used as coarse woody debris in the adjacent woodland, particularly along the northern edge of the wetland, and as advised by AMBS.
It is recommended that the area of vegetation cleared for the project is re-vegetated post-development. Revegetation works would be co-ordinated with other bush regeneration and management activities undertaken in the study area and be consistent with UBM (2017).
Weed control and monitoring should be undertaken prior, during and post-construction. Any weeds removed would be undertaken using low impact techniques to minimise disturbance and/or destruction of significant flora and fauna, mobilisation of sediments, and pollution by herbicides.

Environmental safeguards and management measures
Herbicides used must be registered or permitted for aquatic situations and personnel must follow all product label directions.
Green waste including weeds is to be disposed of responsibly. Seed bearing debris, bulbs, corms, rhizomes and succulents which regenerate from fragments are to be bagged and removed off-site at the end of work sessions (not stockpiled overnight). All green waste must be taken off-site and disposed at an appropriately licenced facility.
Any temporary stockpiling of soil that may contain seed of exotic species would be away from adjacent vegetation or stormwater drains where they could be spread during rainfall events.
Night-time truck movements would be limited as far as practicable and a speed limit of 20 km/hr at night would be enforced
Light spill into the wetland and surrounding vegetation would be minimised as much as possible. There is to be no additional lighting of the access road and lights on the wharf, truck turning area and site office area would be subdued as much as possible and directed away from the wetland.
Noise such as horns and air brakes would be avoided except during emergencies and noise generally kept to a minimum, particularly along the section of road through the Swamp Oak Forest.
No chemicals, fuels and / or wastes would be stored within or near any natural or stormwater drainage lines or on the foreshore. All such substances are to be contained in sealed vessels of appropriate volumes and, where necessary, stored within bunded areas.
All in-water activities associated with piling would be scheduled to coincide with favourable tidal conditions to ensure that sediment re-suspension and dispersion is minimised, e.g. calm conditions and minimal tidal fluctuation where practicable.
Floating booms, silt curtains or screens would be used during in-stream activities to minimise the mobilisation of sediments and the spread of suspended sediments.
If the blocked drain between the wetland and the river is repaired, the drainage upgrades would ensure that the normal water levels of the Parramatta River and Duck River cannot flow into the wetland; i.e. the drainage would be one-directional, allowing water to drain from the wetland to the river during overflow events, but not the reverse.
A temporary visual screen will be erected on the southern side of the track between the easement and the section of track running north-east from the easement, to screen truck movements from water birds in the wetland.
A detailed Erosion and Sediment Control Plan (ESCP) would be prepared in advance of construction to detail mitigation measures and progressively updates as required during site establishment, operations and decommissioning. The ESCP would include measures to minimise opportunities for mobilised sediments to extend into Parramatta and Duck Rivers.
Erosion and sediment control measures would be implemented in accordance with <i>Managing Urban Stormwater: Soils and Construction Volume 1</i> (Landcom, 2004) and <i>Managing Urban Stormwater: Soils and Construction Volume 2</i> (Department of Environment and Climate Change, 2008a). Measures would be designed as a minimum for the 80th percentile; 5-day rainfall event.
Fuels, oils and other potentially harmful substances would be stored when not in use in a bund sized to be at least 110% of the largest container to be stored.
Water quality monitoring upstream and downstream of the worksite would be undertaken during wharf upgrade works at a frequency of at least one sample per fortnight.
A site-specific Spill Management Procedure would be developed and implemented. It would identify spill management equipment to be kept onsite and procedures to be implemented in the event of a spill.
Aquatic habitat will be protected in accordance with Section 3.3.2 <i>Standard precautions and mitigation measures</i> of the <i>Policy and guidelines for fish habitat conservation and management Update 2013</i> (NSW DPI 2013) and <i>NSW control Plan for the Noxious Marine Alga <i>Caulerpa taxifolia</i></i> (I&I NSW 2009)

Environmental safeguards and management measures

Unsealed work areas would be regularly damped down in dry and windy conditions

All road vehicles and barges carrying loose or potentially dusty material to or from the site would be covered.

Stockpiles would be managed to minimise dust generation.

8 Conclusion

The Clyde Wetlands, although highly modified, are a significant local resource in an otherwise industrial landscape and contain flora and fauna of National, State and regional significance. The proposed development will directly impact on some of these biota. However, the direct impacts of project are limited to a small area of partly-planted Swamp Oak Forest and possibly a very small area of weed-infested Freshwater Wetland along the northern edge of the wetlands area. Potential indirect impacts can be controlled and minimised.

The project is temporary and vegetation will be re-planted at the conclusion. Provided that the project is carried out in a particular manner and incorporates the measures recommended in this report, the project is not likely to have a significant impact on threatened species, populations or ecological communities. The project will however remove terrestrial habitat from a known GGBF area, which is a trigger for a referral under the EPBC Act.

The works associated with the proposed wharf upgrade would be confined to a relatively small area (approximately 50 m in length) that has previously been disturbed through piling and backfilling and clearing of vegetation. The proposal would not result in the removal of seagrass, macroalgae or Grey Mangroves which have opportunistically established at the southern end of the proposed wharf extension.

An Assessment of Significance to assess the potential impacts on the Black Rockcod listed as Vulnerable under the FM Act concluded that the risks to this species are minimal and could be managed with commonly applied measures, and therefore it is considered unlikely that this proposal would cause significant impacts and hence the preparation of a Species Impact Statement is not required. A test for determining whether proposed development would be likely to significantly impact the Coastal Saltmarsh EEC listed under the BC Act, concluded that this community was not at direct risk and that any potential indirect impacts could be managed with the implementation of commonly applied measures that would be documented within the Construction Environmental Management Plan (CEMP), Operational Environmental Management Plan (OEMP) and Erosion and Sediment Control Plan (ESCP), and hence the preparation of a Species Impact Statement is not required. Key to these mitigation measures will be the protection of the adjacent areas of conservation significance.

Bibliography

AECOM (2013). Clyde Terminal Conversion Project - Environmental Impact Statement. Prepared for The Shell Company of Australia Ltd. Available at:
<https://www.vivaenergy.com.au/operations/clyde/conversion-project>

Alison Hunt & Associates Pty Ltd 2016 Kendall Bay. Sediment Remediation Project. Marine Benthic Infauna Assemblages. Final Draft. Prepared for Synnot & Wilkinson Pty Ltd.

Aquaculture, Conservation & Marine Parks Unit, Port Stephens Fisheries Institute 2012 Black Rockcod (*Epinephelus daemeli*) Recovery Plan. NSW Department of Primary Industries.

Bishop MJ 2003 Making waves. The effects of boat-wash on macrobenthic assemblages of estuaries. PhD thesis, University of Sydney, April 2003.

Biosphere (2013a). Conservation of Green and Golden Bell Frogs; Shell site, Clyde. Prepared by Biosphere Environmental Consultants Pty Ltd.

Biosphere (2013b). Plan of Management – Restoration of Green and Golden Bell Frog Habitat – Clyde. Biosphere Environmental Consultants Pty Ltd.

Biosphere (2014). Plan of Management – Restoration of Green and Golden Bell Frog Habitat – Clyde.

Cardno Ecology Lab 2009 Inner West Marina Sydney. Aquatic Ecology Studies. 330809E. Prepared for TLD Engineers for Breakfast Point Pty Ltd. August 2009.

Cropper (1993). Management of Endangered Plants. CSIRO, Melbourne, Victoria.

DE&E 2017 Protected Matters Search Tool – Matters of National Environmental Significance. Department of the Environment. Accessed online October 2017.

DE&E 2017 Register of Critical Habitat. Department of the Environment Accessed online September 2016. Accessed online October 2017.

DE&E 2017 Species Profile and Threats Database. Department of the Environment. Online <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>. Accessed online October 2017.

DECC 2007a Threatened Species Assessment Guidelines. The Assessment of Significance. Department of Environment & Climate Change, Goulburn Street, Sydney.

DECC 2007b Coastal Saltmarsh. Identification Guidelines for Endangered Ecological Communities. Department of Environment and Climate Change.

DECC 2008a Best Practice Guidelines for Coastal Saltmarsh. Department of Environment and Climate Change NSW, Goulburn Street, Sydney.

DoE 2013a Matters of National Environmental Significance. Significant Impact Guidelines 1.1. Environmental Protection & Biodiversity Conservation Act 1999. Department of the Environment Accessed Online <http://www.environment.gov.au/epbc/publications/pubs/nes-guidelines.pdf>

DoE 2013b Recovery Plan for the White Shark. Department of the Environment.

DoE 2014 Recovery Plan for the Grey Nurse Shark. Department of the Environment.

DotEE (2017). EPBC Act Protected Matters Report. Department of the Environment and Energy. Prepared 17/11/17.

Ecological (2012). Shell Clyde Refinery – Bats. Unpublished report prepared by Eco Logical Australia Pty Ltd for Shell.

Gunninah Consultants (1990). Shell Clyde Refinery Wetland – Environmental Statement and Plan of Management. Prepared by Gunninah Consultants for Shell Refining (Aust) Pty Ltd.

Environment Australia 2003 Recovery Plan for Marine Turtles in Australia. <https://www.environment.gov.au/system/files/resources/6d26f4aa-751e-4b72-9ab0-984a1d6e0fea/files/marine-turtles.pdf>

Fairfull S 2013 Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (2013 update). Fisheries Ecosystems, Fisheries NSW, Wollongbar. NSW Department of Primary Industries, a part of the Department of Trade and Investment, Regional Infrastructure and Services.

Industry & Investment NSW 2009 NSW Control Plan for the Noxious Marine Alga *Caulerpa taxifolia*. Aquatic Biosecurity & Risk Management Unit, Industry & Investment NSW, Orange.

Jacobs (2016). Parramatta Light Rail – Duck River Crossing: Biodiversity Review. Prepared by Jacobs Australia Pty Limited for Transport of NSW.

Keith D 2004 Ocean shores to desert dunes: the native vegetation of New South Wales and the ACT. NSW Department of Environment & Conservation, Hurstville.

Montoya D 2015 Pollution in Sydney Harbour: sewage, toxic chemicals and microplastics. Briefing Paper No. 03 / 2015. NSW Parliamentary Research Service.

NSW DPI 2008 Threatened Species Assessment Guidelines. The Assessment of Significance. NSW Department of Primary Industries.

NSW DPI 2012a Recovery Plan for the Black Rockcod. Department of Primary Industries, NSW.

NSW DPI 2012b Factsheet: *Posidonia australis* in Port Hacking, Botany Bay, Sydney Harbour, Pittwater, Brisbane Waters and Lake Macquarie. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/437728/Endangered-populations-of-Posidonia-australis.pdf

NSW DPI 2017a What is Currently Listed. Online resource (accessed October 2017). NSW Department of Primary Industries. Accessed October 2017.

NSW DPI 2017b Key Fish Habitat Maps. LGAs in Sydney Area. Department of Primary Industries. (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/634354/Sydney_updated.pdf).

NSW DPI 2017c Activities requiring a permit. <https://www.dpi.nsw.gov.au/fishing/habitat/protecting-habitats/activities-requiring-a-permit>

OEH (2016). The Native Vegetation of the Sydney Metropolitan Area - Version 3 (OEH, 2016) VIS_ID 4489. NSW Office of Environment and Heritage [Available at: <http://data.environment.nsw.gov.au/>

Parramatta City Council (2015). Parramatta Biodiversity Strategy 2015-2025.

OEH (2017). Bionet Atlas – Search for threatened species. Prepared 17/11/17.

Parramatta City Council (2015). Life in Our City' Parramatta Biodiversity Strategy 2015-2025. Available at: <https://www.cityofparramatta.nsw.gov.au/recreation-environment/biodiversity>

OEH 2017b **Threatened Species Profiles**. NSW Office of Environment & Heritage, Hurstville. <http://www.threatenedspecies.environment.nsw.gov.au/index.aspx>

OEH 2017c **Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions - Profile**. NSW Department of Environment and Conservation, Hurstville. <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/index.aspx>

Pronk R & Holder G 2012 **Factsheet. Endangered Populations in NSW: Endangered populations in NSW: Posidonia australis in Port Hacking, Botany Bay, Sydney Harbour, Pittwater, Brisbane Waters and Lake Macquarie**. Department of Primary Industries. Fisheries Ecosystems Unit, Port Stephens Fisheries Institute.

Stark JS 1998 Heavy Metal Pollution and Macrobenthic Assemblages in Soft Sediments in Two Sydney Estuaries, Australia. Mar. Freshwater Res. 49: 533-540.

UBMC (2006). Flora and Fauna Survey of a Wetland within the Shell Refinery, Rosehill. Report prepared by Urban Bushland Management Consultants Pty Ltd for Shell Refinery.

UBMC (2007). *Wetland Management Plan for the Clyde Wetlands at the Shell Clyde Refinery at Rosehill, NSW*. Unpublished report prepared for Shell Refinery (Australia) Pty Ltd.

UBM (2017). Revised Wetland Management Plan for the Clyde Wetlands, Clyde Terminal, Rosehill, NSW. Report prepared by UBM Ecological Consultants Pty Ltd for Viva Energy Australia Pty Ltd.

West G & Williams RJ 2008 A preliminary assessment of the historical, current and future cover of seagrass in the estuary of the Parramatta River. NSW Department of Primary Industries, Port Stephens Fisheries Centre.

West G, Thorogood CA, Walford TR & Williams RJ 1985 An estuarine inventory for New South Wales, Australia. Fisheries Bulletin 2. Department of Agriculture, NSW. 140 PP.

West G, Williams RJ & Laird R 2004 Distribution of estuarine vegetation in the Parramatta River and Sydney Harbour, 2000. Final Report to NSW Maritime and the Australian Maritime Safety Authority. NSW Department of Primary Industries - Fisheries Final Report Series No. 70. 37pp. ISSN 1449-9967.

Appendix A: Threatened Flora Likelihood of Occurrence

Scientific Name	Common Name	Conservation status		Previously recorded in locality		Found during surveys	Habitat availability in study area	Likelihood of occurrence
		BC Act	EPBC Act	Bionet ¹	EPBC Report ²			
<i>Acacia bynoeana</i>	Bynoe's Wattle		V		✓	No	No	Unlikely. Suitable habitat not present
<i>Acacia pubescens</i>	Downy Wattle	V	V	✓	✓	Yes	Planted.	Suitable habitat not present however plants of this species do occur. Highly likely to have been planted during landscaping works.
<i>Allocasuarina glareicola</i>			E		✓	No	No	Unlikely. Suitable habitat not present
<i>Callistemon linearifolius</i>	Netted Bottle Brush	V		✓		No	No	Unlikely. Suitable habitat not present
<i>Caladenia tessellata</i>	Thick-lipped Spider-orchid		V		✓	No	No	Unlikely. Suitable habitat not present
<i>Cryptostylis hunteriana</i>	Leafless Tongue-orchid		V		✓	No	No	Unlikely. Suitable habitat not present
<i>Darwinia biflora</i>			V		✓	No	No	Unlikely. Suitable habitat not present
<i>Dillwynia tenuifolia</i>		V		✓		No	No	Unlikely. Suitable habitat not present
<i>Epacris purpurascens subsp. purpurascens</i>		V		✓		No	No	Unlikely. Suitable habitat not present
<i>Genoplesium baueri</i>	Yellow Gnat-orchid		E		✓	No	No	Unlikely. Suitable habitat not present
<i>Grammitis stenophylla</i>	Narrow-leaf Finger Fern	E		✓		No	No	Unlikely. Suitable habitat not present
<i>Melaleuca biconvexa</i>	Biconvex Paperbark		V		✓	No	No	Unlikely. Suitable habitat not present
<i>Pelargonium sp. striatellum</i>			E		✓	No	No	Unlikely. Suitable habitat not present
<i>Pimelea curviflora var. curviflora</i>			V		✓	No	No	Unlikely. Suitable habitat not present
<i>Pimelea spicata</i>	Spiked Rice-flower	E	E	✓	✓	No	No	Unlikely. Suitable habitat not present
<i>Pomaderris prunifolia</i>	P. prunifolia in the Parramatta, Auburn, Strathfield and Bankstown Local Government Areas	EPop		✓		No	No	Unlikely. Suitable habitat not present
<i>Pterostylis saxicola</i>	Sydney Plains Greenhood		E		✓	No	No	Unlikely. Suitable habitat not present
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	E	V	✓	✓	No	No	Unlikely. Suitable habitat not present
<i>Tetratheca glandulosa</i>		V		✓		No	No	Unlikely. Suitable habitat not present
<i>Thesium australe</i>			V		✓	No	No	Unlikely. Suitable habitat not present
<i>Triplarina imbricata</i>	Creek Triplarina	E	E	✓		No	No	Unlikely. Suitable habitat not present
<i>Wahlenbergia multicaulis</i>	Tadgell's Bluebell in the local government areas of Auburn,	Epop		✓		No	No	Unlikely. Suitable habitat not present

Scientific Name	Common Name	Conservation status		Previously recorded in locality		Found during surveys	Habitat availability in study area	Likelihood of occurrence
		BC Act	EPBC Act	Bionet ¹	EPBC Report ²			
	Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield							
<i>Wilsonia backhousei</i>	Narrow-leafed Wilsonia	V		✓		No	No	Unlikely. Suitable habitat not present. Species has been recorded in saltmarsh near by.
<i>Zannichellia palustris</i>		E		✓		No	No	Unlikely. Suitable habitat not present

Notes:

BC Act = Biodiversity Conservation Act 2016; EPBC Act = Environment Protection and Biodiversity Conservation Act 1999

V = Vulnerable, E = Endangered, EPop = Endangered Population

¹ Only records that fell within 5 km of the proposed wharf locations were included.

² The report is based on an area within 5 km of the proposed wharf location.

Appendix B: Threatened Fauna Likelihood of Occurrence

Common Name	Scientific Name	Conservation status		Previously recorded in locality		Likelihood of occurrence
		BC Act	EPBC Act	Bionet ¹	EPBC Report ²	
Giant Burrowing Frog	<i>Heleioporus australiacus</i>		V		✓	Low
Green and Golden Bell Frog	<i>Litoria aurea</i>	E	V	✓	✓	Known to occur. Potential impacts assessed.
Stuttering Frog	<i>Mixophyes balbus</i>		V		✓	Low
Red-crowned Toadlet	<i>Pseudophryne australis</i>	V		✓		Low
Common Sandpiper	<i>Actitis hypoleucos</i>		M	✓	✓	High. Potential impacts considered.
Regent Honeyeater	<i>Anthochaera phrygia</i>	CE	CE	✓	✓	Low
Fork-tailed Swift	<i>Apus pacificus</i>		M	✓	✓	May fly over the project area seasonally on migration.
Cattle Egret	<i>Ardea ibis</i>		M	✓		Moderate
Ruddy Turnstone	<i>Arenaria interpres</i>		M	✓	✓	Moderate
Dusky Woodswallow	<i>Artamus cyanopterus cyanopterus</i>	V		✓		Moderate
Australasian Bittern	<i>Botaurus poiciloptilus</i>	E	E	✓	✓	Moderate
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>		M	✓	✓	Moderate
Red Knot	<i>Calidris canutus</i>		E, M	✓	✓	Moderate
Curlew Sandpiper	<i>Calidris ferruginea</i>	E	CE, M	✓	✓	Moderate
Western Sandpiper	<i>Calidris mauri</i>		M	✓		Moderate
Pectoral Sandpiper	<i>Calidris melanotos</i>		M	✓	✓	Moderate
Red-necked Stint	<i>Calidris ruficollis</i>		M	✓	✓	Moderate
Great Knot	<i>Calidris tenuirostris</i>	V	CE, M	✓	✓	Moderate
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	V		✓		Moderate
Double-banded Plover	<i>Charadrius bicinctus</i>		M		✓	Moderate
Greater Sand-plover	<i>Charadrius leschenaultii</i>	V	V, M	✓	✓	Moderate
Lesser Sand-plover	<i>Charadrius mongolus</i>		E, M		✓	Moderate
White-winged Black Tern	<i>Chlidonias leucopterus</i>		M	✓		Low
Spotted Harrier	<i>Circus assimilis</i>	V		✓		Low
Oriental Cuckoo	<i>Cuculus optatus</i>		M		✓	Low
Varied Sittella	<i>Daphoenositta chrysoptera</i>	V		✓		Low
Eastern Bristlebird	<i>Dasyornis brachypterus</i>		E		✓	Low
White-fronted Chat	<i>Epthianura albifrons</i>	V		✓		Low
White-fronted Chat (endangered population)	<i>Epthianura albifrons</i> in the Sydney Metropolitan Catchment Management Area			✓		Low

Common Name	Scientific Name	Conservation status		Previously recorded in locality		Likelihood of occurrence
		BC Act	EPBC Act	Bionet ¹	EPBC Report ²	
Black Falcon	<i>Falco subniger</i>	V		✓		Low
Latham's Snipe	<i>Gallinago hardwickii</i>		M	✓	✓	Moderate
Swinhoe's Snipe	<i>Gallinago megala</i>		M		✓	Low
Pin-tailed Snipe	<i>Gallinago stenura</i>		M		✓	Low
Gull-billed Tern	<i>Gelochelidon nilotica</i>		M	✓		Low
Little Lorikeet	<i>Glossopsitta pusilla</i>	V		✓		Moderate
Painted Honeyeater	<i>Grantiella picta</i>		V		✓	Low
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	V		✓		High
Little Eagle	<i>Hieraaetus morphnoides</i>	V		✓		Low
White-throated Needletail	<i>Hirundapus caudacutus</i>		M	✓	✓	May fly over the project area seasonally on migration
Caspian Tern	<i>Hydroprogne caspia</i>		M	✓		Low
Black Bittern	<i>Ixobrychus flavicollis</i>	V		✓		Moderate
Swift Parrot	<i>Lathamus discolor</i>	E	CE	✓	✓	Low
Broad-billed Sandpiper	<i>Limicola falcinellus</i>	V	M	✓		Moderate
Bar-tailed Godwit (baueri)	<i>Limosa lapponica baueri</i>		V, M	✓	✓	Moderate
Bar-tailed Godwit (menzbieri)	<i>Limosa lapponica menzbieri</i>		CE, M	✓	✓	Moderate
Black-tailed Godwit	<i>Limosa limosa</i>	V	M	✓	✓	Moderate
Rainbow Bee-eater	<i>Merops ornatus</i>		M	✓		Moderate
Black-faced Monarch	<i>Monarcha melanopsis</i>		M		✓	Low
Spectacled Monarch	<i>Monarcha trivirgatus</i>		M		✓	Low
Yellow Wagtail	<i>Motacilla flava</i>		M		✓	Low
Satin Flycatcher	<i>Myiagra cyanoleuca</i>		M		✓	Moderate
Barking Owl	<i>Ninox connivens</i>	V		✓		Low
Powerful Owl	<i>Ninox strenua</i>	V		✓		Moderate
Eastern Curlew	<i>Numenius madagascariensis</i>		CE, M	✓	✓	Moderate
Little Curlew	<i>Numenius minutus</i>		M		✓	Low
Whimbrel	<i>Numenius phaeopus</i>		M	✓	✓	Moderate
Fairy Prion (southern)	<i>Pachyptila turtur subantarctica</i>		V		✓	Low
Eastern Osprey	<i>Pandion cristatus</i>	V	M	✓	✓	Moderate
Scarlet Robin	<i>Petroica boodang</i>	V		✓		Moderate
Ruff	<i>Philomachus pugnax</i>		M	✓	✓	Moderate
Glossy Ibis	<i>Plegadis falcinellus</i>		M	✓		Moderate
Pacific Golden Plover	<i>Pluvialis fulva</i>		M	✓	✓	Moderate
Grey Plover	<i>Pluvialis squatarola</i>		M	✓		Moderate

Common Name	Scientific Name	Conservation status		Previously recorded in locality		Likelihood of occurrence
		BC Act	EPBC Act	Bionet ¹	EPBC Report ²	
Superb Fruit-Dove	<i>Ptilinopus superbus</i>	V		✓		Low
Rufous Fantail	<i>Rhipidura albifrons</i>		M		✓	Moderate
Australian Painted Snipe	<i>Rostratula australis</i>	E	E	✓	yes	Moderate
Common Tern	<i>Sterna hirundo</i>		M	✓		Low
Little Tern	<i>Sternula albifrons</i>	E	M	✓		Low
Australian Fairy Tern	<i>Sternula nereis nereis</i>		V		✓	Low
Freckled Duck	<i>Stictonetta naevosa</i>	V		✓		Moderate
Grey-tailed Tattler	<i>Tringa brevipes</i>		M	✓	✓	Moderate
Wood Sandpiper	<i>Tringa glareola</i>		M	✓		Moderate
Common Greenshank	<i>Tringa nebularia</i>		M	✓	✓	Moderate
Marsh Sandpiper	<i>Tringa stagnatilis</i>		M	✓	✓	Moderate
Eastern Grass Owl	<i>Tyto longimembris</i>	V		✓		Low
Terek Sandpiper	<i>Xenus cinereus</i>	V	M	✓		Moderate
Cumberland Plain Land Snail	<i>Meridolum corneovirens</i>	E		✓		Low
Dural Woodland Snail	<i>Pommerhelix duralensis</i>	E	E	✓	✓	Low
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>		V		✓	Low
Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	V	E	✓	✓	Low
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	V		✓		Low
Southern Brown Bandicoot	<i>Isodon obesulus obesulus</i>		E		✓	Low
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	V		✓		High. Potential impacts considered.
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	V		✓		Moderate
Southern Myotis	<i>Myotis macropus</i>	V		✓		Moderate
Greater Glider	<i>Petauroides volans</i>		V		✓	Low
Brush-tailed Rock-wallaby	<i>Petrogale penicillata</i>		V		✓	Low
Koala	<i>Phascolarctos cinereus</i>		V		✓	Low
New Holland Mouse	<i>Pseudomys novaehollandiae</i>		V		✓	Low
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V	V	✓	✓	High. A camp of this species is located on the Duck River. Potential impacts considered.
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	V		✓		Low
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	V		✓		Moderate
Broad-headed Snake	<i>Hoplocephalus bungaroides</i>		V		✓	Low

Notes:

Marine species such as albatross excluded.

BC Act = Biodiversity Conservation Act 2016; EPBC Act = Environment Protection and Biodiversity Conservation Act 1999

V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory

¹ Only records that fell within 5 km of the proposed wharf locations were included.

² The report is based on an area within 5 km of the proposed wharf location.

Appendix C: Plant Species Recorded During Survey

Family	Scientific Name	Common Name	Status	Priority Weed	Exotic
Fabaceae	<i>Acacia floribunda</i>	White Sally Wattle			
Fabaceae	<i>Acacia linifolia</i>	White Wattle			
Fabaceae	<i>Acacia longifolia</i>	Sydney Golden Wattle			
Fabaceae	<i>Acacia parramattensis</i>	Parramatta wattle			
Fabaceae	<i>Acacia pubescens</i>	Downy Wattle	Listed under the BC Act		
Asteraceae	<i>Ageratina adenophora</i>	Crofton Weed			Yes
Amaranthaceae	<i>Alternanthera denticulata</i>	Lesser Joyweed			
Myrtaceae	<i>Callistemon linearis</i>	Narrow-leaved Bottlebrush			
Myrtaceae	<i>Callistemon viminalis</i>	Weeping Bottlebrush			
Sapindaceae	<i>Cardiospermum grandiflorum</i>	Balloon Vine			
Cyperaceae	<i>Carex appressa</i>	Tall Sedge			
Casuarinaceae	<i>Casuarina glauca</i>	Swamp Oak			
Poaceae	<i>Cenchrus clandestinus</i>	Kikuyu			Yes
Poaceae	<i>Chloris gayana</i>	Rhodes Grass			Yes
Asteraceae	<i>Chrysanthemoides monilifera</i>	Boneseed		Biosecurity Zone	Yes
Lauraceae	<i>Cinnamomum camphora</i>	Camphor laurel			Yes
Commelinaceae	<i>Commelina cyanea</i>				
Myrtaceae	<i>Corymbia maculata</i>	Spotted Gum			
Rosaceae	<i>Cotoneaster sp.</i>	Cotoneaster			Yes
Poaceae	<i>Cynodon dactylon</i>	Couch			
Phormiaceae	<i>Dianella revoluta</i>	Blueberry Lily			
Poaceae	<i>Ehrharta erecta</i>	Panic Veldtgrass			Yes
Myrtaceae	<i>Eucalyptus amplifolia</i>	Cabbage Gum			
Myrtaceae	<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark			
Myrtaceae	<i>Eucalyptus robusta</i>	Swamp Mahogany			

Myrtaceae	<i>Eucalyptus tereticornis</i>	Forest Red Gum			
Phyllanthaceae	<i>Glochidion ferdinandii</i>	Cheese Tree			
Euphorbiaceae	<i>Homalanthus populifolius</i>	Bleeding Heart			
Araliaceae	<i>Hydrocotyle bonariensis</i>	Largeleaf Pennywort			Yes
Cyperaceae	<i>Juncus acutus</i>	Sharp Rush			Yes
Asteraceae	<i>Lactuca serriola</i>	Prickly Lettuce			Yes
Verbenaceae	<i>Lantana camara</i>	Lantana		Prohibition of dealings	Yes
Oleaceae	<i>Ligustrum lucidum</i>	Large-leaved Privet			Yes
Oleaceae	<i>Ligustrum sinense</i>	Small-leaved Privet			Yes
Lomandraceae	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush			
Myrtaceae	<i>Melaleuca ericifolia</i>	Swamp Paperbark			
Myrtaceae	<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark			
Myrtaceae	<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree			
Poaceae	<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Grass			
Oleaceae	<i>Olea europaea</i> subsp. <i>Cuspidata</i>	African Olive		Regionally Recommended Measure	Yes
Poaceae	<i>Oplismenus aemulus</i>	Australian Basket Grass			
Polygonaceae	<i>Persicaria decipiens</i>	Slender Knotweed			
Poaceae	<i>Phragmites australis</i>	Common Reed			
Pittosporaceae	<i>Pittosporum undulatum</i>	Native Daphne			
Typhaceae	<i>Typha orientalis</i>	Cumbungi			

Appendix D: Fauna Recorded During Survey

Group	Common Name	Scientific Name
Frog	Striped Marsh Frog	<i>Limnodynastes peronii</i>
Bird	Chestnut Teal	<i>Anas castanea</i>
	Pacific Black Duck	<i>Anas superciliosa</i>
	Red Wattlebird	<i>Anthochaera carunculata</i>
	Shining Bronze-cuckoo	<i>Chalcites lucidus</i>
	Silver Gull	<i>Chroicocephalus novaehollandiae</i>
	Rock Dove*	<i>Columba livia</i>
	Australian Raven	<i>Corvus coronoides</i>
	Grey Butcherbird	<i>Cracticus torquatus</i>
	Black Swan	<i>Cygnus atratus</i>
	White-faced Heron	<i>Egretta novaehollandiae</i>
	Eurasian Coot	<i>Fulica atra</i>
	Australian Magpie	<i>Gymnorhina tibicen</i>
	Welcome Swallow	<i>Hirundo neoxena</i>
	Superb Fairy-wren	<i>Malurus cyaneus</i>
	Red-browed Finch	<i>Neochmia temporalis</i>
	Red-whiskered Bulbul*	<i>Pycnonotus jocosus</i>
	Willie Wagtail	<i>Rhipidura leucophrys</i>
	White-browed Scrubwren	<i>Sericornis frontalis</i>
	Australasian Grebe	<i>Tachybaptus novaehollandiae</i>
	Australian White Ibis	<i>Threskiornis molucca</i>
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	
Reptile	Eastern Water Skink	<i>Eulamprus quoyii</i>
	unidentified Lampropholis	<i>Lampropholis</i> sp.

* indicates an introduced species

Appendix E: Assessments of Significance

5 Part Test for the Green and Golden Bell Frog (GGBF) (*Litoria aurea*)

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The proposed development will not directly impact on this species' breeding habitat (with the possible exception of a very small area of weed-infested Freshwater Wetland near the easement), or any important areas of foraging, shelter or overwintering habitat. Provided that the indirect impacts of the proposed development are effectively avoided or minimised, the proposed development is not likely to place the Clyde/Rosehill GGBF population at risk of extinction.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Not applicable to a threatened species.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable to a threatened species.

(c) in relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The proposed development will result in the removal of less than 1% of the Freshwater Wetland habitat and approximately 15% of the Swamp Oak Forest within the study area. The Swamp Oak Forest is not an important area of habitat for the species.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

The proposed development will not fragment the Freshwater Wetland and it will not further isolate the GGBF population from other populations in the region.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,

The habitat to be removed comprises Swamp Oak Forest and a small area of Freshwater Wetland that is affected by weeds and runoff from adjacent industrial facilities. It is not considered of importance to the long-term survival of the species.

The large area of Freshwater Wetland outside of the development footprint is likely to be highly important to the long-term survival of the Clyde/Rosehill population and a range of measures to protect this area are proposed.

The long-term survival of the species in the locality is more likely to be dependent on the survival of the population at Sydney Olympic Park, which appears to be larger and more secure than the Clyde/Rosehill population.

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The proposed development will not affect any declared area of outstanding biodiversity value.

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

The proposed development has the potential to increase the impact of key threatening processes if undertaken in an uncontrolled manner. A range of management and mitigation measures are proposed to be implemented. If undertaken in an appropriate manner, key threatening processes can be avoided, minimised and/or managed.

Conclusion

The proposed development will not have a significant impact on the Green and Golden Bell Frog.

EPBC Significance Assessment for the Green and Golden Bell Frog

Criterion 1: lead to a long-term decrease in the size of an important population

The proposed development will not directly impact on this species' breeding habitat (with the possible exception of a very small area of weed-infested Freshwater Wetland near the easement), or any important areas of foraging, shelter or overwintering habitat. Provided that the indirect impacts of the proposed development are effectively avoided or minimised, the proposed development is not likely to have any effect on the size of the Clyde/Rosehill GGBF population.

Criterion 2: reduce the area of occupancy of an important population

The main areas occupied by the Clyde/Rosehill GGBF population are the wetland itself, planted woodland areas around the wetland and a number of man-made sites in the industrial section of the Clyde Facility. The Swamp Oak Forest to be removed is not an important area of habitat and is probably utilised only rarely by the species. The small area of Freshwater Wetland in the north-western corner near the easement is less than 1% of the wetland area, is heavily weed infested and is affected by runoff from adjoining industrial sites. The loss of these areas will not affect the GGBF population's use of the wetland or any other areas from which the species has been recorded in the Clyde Facility.

Criterion 3: fragment an existing important population into two or more populations;

The proposed development will not fragment the existing population, which is centred around the wetland and other sites to the west and south.

Criterion 4: adversely affect habitat critical to the survival of a species

No critical habitat has been identified for this species and no breeding habitat would be impacted. The small area of habitat that would be cleared is not critical to the survival of the local population or the species.

Criterion 5: disrupt the breeding cycle of a population;

Breeding habitat for the Clyde/GGBF population includes the large wetland area outside of the proposed development area and a number of other sites in the industrial landscape. The proposed development is not likely to disrupt the breeding cycle of the population.

Criterion 6: modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

The main areas occupied by the Clyde/Rosehill GGBF population are the wetland itself, planted woodland areas around the wetland and a number of man-made sites in the industrial section of the Clyde Facility. The Swamp Oak Forest to be removed is not an important area of habitat and is probably utilised only rarely by the species. The small area of Freshwater Wetland in the north-western corner near the easement is less than 1% of the wetland area, is heavily weed infested and is affected by runoff from adjoining industrial sites. The loss of these areas will not affect the GGBF population's use of the wetland or any other areas from which the species has been recorded in the Clyde Facility. A range of management and mitigation measures are proposed to protect the species' habitat from modification. The proposed development will not isolate the wetland.

Accordingly, it is considered that the proposed development will not cause the species to decline.

Criterion 7: result in invasive species that that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The proposed development includes a range of measures to minimise the potential for invasive species, including intercepting incoming traffic at a wash down area and weed control.

A number of weed species are already established in the area and the wetland is known to already contain Plague Minnow.

Criterion 8: introduce disease that may cause species to decline; or

The proposed development includes intercepting incoming traffic at a wash down area to prevent entry of amphibian chytrid to the site.

Criterion 9: interfere substantially with the recovery of the species

The proposed development is situated in an area that is the subject of another development consent (i.e. the overall Clyde Refinery area). A management plan has been prepared for the species (Biosphere 2013a, 2014) and for the Clyde Wetlands (UBM 2017). In addition, the water regime of the wetland area is under investigation by UNSW.

Accordingly, this study recommends that implementation of management and mitigation measures such as weed control, post-development revegetation and wetland drainage systems are consistent with these existing plans and studies and are updated as required. If this is done the proposed development will not interfere substantially with the management of the species at this site or with the recovery of the species as a whole.

Conclusions

The proposed activity is not considered likely to result in a significant impact on the GGBF if undertaken in the manner described in this study.

5-part Test for Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions (SOFF) TEC.

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable to an EEC.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Approximately 1.45 ha of SOFF occurs within the study area. The proposed works will widen an existing road from approximately 3.5m to 7m. These works will result in the removal of trees that contribute to the canopy of SOFF and, shrub and ground layer species. The SOFF vegetation in the study area is a composite of mature regenerated and plant tree species and has a high cover of exotic species in the shrub and ground layers. It is located as a small patch between grey mangroves, growing at the edge of the Parramatta River, and the large man-made Clyde Wetlands. It is a small remnant in a fragmented landscape with little of this vegetation community left in it. The nearest remnants are other small, isolated patches over 1 km away. A strip of the SOFF will be removed to widen the existing road and this will reduce the total area. The SOFF is a composite of mature regenerated and plant tree species and has a high cover of exotic species in the shrub and ground layers, and the vegetation to be removed is within the stand along an existing road. It is not expected that the proposed works will place the stand of SOFF at a greater risk of extinction than it already suffers given its isolation and the surrounding industrial activities.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

The SOFF of the study area is highly modified with planted native trees and shrubs and exotic shrubs introduced by birds. Widening the road will allow more light to penetrate below the currently dense canopy and this will encourage the growth of exotic species particularly along the road edge. As well, road works may introduce propagules from exotic species that will further degrade the SOFF. Further, dust from many truck movements will coat the leaves of plants adjacent to the road and well into the remnant. Mitigation measures such as sealing the road surface, adequate control of run off from the road to direct away from the SOFF, machinery hygiene measures and weed control along the road prior to and post construction activities, should be introduced to prevent further degradation and modification of the SOFF.

(c) in relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

A strip of SOFF will be removed to allow a road to be widened and this will reduce the extent of the SOFF. The SOFF is already highly modified but this may increase with the proposed works by allowing light to penetrate deeper into the ground layer, introducing weed

propagules from truck and construction machinery, deposition of dust from and unsealed road and runoff into the remaining SOFF. Mitigation measures such as sealing the road surface, adequate control of run off from the road to direct away from the SOFF, machinery hygiene measures and weed control along the road prior to and post construction activities, should be introduced to prevent the extent of modification to the stand of SOFF.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

The removal of a strip of the SOFF in the study area is unlikely to result in further fragmentation of the SOFF. The stand is already isolated from other stands of this community by the Parramatta River, Duck Creek and the industrial area to its west and north.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality

SOFF is considered to be of high conservation value at the state and local government level with only small patches, fragmented of this patches community remaining in the LGA. The highly modified remnant of SOFF is important to the long-term survival of this endangered ecological community and at the local level, provides a buffer to the freshwater wetland to its west. Although small, the study area contains biodiversity values which will become increasingly important over time to the species diversity within the total area of occurrence of SOFF, and provides habitat connectivity along the Parramatta River and Duck Creek corridors.

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The proposed works will not impact upon a declared area of outstanding biodiversity value.

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

The proposed works could contribute to several key threatening processes listed under the BC Act that could impact the SOFF:

- Spread of priority weed species
 - Invasion, establishment and spread of Lantana (*Lantana camara*)
 - Invasion of native plant communities by African Olive (*Olea europaea* subsp. *cuspidate*)
 - Invasion and establishment of exotic vines and scramblers
- Clearing of vegetation

These KTP's can cause a general decline in habitat health and ecosystem function. Implementation of the recommendations in this report should ensure that the SOFF in the study area is protected from further degradation that these key threatening processes may facilitate.

Conclusion

The proposed works are unlikely to result in a significant impact to Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions within the study area as long as mitigation measures to reduce weed invasion, dust generation and to control runoff are implemented.

5-part Test for Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions

Background

Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions was the only marine matter listed under the BC Act considered to potentially be at risk from this proposal. The test for determining whether the proposal is likely to significantly affect the EEC is provided below.

Endangered Ecological Community

Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is listed as an EEC under the BC Act. This community generally occurs in the intertidal zone on the shores of estuaries and lagoons that are permanently or intermittently open to the sea. It is frequently found as a zone on the landward side of mangrove stands. This community was not recorded on or directly adjacent to the Site of the wharf upgrade but considerable occurrences are found within the wetland in the Study Area and on the margins of Estuarine Mangroves which occur along the Parramatta and Duck Rivers (AECOM 2013).

- a) **In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.**

Not a threatened species.

- b) **In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:**
- I. **Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
 - II. **Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

There will be no direct impact on this community. However, this EEC is vulnerable to changes in water quality brought about by increased nutrient levels, sedimentation and pollution. It is considered that risks to these communities would be appropriately managed through implementation of commonly applied measures which would be detailed in the Construction and Operational Environmental Management Plans and Erosion & Sedimentation Control Plan.

- c) **In relation to the habitat of a threatened species or ecological community:**
- I. **The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and**
 - II. **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**
 - III. **The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality.**

This proposal does not include removal or modification of this EEC and hence is unlikely to become fragmented or isolated from the local population. However, this EEC is vulnerable to changes in water quality brought about by increased nutrient levels, sedimentation and pollution. It is considered that risks to these communities would be appropriately managed through

implementation of commonly applied measures which would be detailed in the CEMP, OEMP and ESCP.

d) Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

An Area of Outstanding Biodiversity Value has not been declared at the location of the Site, or for any occurrence of Coastal Saltmarsh.

e) Whether the proposed development or activity is part of a key threatening process or is likely to increase the impact of, a key threatening process

One KTP is relevant to this EEC and proposal:

Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands – Habitat loss / change (BC Act).

This proposal is likely to result in changes to flow regimes during construction. These changes are likely to be temporary as flow regimes would be reinstated at the completion of construction.

CONCLUSION

This proposal is unlikely to have a significant impact on the Coastal Saltmarsh EEC as it is considered that:

- The Coastal Saltmarsh community is unlikely to be directly impacted by this proposal; and
- Risks to water quality and sedimentation of the adjacent saltmarsh communities along the Parramatta and Duck Rivers and the broader environs would be minimal with the implementation of commonly applied environmental management techniques which would be detailed in the CEMP, OEMP and ESCP.

NSW Fisheries Management Act Assessment of Significance for the Black Rockcod

Background

As required under Section 5 of the EP&A Act, Assessments of Significance are required to be undertaken to determine the significance of impacts of the proposal on threatened species, populations and endangered ecological communities listed on Schedules of the FM Act. An Assessment of Significance has been undertaken for the Black Rockcod (*Epinephelus daemeli*) as this was the only species considered to be relevant to this proposal.

Fish Species

Black Rockcod is listed as Vulnerable under the FM Act. This species generally inhabits near-shore rocky and off-shore coral reefs at depths down to 50 m. Recently settled juvenile Black Rockcod (i.e. individuals that have recently completed the pelagic, drifting larval stage) are often found in coastal rock pools while slightly older juvenile Black Rockcod are often found in estuary systems. Juveniles may on occasion be found in the estuarine environments within the Parramatta River.

- a) **In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.**

There is unlikely to be any direct impact on this species or habitat such that a viable local population would be placed at risk of extinction, as breeding adults would not be found within the estuarine environment of the Site as these inhabit near-shore and off-shore coral reefs. Any occurrences of this species within the estuarine sections of the Parramatta River would be juveniles and hence not in breeding condition. However, juveniles are also impacted by the loss or degradation of estuarine and intertidal nursery areas and the degradation of these could cause long-term impacts on population sizes.

- b) **In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.**

These are not endangered populations.

- c) **In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- I. **Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
 - II. **Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

These are not endangered ecological communities.

- d) **In relation to the habitat of a threatened species, population or ecological community:**
- I. **The extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
 - II. **Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
 - III. **The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

There is unlikely to be direct impacts on the habitat of this species and habitats are unlikely to become fragmented or isolated. There are no records of this species within the Study Area and hence the habitat available at the Site is unlikely to be of importance to the sustainability of this species.

- e) **Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).**

Critical habitat in NSW has not been listed in the Register of Critical Habitat kept by the Director General of the Office of the Environment or the Register of Critical Habitat kept by the Director General of Department of Primary Industries for the Black Rockcod.

- f) **Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.**

A recovery plans exist for the Black Rockcod (Aquaculture, Conservation & Marine Parks Unit, Port Stephens Fisheries Institute 2012). The proposal does not contravene the management objectives for this species. Any indirect impacts on habitat quality and potential threats would be mediated by mitigation measures stated in the CEMP, OEMP and ESCP.

g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Two KTPs of relevance to Black Rockcod are listed under the FM and these are:

- *Hook and line fishing in areas important for the survival of threatened species.* Black Rockcod populations have been reduced by over-harvesting by line, net and spear fishers. This proposal does not increase opportunities for fishing and hence is unlikely to be applicable.
- *Introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales.* This proposal could assist the spread of *Caulerpa taxifolia* via equipment used in piling and the movement of vessels. This species is listed as a marine pest and is easily spread to areas where it can smother marine habitats and displace naturally occurring species. To reduce the risk, equipment should be thoroughly cleaned if moved from areas that are infested with *C. taxifolia*. It is recommended that management of *C. taxifolia* be addressed in the CEMP, OEMP and ESCP so as to minimise the risk of invasive species establishment and that these measures be in line with the *NSW control Plan for the Noxious Marine Alga Caulerpa taxifolia* (I&I NSW 2009).

CONCLUSION

This proposal is unlikely to have a significant impact on the Black Rockcod as it is considered that:

- Estuarine fauna habitat and connectivity for the Black Rockcod are unlikely to be significantly impacted by this proposal; and
- Risks to water quality and sedimentation of the Parramatta and Duck Rivers, and the broader environs would be minimal with the implementation of commonly applied environmental management techniques which would be detailed in the CEMP, OEMP and ESCP.

Appendix C – Preliminary Hazard Analysis

											Risk Rating			Status
Risk Discipline	Area			Issue/Hazard	Potential/Causes	Subissue/Hazard	Control/Actions/Req	Risk Owner	Consequence	Likelihood	Risk Rating	Status		
ID	Discipline	WP	Activity	HRCW	Hazard	Potential Causes	Threat/Opportunity	Risk Controls (including reference documents from which specific actions are to be nominated)	Risk Owner	Consequence	Likelihood	Risk Rating	Status	
Site Establishment														
CLD-001	Safety	Clyde	Earthworks	Chemical, fuel or refrigerant lines	Plant or heavy vehicle contacting/damaging underground/ above ground pipes/ services	Incomplete or inadequate services survey Failure to delineate/ identify underground service Operators not acting in accordance with instructions Penetration of pipe or protective structure leak, perforation, break or seal failure caused by plant, heavy vehicle or fatigue.	Fuel spillage to land and water Disruption of fuel supply Material Environmental harm Fire and Explosion Personal Injury Evacuation	Identify services clearly delineate 'no go' areas include in site specific induction and or toolbox on specific utilities Emergency Response Duty Cards (090022) Spill Management Procedure (003003) Environmental Protection Manual Technical Bulletin Bunding and Spill Management Bunded facilities Spill kits <u>Refer to Viva Energy Emergency Response Plan</u> Liase closely with pipeline owner and management team	Lead WHS Manager	C2 - Severe	L4 - Unlikely	C - Medium	Open	
CLD-002	Emergency	Clyde	Site works	Chemical, fuel or refrigerant lines	Fire and/or emergency on adjoining site	Uncontrolled hazard	Injuries including burns, smoke inhalation, respiratory irritation Toxic smoke, dust and vapours Damage to property and plant Smoke entering underground ventilation system	Emergency Response Plan (002081) Site Specific Management Plans including off-site emergency sources Interface arrangements for early notification by nearby stakeholders. Communication protocols with emergency services - Project emergency contact details provided Evacuation plans <u>Refer to Viva Energy Australia Emergency Response Plan</u>	Lead WHS Manager	C5 - Minor	L3 - Possible	C - Medium	Open	
CLD-003	Safety	Clyde	Wharf upgrade - piles	Chemical, fuel or refrigerant lines	Damage to pipeline piling works . Capsize of barge if water based piles . vibration impact to pipeline , fuel in water	Plant and materials falling from temporary floating structures during piling operations. Floating structures overturning due to uneven ballast Piling rig striking pipeline enclosure Crane delivering piles drops the load due to failure of lifting gear	Cessation of works Investigations Fuel spills Material Environmental harm Reputational damage	Survey and certification of piling barge Piling rig positioned in designate spot Locating of piles using land- based mobile cranes Booms and silt screen installed "Clip" flexible pump hose when slewing to or from concrete discharge point Inspection and test of lifting gear Liase closely with pipeline owner and management team <u>Refer to Viva Energy Australia Emergency Response Plan</u>	Lead WHS Manager	C5 - Minor	L4 - Unlikely	D - Low	Open	
CLD-004	Emergency	Clyde	Site works	Chemical, fuel or refrigerant lines	Bush Fire	Flammable materials in contact with ignition source e.g. sparks from grinder High surrounding fuel load Lightning strikes Arson	Injuries including burns, smoke inhalation, respiratory irritation Damage to property and plant Smoke entering underground ventilation system	<u>Refer to Viva Energy Australia Emergency Response Plan</u> Liase closely with pipeline owner and management team	Lead WHS Manager	C5 - Minor	L3 - Possible	C - Medium	Open	
CLD-005	Safety	Clyde	Crane Platforms	Lifting Operations	Failure of platforms Crane into water Damage to EEC/ Wharf/ Pipeline Loss of life	Operators not acting in accordance with instruction ground failure Insufficient ground testing/ survey for suitability Plant failure	Drowning Loss of or damage to Plant Mterial Environmental harm Fuel Spill Crisis Fire Evacuation Regulatory involvement Damage to Reputation	Survey indicating suitability of platform maintain exclusion zones and plant buffer zones maintain safe distance from depressions/ waterways <u>Refer to Viva Energy Australia Emergency Response Plan</u> Liase closely with pipeline owner and management team	Lead WHS Manager	C5 - Minor	L4 - Unlikely	D - Low	Open	
Spoil Operations - Land Based														
CLD-006	Safety	Clyde	Movement of Spoil	Chemical, fuel or refrigerant lines	Plant or heavy vehicle contacting/damaging underground/ above ground pipes/ services	Incomplete or inadequate services survey Failure to delineate underground service Operators not acting in accordance with instructions Penetration of pipe or protective structure leak, perforation, break or seal failure caused by plant, heavy vehicle or fatigue.	Fuel spillage to land and water Disruption of fuel supply Material Environmental harm Fire and Explosion Personal Injury Evacuation	Identify services clearly delineate 'no go' areas include in site specific induction and or toolbox on specific utilities Emergency Response Duty Cards (090022) Spill Management Procedure (003003) Environmental Protection Manual Technical Bulletin Bunding and Spill Management Bunded facilities Spill kits Liase closely with pipeline owner and management team <u>Refer to Viva Energy Australia Emergency Response Plan</u>	Lead WHS Manager	C2 - Severe	L4 - Unlikely	C - Medium	Open	
CLD-007	Safety	TPW - TSE Project Wide	Transport of Spoil	Heavy Haulage	Uncontrolled heavy vehicle operations (including deviating from prescribed routes) not following instructions	CoR (Chain of Responsibility) obligations into assigned. Performance requirements not set or monitored. Operators and drivers not trained or assessed in CoR requirements. Consultative arrangements not implemented	Damage to pavement & structures Traffic congestion Obstructing precinct or suburban roads Heavy vehicle incidents Complaints Serious personal injury Vehicle and property damage	Chain of Responsibility (CoR) Management Plan (002164) Heavy Vehicle Driver Code of Conduct (004218) Delivery & Cartage Drivers Induction (003021)	Lead Safety Manager	C5 - Minor	L4 - Unlikely	C - Medium	Open	
CLD-008	Emergency	Clyde	Piling/ site works	Work causing fire risks	Fire and/or emergency on adjoining site	Uncontrolled hazard	Injuries including burns, smoke inhalation, respiratory irritation Toxic smoke, dust and vapours Damage to property and plant Smoke entering underground ventilation system	Emergency Response Plan (002081) Site Specific Management Plans including off-site emergency sources Interface arrangements for early notification by nearby stakeholders. Communication protocols with emergency services - Project emergency contact details provided Evacuation plans <u>Refer to Viva Energy Australia Emergency Response Plan</u>	Lead WHS Manager	C5 - Minor	L3 - Possible	C - Medium	Open	
Spoil Operations - water base														
CLD-009	Safety	Clyde	Positioning /mooring of barge - side on	Chemical, fuel or refrigerant lines	Collision of barge into pipeline, protection structure, or ferries , resulting from break down of tugs	Mechanical failure of tugs Lack of maintenance program Lack contingency planning Adverse weather conditions	Collision with wharf, ferries, pipeline Dangerous goods spill under pressure Disruption of supply Crisis Adverse Media attention Regulatory intervention Pollution of waters Injury to ferry passengers Drowning	Install additional piles to provide physical barrier and maximum practicable clearance from pipeline enclosure Using two tugs and land-based winches to berth the barge <u>Refer to Viva Energy Australia Emergency Response Plan</u> Liase closely with pipeline owner and management team	Lead WHS Manager	C5 - Minor	L4 - Unlikely	D - Low	Open	
TBM equipment - unloading														
CLD-010	Emergency	Clyde	Movement of oversized plant	Chemical, fuel or refrigerant lines	Fire and/or emergency on adjoining site	Uncontrolled hazard	Injuries including burns, smoke inhalation, respiratory irritation Toxic smoke, dust and vapours Damage to property and plant Smoke entering underground ventilation system	Emergency Response Plan (002081) Site Specific Management Plans including off-site emergency sources Interface arrangements for early notification by nearby stakeholders. Communication protocols with emergency services - Project emergency contact details provided Evacuation plans <u>Refer to Viva Energy Australia Emergency Response Plan</u>	Lead WHS Manager	C5 - Minor	L3 - Possible	C - Medium	Open	
CLD-011	Emergency	Clyde	Movement of oversized plant	Chemical, fuel or refrigerant lines	Contact with high pressure services	Site Safety System Failure	Significant injuries including burns, hearing loss, embolism, fractures etc Damage to property, services and works, Impacts on worksite and public safety Service disruption for Asset owner, Large Scale evacuation	Identification & Marking Underground Services (080021) GDP procedure in place Contact 000 Emergency Services Contact Asset Owner Liase closely with pipeline owner and management team <u>Refer to Viva Energy Australia Emergency Response Plan</u>	Lead WHS Manager	C3 - Major	L5 - Rare	C - Medium	Open	

										Risk Rating			Status
Risk Discipline	Area			Issue/Hazard	Potential Causes	Subissue/Hazard	Control/Actions Req	Risk Owner	Consequence	Likelihood	Risk Rating	Status	
ID	Discipline	WP	Activity	HRCW	Hazard	Potential Causes	Threat/Opportunity	Risk Controls (including reference documents from which specific actions are to be nominated)	Risk Owner	Consequence	Likelihood	Risk Rating	Status
CLD-012	Safety	Clyde	Movement of oversized plant	Work causing fire risks	Ignition of fuel vapours or spills	Static electricity build up No earth straps Sparks are generated when working near pipework. Heat sources on site ignite fumes. Fumes concentrated in explosive concentrations	Chronic Health risks to workers and the public Injuries to workers - including burns Damage to plant and equipment	Fire Prevention and Control (081011) Site Safety Rules (003045) Chemicals (081015) WHS Monitoring, Inspection & Testing (003040) Liase closely with pipeline owner and management team Refer to Viva Energy Australia Emergency Response Plan	Lead WHS Manager	C4 - Moderate	L5 - Rare	C - Medium	Open
CLD-013	Emergency	Clyde	Movement of oversized plant	Chemical, fuel or refrigerant lines	Bush Fire	Flammable materials in contact with ignition source High surrounding fuel load Lightning strikes Arson	Injuries including burns, smoke inhalation, respiratory irritation Damage to property and plant Smoke entering underground ventilation system	Refer to Viva Energy Australia Emergency Response Plan Liase closely with pipeline owner and management team	Lead WHS Manager	C5 - Minor	L3 - Possible	C - Medium	Open
CLD-014	Emergency	Clyde	Movement of oversized plant	Chemical, fuel or refrigerant lines	Plant and Vehicle Fire	Flammable materials in contact with ignition source	Injuries including fatality, burns, smoke inhalation, respiratory irritation Damage to property and plant Smoke entering underground ventilation system Evacuation of work area	Refer to Viva Energy Australia Emergency Response Plan Liase closely with pipeline owner and management team	Lead WHS Manager	C3 - Major	L5 - Rare	C - Medium	Open
CLD-015	Safety	Clyde	Positioning /mooring of barge - perpendicular	Chemical, fuel or refrigerant lines	Collision of barge into pipeline, protection structure, or ferries, resulting from break down of tugs	Mechanical failure of tugs Lack of maintenance program Lack contingency planning Adverse weather conditions	Collision with wharf, ferries, pipeline Dangerous goods spill under pressure Disruption of supply Crisis Adverse Media attention Regulatory intervention Pollution of waters Injury to ferry passengers Drowning	Install additional piles to provide physical barrier and maximum practicable clearance from pipeline enclosure Using two tugs and land-based winches to berth the barge Liase closely with pipeline owner and management team Refer to Viva Energy Australia Emergency Response Plan	Lead WHS Manager	C5 - Minor	L4 - Unlikely	D - Low	Open



Clyde Barging Facility - Preliminary Hazard Assessment

										Risk Rating			Status
Risk Discipline	Area			Issue/Hazard	Potential Causes	Subissue/Hazard	Control/Actions Req	Risk Owner	Consequence	Likelihood	Risk Rating		
ID	Discipline	WP	Activity	HRCW	Hazard	Potential Causes	Threat/Opportunity	Risk Controls (including reference documents from which specific actions are to be nominated)	Risk Owner	Consequence	Likelihood	Risk Rating	Status

WHS-123

Segment removal system designed to allow safe removal (supported ring), segment removal to be carried out only when delineation is in place. Procedure in place to confirm ground

Appendix D – Historic heritage assessment



Clyde Barging Facility Statement of Heritage Impact

Prepared by AMBS Ecology & Heritage
for John Holland CPB Ghella Joint Venture

Final

December 2017

AMBS Reference: 16314

Document Information

Citation:	AMBS Ecology & Heritage 2017, <i>Clyde Barging Facility Statement of Heritage Impact</i> . Consultancy report to John Holland CPB Ghella Joint Venture.
AMBS Ref:	16314
Versions:	Version 1: Draft Report issued December 2017 Version 2: Final Draft issued December 2017 Version 3: Final Report issued December 2017
Recipient:	Robert Muir, Senior Environment Coordinator Tunnel and Station Excavation Works Sydney Metro City & Southwest
Approved by:	Jennie Lindbergh AMBS Director Historic Heritage

Contents

1	Introduction.....	1
1.1	The site.....	1
1.2	Heritage Context.....	1
1.3	Methodology & Authorship.....	4
2	Historic Context	5
2.1	The Elizabeth Farm Estate.....	5
2.2	Early Ferry Services to Parramatta.....	5
2.3	The Redbank-Parramatta Tramway.....	8
3	Analysis of the Proposal	16
3.1	Scope of Works	16
3.2	Previous studies.....	17
3.2.1	<i>The Parramatta River Maritime Archaeological Works Project</i>	17
4	Assessment of Heritage Impact	21
4.1	Consultation.....	21
	Bibliography.....	22

Tables

Table 1.1	Heritage Listing relevant to the Clyde Barging Facility.....	2
-----------	--	---

Figures

Figure 1.1	The broader environment of the Clyde Barging Facility (arrowed) (https://maps.six.nsw.gov.au/).....	1
Figure 1.2	Detail from Parramatta LEP Heritage Map 6250_COM_HER_015_010_20130325 showing the local heritage context. The relevant PAMUs have been noted (https://legislation.nsw.gov.au/maps/c8d69acc-15c7-6acb-bc00-dd356a46464f/6250_COM_HER_015_010_20130325.pdf).....	3
Figure 1.3	Detail of the PHALMS map of the relevant PAMUs.....	3
Figure 2.1	Undated parish map of St John, showing John MacArthur’s land. The approximate location of the study area is outlined and arrowed (http://images.mhttp://images.maps.nsw.gov.au/pixel.htm#).....	5
Figure 2.2	1844 plan showing the proposed continuation of Parramatta into Elizabeth Farm. King’s Wharf, Redbank and the study area are arrowed from left to right (Surveyor General’s sketchbook 4, folio 158 https://www.records.nsw.gov.au/image/nrs13886%5Bx757%5D_a110_000090).....	7
Figure 2.3	An 1885-1889 Auction advertisement for 380 acres of land within the area of Elizabeth Farm (National Library of Australia, Map F158, at http://nla.gov.au/nla.map-f158).....	11
Figure 2.4	A 1980map showing the route of the Redbank-Parramatta tramway. Note the detail in the bottom-right corner showing the layout of Redbank Wharf; here titled as ‘Parramatta Wharf’ (Charles 1986: 75).....	11
Figure 2.5	C.1914 photograph of Redbank Wharf, with a steam tram in the background (Bagot family photograph album B 28518 https://collections.slsa.sa.gov.au/resource/B+28518/45).....	12
Figure 2.6	Undated photograph of a screw-propelled ferry at Redbank Wharf (McClymont and Kass 2015: 67).....	12
Figure 2.7	C.1914 photograph of the passenger waiting shed at Redbank for the Redbank-Parramatta steam tram (Bagot family photograph album B 28518 https://collections.slsa.sa.gov.au/resource/B+28518/47).....	12
Figure 2.8	Undated photograph taken from the waiting shed at the Redbank Terminus, with the car shed and trams in the background (McClymont and Kass 2015: 67).....	13
Figure 2.9	Undated photograph of Steam Tram No 5A and mixed passenger and freight cars. Linseed loading at Redbank Wharf. Note the construction of the track. (Charles 1986: 75).....	13

Figure 2.10 1905 photograph of Steam Tram No 3 and two passenger cars at the Domain Park Gates, Parramatta (Charles 1986: 75).	13
Figure 2.11 1943 aerial photograph with the site of study arrowed.	14
Figure 2.12 2017 aerial photograph with the site of study arrowed.	14
Figure 2.13 1943 aerial photograph with the site of study outlined in red. Note the Redbank Terminus and associated buildings, wharf and track.	15
Figure 2.14 2017 aerial photograph with the site of study outlined in red.	15
Figure 3.1 Location of the Clyde Barging Facility on the Parramatta and Duck Rivers.	16
Figure 3.2 Plan showing the proposed layout for the Clyde Barging Facility Site (Transport for NSW).	17
Figure 3.4 Map showing the locations of the Shell Oil Refinery Jetties and Camellia Industrial Wharf (Wolfe and Associates 1992: 72).	19
Figure 3.5 Photograph taken in 1992 of timber wharf piling at the Shell Refineries Jetties location, looking southwest. The southernmost jetty base is at the back, and the central jetty base to the front. (Wolfe and Associates 1992: 90)	19
Figure 3.6 Recent photograph of timber piles at the Shell Refineries Jetties location.....	20
Figure 3.7 Photographs showing the Burwood rail line and Hunter Street tram track intersection, Newcastle, in 1940 (left), and as excavated by Umwelt in 2017 (right). Retrieved online from Umwelt at http://www.umwelt.com.au/inner-city-archaeology/ and http://www.umwelt.com.au/wp-content/uploads/Oct2017_News_E-726x368.jpg	20

1 Introduction

The Sydney Metro & City Southwest project is a 30km-long new rail system from Chatswood to Sydenham. Transport for NSW (TfNSW) is delivering the Project on behalf of the NSW Government and has commissioned John Holland CPB Ghella Joint Venture (JHCPBG) to undertake the Tunnelling and Station Excavation (TSE) works.

The Clyde Barging Facility is the subject of a Review of Environmental Factors (REF) under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) being prepared by JHCPBG. AMBS Ecology & Heritage (AMBS) has been commissioned by JHCPBG to prepare this Statement of Heritage Impact as supporting documentation to the REF.

1.1 The site

The Clyde Barging Facility will be located within the former Shell Refinery site, adjacent to the Parramatta River. The site lies at the confluence of the Parramatta River with the Duck River, within the Parramatta Local Government Area. It is approximately 15km west of the Sydney Central Business District (Figure 1.1). The site will be accessed by barges from the Parramatta River via an upgraded wharf, and by trucks by an upgraded access road which runs along the boundary of the former refinery.

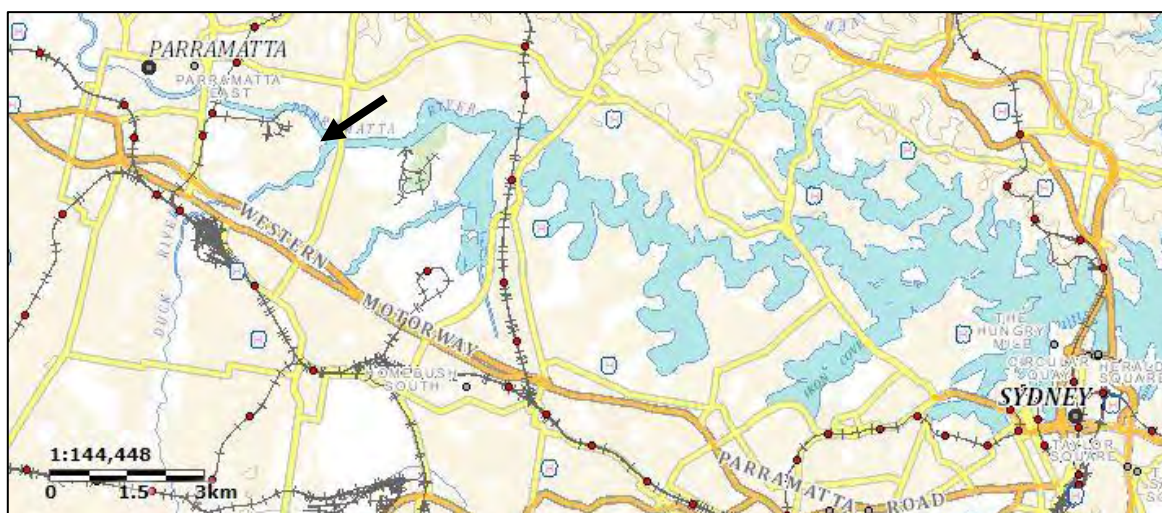


Figure 1.1 The broader environment of the Clyde Barging Facility (arrowed) (<https://maps.six.nsw.gov.au/>).

1.2 Heritage Context

The conservation and management of heritage items, places, and archaeological sites takes place within the framework of relevant Commonwealth, State or local government legislation. Non-statutory heritage lists and registers, ethical charters, conservation policies, and community attitudes and expectations can also have an impact on the management, use, and development of heritage items. The following describes the relevant statutory and non-statutory heritage listings for the study area.

The following statutory and non-statutory lists and registers have been reviewed to identify the location and significance of historic heritage items and places in the vicinity of the study area:

- National Heritage List (NHL)
- Commonwealth Heritage List (CHL)
- State Heritage Register (SHR)

- Maritime NSW Heritage & Conservation (Section 170) Register
- Sydney Regional Environmental Plan (SREP) (Sydney Harbour Catchment) 2005
- Parramatta Local Environmental Plan (LEP) 2011
- Parramatta Historical Archaeological Landscape Management Study (PHALMS)
- National Trust of Australia (NSW) Register
- Register of the National Estate (RNE)

The site of the Clyde Barging Facility is not listed on the NHL or CHL, nor the SHR. It is not listed on the non-statutory RNE or National Trust Register. In addition, there are no items within the near vicinity included on these lists or registers. However, it is included on the PHALMS, which is divided into areas of archaeological sensitivity identified as Parramatta Archaeological Management Units (PAMU) which are included in the relevant heritage listings tabulated below and illustrated in Figure 1.2 and Figure 1.3:

Table 1.1 Heritage Listing relevant to the Clyde Barging Facility.

ID	Item	Address	Listing
PAMU 2967	Manufacturing and Processing	Grand Avenue, Camellia, NSW 2142	PHALMS
PAMU2972	Tramway Avenue; Route of 1884 Tramline		PHALMS
PAMU2996	Parramatta and Duck Rivers	N/A	PHALMS
35	Shell Oil Refinery Wharf	Duck River, Rosehill, NSW 2142	SREP 2005
1	Wetlands	Parramatta River, Camellia	Parramatta LEP 2011
6	Tram alignment	Grand Avenue, Camellia	Parramatta LEP 2011
575	Capral Aluminium	3-11 Shirley Street, Rosehill	Parramatta LEP 2011
19254	Lower Duck River Wetlands	N/A	RNE

There are no further details regarding the above listings; however, the study area is within:

- **PAMU 2967**, which is described as being reclaimed swampland and an important area for the development of industry in Parramatta, including the Shell Oil Refinery; however, it has no identified archaeological potential.
- **PAMU 2972** which is described as the alignment of tramway on Grand Avenue and Grand Avenue North from James Ruse Drive to wharf at junction of Parramatta and Duck Rivers. It is likely that the tramline remains intact. Archaeological evidence is likely to be intact. Has moderate archaeological research potential.
- **PAMU 2996** which is a section of the Parramatta and Duck Rivers and is described as having moderate archaeological research potential for its association with early landscape modifications and transport and as having local significance.

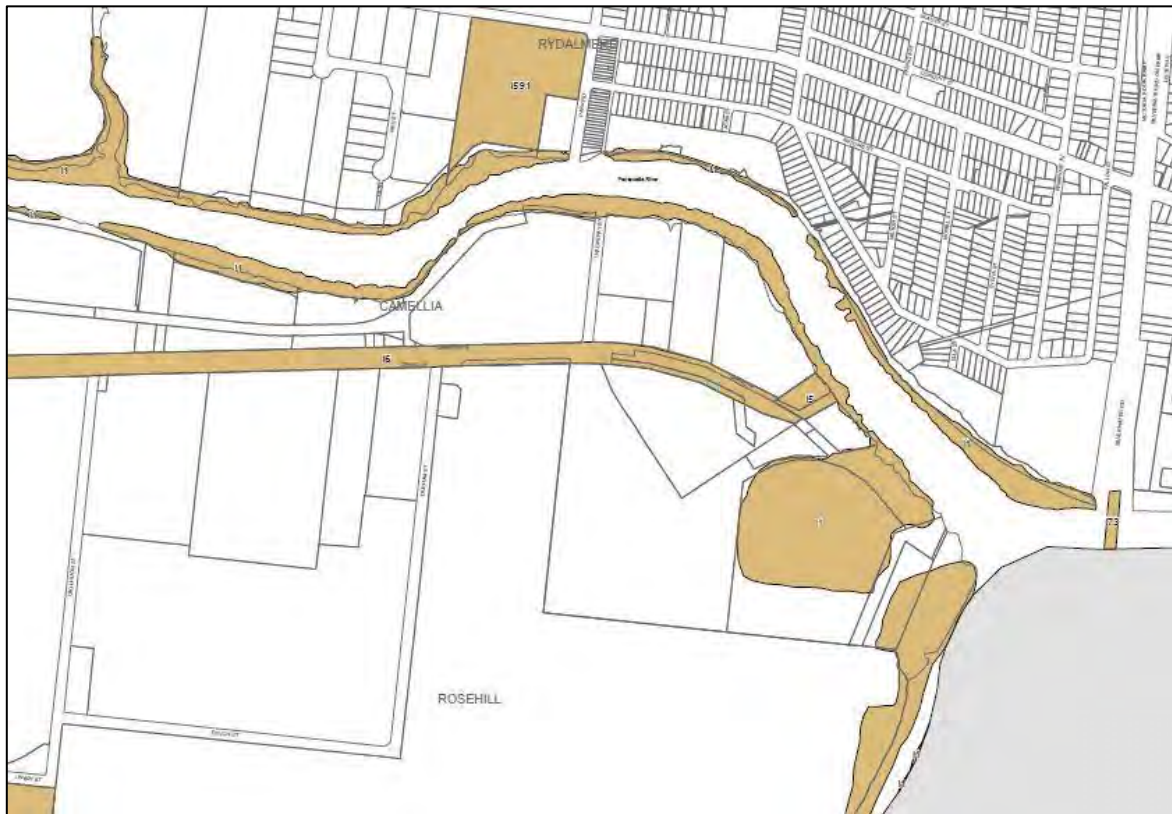


Figure 1.2 Detail from Parramatta LEP Heritage Map 6250_COM_HER_015_010_20130325 showing the local heritage context. The relevant PAMUs have been noted (https://legislation.nsw.gov.au/maps/c8d69acc-15c7-6acb-bc00-dd356a46464f/6250_COM_HER_015_010_20130325.pdf).

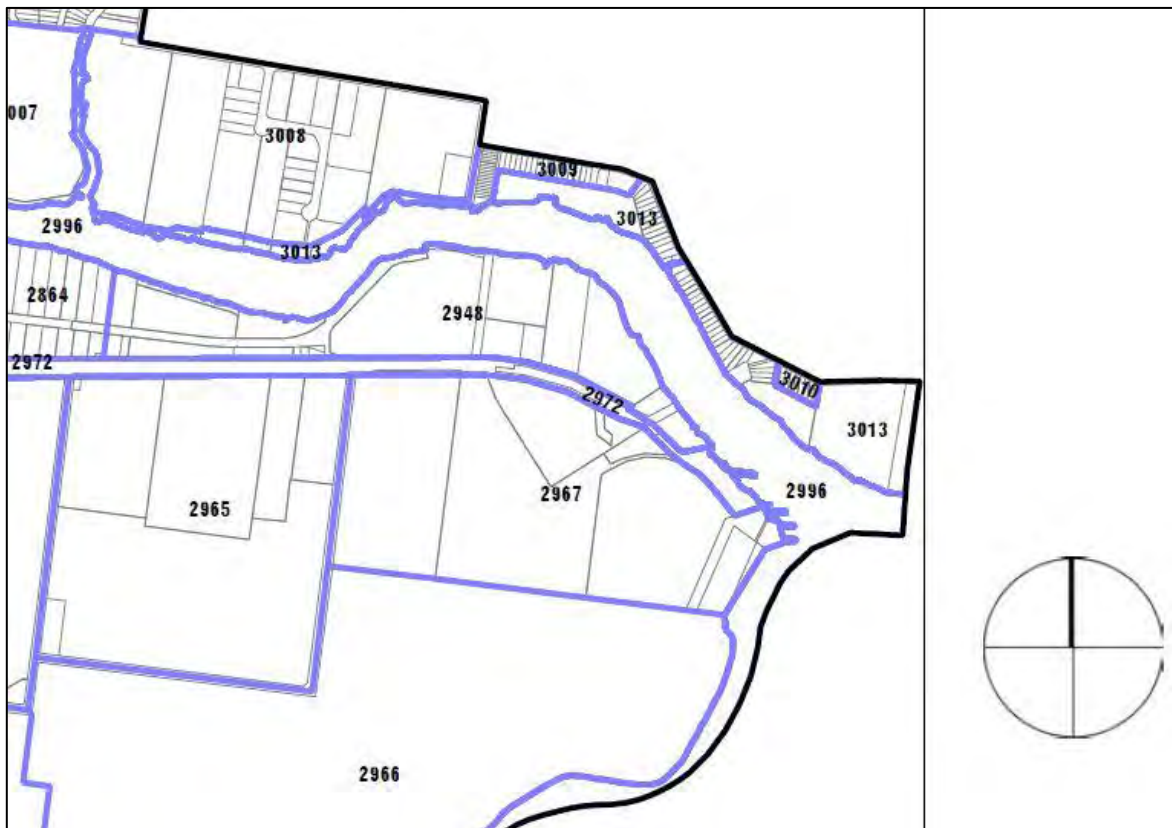


Figure 1.3 Detail of the PHALMS map of the relevant PAMUs.

1.3 Methodology & Authorship

This report is consistent with the principles and guidelines of the *Burra Charter: The Australian ICOMOS charter for the Conservation of Places of Cultural Significance 2013*. The report has been prepared in accordance with current best-practice guidelines as identified in the *NSW Heritage Manual (1996)*, published by the Heritage Office and Department of Urban Affairs and Planning, and associated supplementary publications, including *Statements of Heritage Impact (rev.2002)*.

This report has been prepared by AMBS Senior Archaeologist, Adam Pietrzak. Director Historic Heritage, Jennie Lindbergh provided technical advice and input, and reviewed the report.

2 Historic Context

2.1 The Elizabeth Farm Estate

The study area is part of the land granted to Lieutenant John MacArthur by acting Governor Major Francis Grouse. MacArthur was granted 100 acres of land in 1793, between the Duck and Parramatta Rivers, and an additional 100 acres the following year. Within three years MacArthur had purchased a further 300 acres, and had named his estate Elizabeth Farm, after his wife. He established a successful farming estate with a dairy, gardens, various crops, horses, cattle, and over a thousand sheep. In 1816, when MacArthur was granted a further 600 acres for contributions to the agricultural improvement of the colony, his estate was one of the largest in the area (Figure 2.1).

Following John MacArthur's death in 1834, the estate was inherited by his eldest son, Edward, a Lieutenant in the British Army. In his absence, the estate was successfully managed by John MacArthur's widow, Elizabeth. An 1844 plan in the Surveyor General's sketchbook shows a proposal to extend Parramatta eastwards across the Elizabeth Farm Estate, with roads extending east across to the foreshore. However, it would appear that this proposal was never carried out (Figure 2.2). Following Elizabeth's death in 1850, the estate agent Henry Curzon Allport leased the farmstead and grounds to various tenants on behalf of Edward. Following Edward's death in 1872, the farm was administered by trustees of the estate. In 1880 Elizabeth Farm, over 1000 acres of land, was sold to Septimus Alfred Stephen for 50,000 pounds. Between 1883-1884 Stephen subdivided and sold off the property.



Figure 2.1 Undated parish map of St John, showing John MacArthur's land. The approximate location of the study area is outlined and arrowed (<http://images.mhttp://images.maps.nsw.gov.au/pixel.htm#>).

2.2 Early Ferry Services to Parramatta

The first wharf to facilitate boat transport to Parramatta from Sydney Cove was established in 1788. The wharf, known as King's Wharf, was constructed from red gum logs laid up against the sandy bank of the Parramatta River, and was located west of the present Gasworks Bridge (Figure 2.2) (Dictionary of Sydney: King's Wharf). This was replaced in 1790 as river traffic increased by the

Queen's Wharf, which was moved to its present location, 250 metres to the east, in 1808, and later reinforced with sandstone. It remained in use until the 1920s (Dictionary of Sydney: Queen's Wharf).

The first river ferry, the Rose Hill Packet, was launched in 1789, sailing to Queen's Wharf with passengers and cargo from Sydney Cove. Although an overland track, the Parramatta Road, was created linking Sydney and Parramatta by 1791, the river remained a significant waterway. The often slow and laborious journey up the river was made easier in the 1830s, when steam-powered paddle-wheel ferries became common on the Parramatta River. Freight was carried separately to passengers as early as 1841 (Kass, Liston and McClymont 1994).

Gradual silting of the Parramatta River on the approach to Parramatta, past the confluence of the Parramatta and Duck Rivers, affected the ability of ferries to sail to the Queen's Wharf from the early 1840s, particularly at low tide. This would become a recurrent problem for river traffic. In 1842 a newspaper article stated that 'above Redbank any vessel drawing more than four feet is not safe. It is the general opinion, that a few barrels of gunpowder and 100 men from Hyde Park Barracks would take one month to make Her Majesty's Wharf at Parramatta accessible for any vessel drawing not more than six feet water' 1842 (*The Sydney Morning Herald* [SMH], 30 November 1842: 2). Instead of docking at the Queen's Wharf, ferries would stop at Redbank at low tide, where the River was deeper, allowing passengers to continue the journey to Parramatta by horse and cab (*The Star and Working Man's Guardian*, 31 August 1844: 3). Disembarking at Redbank was evidently not desirable, as the steamer 'Native', was advertised with the claim that it was the 'only boat that never subjects her passengers to the landing at Redbank' (SMH, 16 December 1844: 1).

It is unlikely that the 'redbank' stop used by the early ferries was at the same location as the later study area or the Redbank Steam Tram Terminus (Figure 2.2). A 1790 chart of Parramatta River by William Bradley labels a location to on the south bank of the Parramatta River, northwest of the study area as '*Red Bank Clay Cliff*' (Bradley 1802). This same area is labelled as 'red bank' on a c.1820 chart (Wolfe and Associates 1992: 57), and as 'redbank' on an 1844 sketch by the Surveyor General, suggesting that this was the accepted name of a specific location on the riverbank, rather than a more general term (Figure 2.2). The name likely derives from the exposed red clay face of the cliffs at this bank.



Figure 2.2 1844 plan showing the proposed continuation of Parramatta into Elizabeth Farm. King's Wharf, Redbank and the study area are arrowed from left to right (Surveyor General's sketchbook 4, folio 158 https://www.records.nsw.gov.au/image/nrs13886%5Bx757%5D_a110_000090).

The silting of waterways was a recurrent problem, and from 1842 to 1844 a steam-powered dredging machine attached to a watercraft was employed in Sydney, at a cost of £9000. It used two punts of 40 tonnes each, and employed twenty-five convicts drawn from Hyde Park Barracks, who were fed and lodged on board the craft. It was employed on the Parramatta River and at Sydney Cove. From the 21st August to the 10th November 1843, it dredged 'at intervals at the mouth of Duck River, Parramatta River'. Here it was in operation for nine weeks and four days removing 4240 tons of earth. It was then employed at Redbank, Parramatta River, until the 21st December, working for four weeks and two days to and removing 2080 tons of earth. It was later at work for fourteen weeks along the Parramatta River (SMH, 19 October 1844: 2).

This dredging programme seems to have been effective initially as a newspaper advertisement on August 1844 announced 'that arrangements have been made to discontinue the practice of landing and receiving Passengers, as heretofore, at Redbank', as well as the associated Town Coach service. Instead, ferries would now again be able travel further up the river to Queen's Wharf (*The Star and Working Man's Guardian*, 31 August 1844: 3).

However, the dredging does not seem to have been effective for long and in 1846 ferries were again stopping at Redbank at low tide. It was remarked that to disembark 'passengers have to climb or descend a very steep ladder, dangerous in dry weather to those who are not very sure footed, and in wet weather is particularly slippery, whereby there is a great hazard of fractures of limbs, if no more serious occurrence' (SMH, 21 August 1846: 2).

In 1846 moves were made to improve the land situation at Redbank, with a newspaper article stating that 'preparations are being made for a platform being erected [at Redbank] and which is to be approached by a road being cut from the high land adjoining thereto' (SMH, 21 August 1846: 2). By 1848 there is a wharf established at Redbank, which was served by a new four horse coach called the 'The Duke of Grafton', capable of carrying 40 people. This replaced an older coach. An 1848 article comments that 'in wet weather the wharf at Redbank is always in a dreadful state; the

descent to it being rather deep, it was yesterday like sliding down a glacier. A few tons of metal would at once remedy this' (*SMH*, 21 January 1848: 3). The location of the 1846 wharf is not certain, but it is likely that it was located at 'redbank' as labelled on the 1790 and 1844 plans, to the northwest of the study area.

It is apparent that by the 1850s there were two wharves at red bank, one apparently of recent construction. In a 1920 newspaper article Walter Campbell reminisces about his childhood in Parramatta in 1854-1856. He states that 'At high tide, steamers were brought to the wharf at the foot of George-street. At half-tide they came to the "New wharf," opposite Subiaco, and at very low tide to a rickety sort of wharf at Redbank midway between the new wharf and Duck River. A coach of some sort conveyed passengers from the two latter wharves to town.' (*The Cumberland Argus and Fruitgrowers Advocate*, 1 December 1920: 4).

With the competition of the railway to Parramatta in 1855, ferry companies such as the Parramatta Steamboat Company were forced to introduce faster, screw-propelled ferries to remain competitive (McClymont and Kass. 2015: 66). Ferries continued to stopped at Redbank at low tide, and throughout the 1850s there were complaints that the coach and horses provided were not sufficient to accommodate the numbers of passengers disembarking at Redbank, and that disembarking was dangerous 'for want of proper landing accommodation' (*SMH*, 15 April 1854: 5; *Empire*, 22 March 1853: 2).

In the late 1860s, the silting of the Parramatta River from Redbank to Queen's Wharf led the people of Parramatta to campaign for the dredging of this section of the river (*Sydney Mail*, 13 June 1869; *SMH*, 22 August 1872). This was undertaken in a limited area in 1873, and the silt was used to 'fill up some of small bays to make a straighter run for the river water' (*SMH*, 21 August 1877: 3).

2.3 The Redbank-Parramatta Tramway

Although the section of the Parramatta River from Redbank to Queen's Wharf was steam dredged in the early 1870s, it was still very difficult to navigate at low tide. Charles Edward Jeanneret (1834-1898) was the manager of the Parramatta and River Steamship Company, which he bought in 1875, and the company ran one of the largest fleets of ferries operating in Sydney. In the 1870s he operated a fleet of steam-powered bow-paddle-wheel ferries from Sydney to The Queen's Wharf in Parramatta. Faced with increasing competition from the railways, and the difficulty of navigating the Parramatta River west of Redbank, Jeanneret decided to invest in screw-propelled ferries, and a steam tramway to facilitate travel from Redbank to Parramatta, bypassing the section of river that was silting up (Kass T, Liston C and McClymont: 1996).

The Parramatta Borough Council approved of Jeanneret's plan for a tramway, and in August 1881 the NSW Parliament passed a private bill, Jeanneret's Tramway Act, authorising the construction and maintenance of the tramway. It was to be the first private tramway in the colony. The Act stated that the track should be the same gauge as the Government tramways, and that it should be laid at the general level of George Street, of which the area on which the tram ran should be 'maintained in perfect order and repair' (*SMH*, 7 July 1851: 5). The Act allowed for a maximum fare of 3d per passenger and 1 shilling per ton for goods or part thereof, and legislated a minimum of six services a day.

The contractor for the work was Thomas Wearne. George Morell was the superintending engineer in charge of the construction of the line, and working under Morell was John Wright, who held the position of engineer-in-charge. The cost of the tramway and engines was £20,000.

There was delay in the opening of the line due to additional work being required for the improvement of the ballasting on that part of the line leading from the outskirts of the town to Duck River, and the line opened on 01 October 1883. It ran to the Domain gates in Parramatta from

a wharf and facilities established at Redbank, at the confluence of the Parramatta and Duck Rivers. It ran along a right of way leased from the Elizabeth Farm Estate, crossing a specially built bridge over Clay Cliff Creek (Dictionary of Sydney: Camelia). The route was 2 miles and 66 chains long (4.5 kilometres), and the journey took 17 minutes to complete. A newspaper article from the day after the tramway opened describes the method of its construction:

The line is laid in two sections, one from the park gates to the end of George-street is a mile in length, and on this the rails are laid in a manner similar to the plan adopted in Sydney, with the exception that instead of the rails resting on a layer of concrete the width of the line, they are placed upon a longitudinal bed of concrete 18 by 6 inches. The road is then filled in as usual with ballast and tarred metal and screenings, which give it a firm and compact appearance. The second section of the line [within the study area] is similar in construction to a light railway. The rails weigh 42lbs. to the yard, the gradients are easy, and the ballasting is of the ordinary description, and apparently well laid. Vignolie's steel rails are the rails used on the line and they are laid upon ordinary hardwood sleepers, 18 x4 (SMH, 2 October 1883: 5).

The article describes the Redbank Terminus as follows:

A very complete waiting room has been built at the river terminus of the line. There the arrangements which have been made for the public are very commendable, and connected with this waiting room is a very substantially-built wharf, constructed for the accommodation of goods as well as passengers. There are 14 feet of water at the wharf at ordinary high tide and eight or nine feet at low tide, and with the aid of a derrick, goods brought by the steamers will be loaded into trucks upon the wharf, whence they will be taken on the tram line to Parramatta (SMH, 2 October 1883: 5).

An 1885-1889 Auction advertisement for the area of the Elizabeth Farm Estate later occupied by the shell oil refinery shows the tramway running northwest from Redbank Wharf, which is shown as a single wharf, before curving to the west to run straight west to Parramatta (Figure 2.3). The 1883 newspaper account also appears to describe a single wharf (SMH, 2 October 1883: 5).

With the subdivision of the Elizabeth Farm estate in the 1880s, the steam tramway became an important factor in attracting industry to Camellia. Jeanerette sold his interests in the tramway to the Parramatta River Steamers and Tramways Company in 1889. In 1901 the ferry and jetty were acquired by the Sydney Ferries Company. A large area of the Elizabeth Farm Estate was sold to the Commonwealth Oil Corporation in 1908, who were attracted by its river frontage and proximity to the Parramatta tramway. One of their clients was Meggitts Pty Ltd, who opened a linseed processing mill in George Street, Paramatta in 1909. Industrial customers such as Meggitt's Limited at Parramatta depended on the tram and ferry for the transport of goods and materials. Meggitts Limited were manufacturers of linseed oil and associated products used as lubricants, as a base for paint and in the manufacture of linoleum. Meggitts used the tramway to transport its products to and from their base on the block bordered by Macquarie, O'Connell and George Streets, to the Redbank wharf. In 1916, the Municipality of Granville constructed a new road, Grand Avenue, which formalised a large section of the Tram route.

After the First World War, factories were erected at Rose Hill and Sandown, and traffic on the tram increased due to industrial demand. A large number of goods sidings were constructed running off the main Tramway and into factories including Meggitts Oil Cake Factory, Wesco Factory, Sandown Meatworks, Goodyear, Cream of Tartar Works, and Anchau's Tannery. It is likely that a second wharf, to the north of the original wharf, was constructed specifically for goods during this time. An undated plan of Redbank Wharf shows that it later comprised two wharves, one for passengers and one for freight, and several buildings (Figure 2.4). The buildings included a station, a waiting shed, a shed for locomotives and passenger-cars, and a shed for goods. Photographs of the wharf

and riverbank at the terminus taken in c.1914 show that it comprised a gently sloping natural bank. At present this area riverbank is level and is fronted by degraded sheet pile. It appears that the bank was reclaimed and straightened after 1914, possibly in 1923 when the Shell Oil Refinery was constructed.

Siltation and shallowing was such that the ferry service all the way to Parramatta was withdrawn in 1928, with all ferries stopping at Redbank. In 1932 the great depression and the construction of the Sydney Harbour Bridge led to reduced traffic on Sydney Ferries Ltd services, who had purchased the steam tram. This led to the decision to suspend ferry services running to Redbank Wharf, with the exception of a tourist ferry on weekends and holiday afternoons. This service was advertised as including, 'a boat trip up the Parramatta River; a mile ride in Australia's oldest steam tram and a 15-mile motor-tour visiting all the major points of scenic and historic interest in Parramatta'.

The tramway was closed on 31 March 1943, and on 14 March 1945 the Jeanneret Tramway Act was repealed). It was the last stream tram to operate in New South Wales, and had been operating for 64 years. At 1943 auction five tramcars, complete with stained glass, were sold for £45, three locomotives for £375, and two heaps of coke for £10.

A 1943 aerial photograph provides a view of the Redbank terminus at the steam tram's last year of operation. At this time the terminus comprised five wharves and several buildings, including the car and engine sheds and passenger waiting room (Figure 2.13).

Wolfe and Associates state that the wharf and surrounding land were requisitioned by the American military as a camp, with the intention that supplies would be brought to the site via the wharf. After the war the tramway was incorporated into the New South Wales Railway Service. The wharf was taken over by the Maritime Services Board, and continued to service industry including the Shell Oil Refinery (Wolfe and Associates 1992: 10). The Shell Oil Refinery was established at the site in 1925, and became the largest in Australia. During the 1980s the refinery went through a period of major rationalisation, with a large number of refinery units closed or merged. Between 1983 and 1984 the refinery's chemical plants were closed, resulting in redundancies for approximately 120 plant operators, as well as the warehouse storemen who had been responsible for packaging and distributing the refinery's chemical products. The wharf was demolished during this time. The Shell Oil Refinery was shut down in 2011 and converted into a fuel import facility.

Following a programme of dredging in 1992, catamaran ferries were introduced by the State Transit Authority and the ferry service to Queen's Wharf was resumed. However, while dredging in the 1990s had made the upper river accessible, the service there would again become dependent upon tidal access with ever more frequently ferries terminated at Rydalmere east of Parramatta.

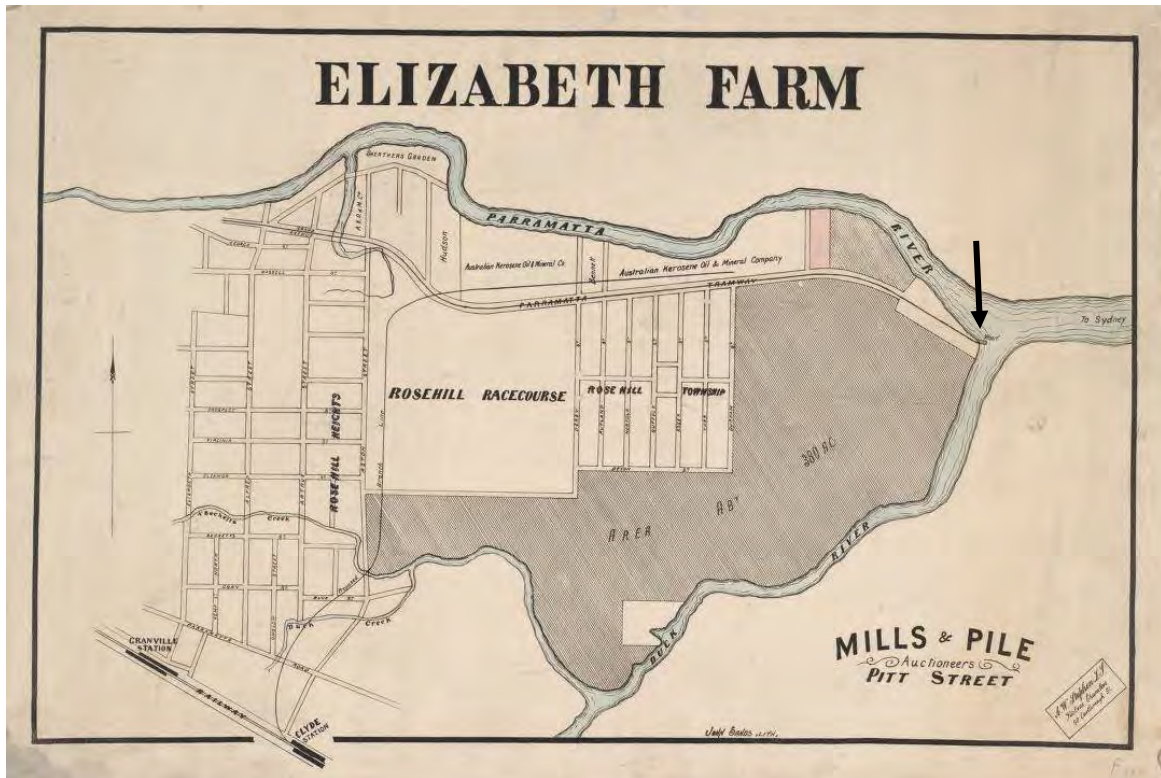


Figure 2.3 An 1885-1889 Auction advertisement for 380 acres of land within the area of Elizabeth Farm (National Library of Australia, Map F158, at <http://nla.gov.au/nla.map-f158>).

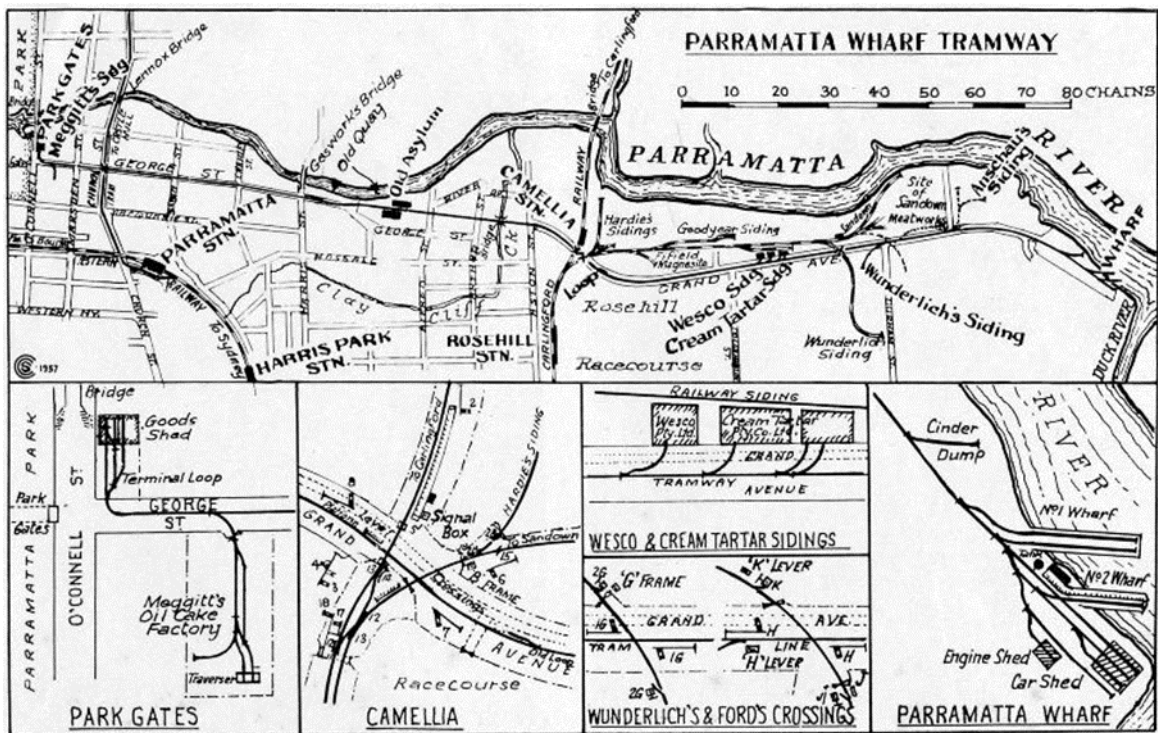


Figure 2.4 A 1980 map showing the route of the Redbank-Parramatta tramway. Note the detail in the bottom-right corner showing the layout of Redbank Wharf; here titled as 'Parramatta Wharf' (Charles 1986: 75).



Figure 2.5 C.1914 photograph of Redbank Wharf, with a steam tram in the background (Bagot family photograph album B 28518 <https://collections.slsa.sa.gov.au/resource/B+28518/45>).



Figure 2.6 Undated photograph of a screw-propelled ferry at Redbank Wharf (McClymont and Kass 2015: 67).



Figure 2.7 C.1914 photograph of the passenger waiting shed at Redbank for the Redbank-Parramatta steam tram (Bagot family photograph album B 28518 <https://collections.slsa.sa.gov.au/resource/B+28518/47>).



Figure 2.8 Undated photograph taken from the waiting shed at the Redbank Terminus, with the car shed and trams in the background (McClymont and Kass 2015: 67).

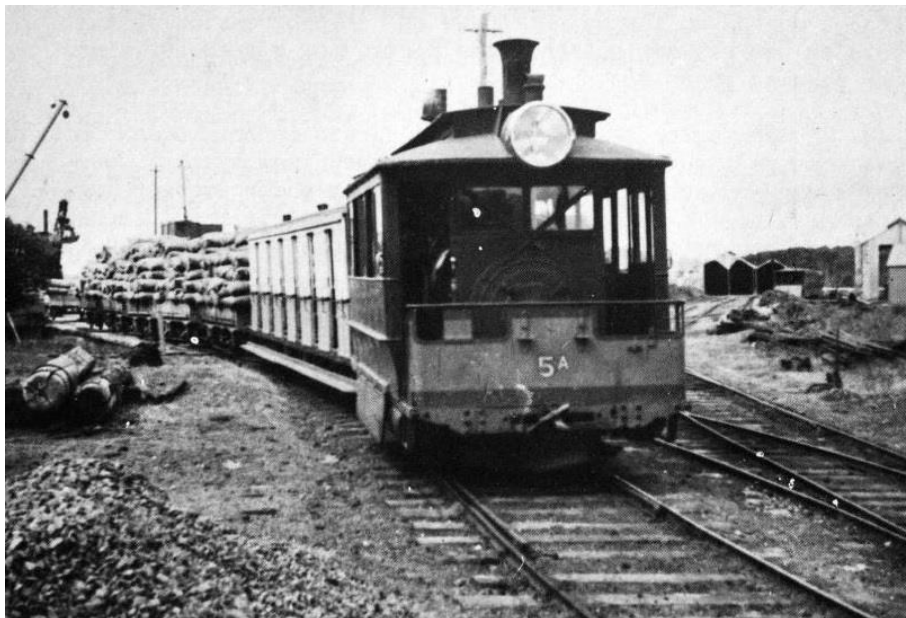


Figure 2.9 Undated photograph of Steam Tram No 5A and mixed passenger and freight cars. Linseed loading at Redbank Wharf. Note the construction of the track. (Charles 1986: 75).



Figure 2.10 1905 photograph of Steam Tram No 3 and two passenger cars at the Domain Park Gates, Parramatta (Charles 1986: 75).



Figure 2.11 1943 aerial photograph with the site of study arrowed.



Figure 2.12 2017 aerial photograph with the site of study arrowed.

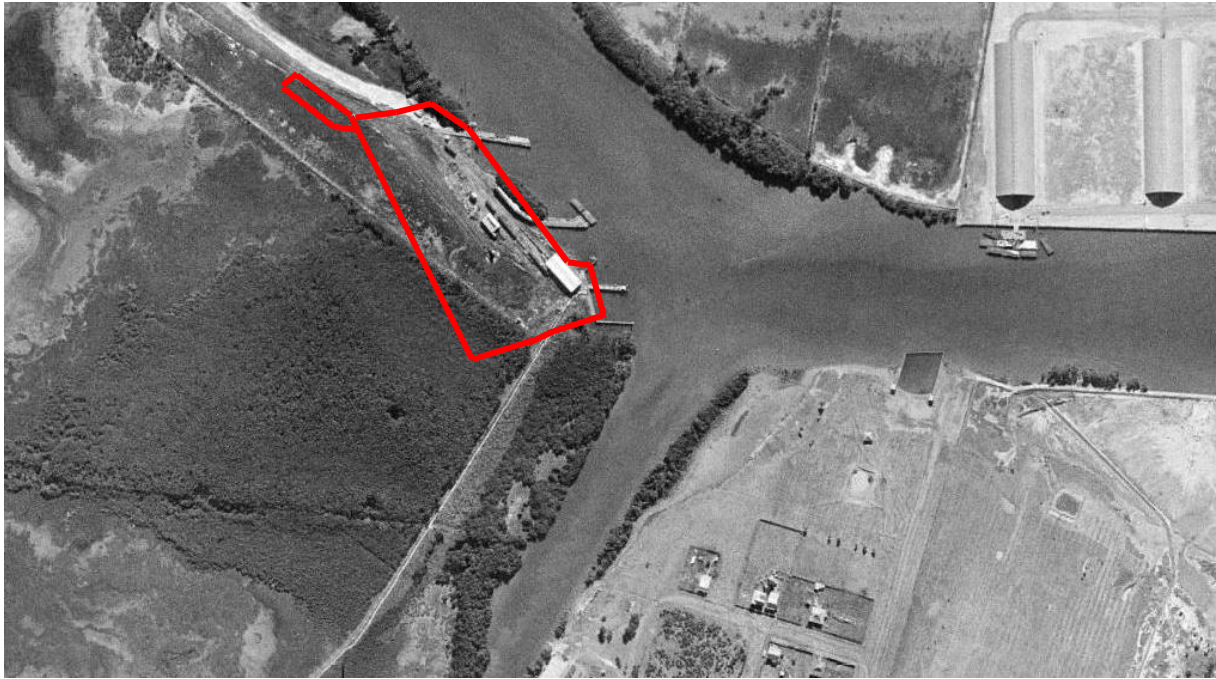


Figure 2.13 1943 aerial photograph with the site of study outlined in red. Note the Redbank Terminus and associated buildings, wharf and track.



Figure 2.14 2017 aerial photograph with the site of study outlined in red.

3 Analysis of the Proposal

The proposed Clyde Barging Facility has the potential to have an impact on archaeological sites PAMUs 2967 (former Shell refinery site, part of), 2972 (historic tramway) and 2996 (Parramatta and Duck Rivers).

3.1 Scope of Works

The site of the Clyde Barging Facility at the confluence of the Parramatta and Duck Rivers in the north-eastern area of the former Shell Refinery site. The site would be used to receive laden spoil barges from the Barangaroo and Blues Point Sydney Metro TSE Worksites, and to facilitate the transfer of plant and equipment including Tunnel Boring Machine(TBM) components, and static and mobile plant and equipment.

Clean spoil material will be loaded by conveyor onto barges at Barangaroo and Blues Point and transferred to the Clyde Barging Facility where it will be loaded into trucks and transferred to approved off site locations for reuse. The Blues Point shaft excavation, constructed for the purpose of TBM extraction, is estimated to produce 12,000 tonnes of spoil, which would also be transferred by barge to the Clyde Barging Facility.

In order to facilitate these operations a number of site establishment works are required. In addition to the site, an existing access road to Grand Avenue will be widened and extended, and an existing wharf will be extended to the south. The proposed site establishment works are:

- Installing concrete barriers, fencing and environment controls
- Removing some casuarinas along the access road and small stands of trees within the worksite
- Upgrading the access road involving earthworks, and upgrading drainage
- Minor earthworks to level the loading area
- Upgrading the existing wharf to cater for the barges.
- Installing a site office, amenities and a weighbridge at the site entry on Grand Avenue.



Figure 3.1 Location of the Clyde Barging Facility on the Parramatta and Duck Rivers.

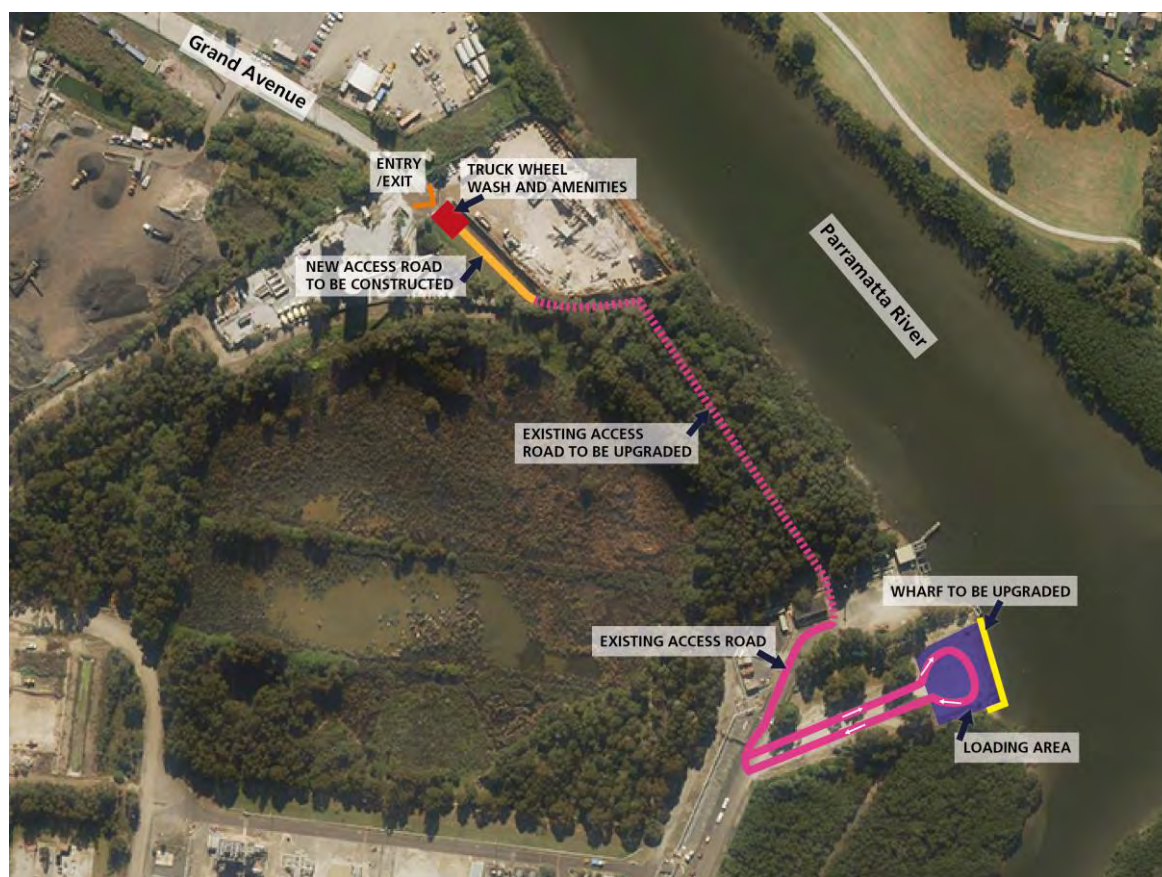


Figure 3.2 Plan showing the proposed layout for the Clyde Barging Facility Site (Transport for NSW).

3.2 Previous studies

An important aspect of these PAMUs are the wharves associated with the tramway and the refinery on the Rivers.

3.2.1 *The Parramatta River Maritime Archaeological Works Project*

In the early 1990s, it was proposed to dredge Parramatta River west of the Duck River, to facilitate ferry access to Queen's Wharf for the first time since ferry services ceased in 1923. As a part of the proposal an Environmental Impact Statement was prepared, which recommend that maritime archaeological test excavations be carried out at five sites along the banks of the Parramatta River, prior to dredging (Gutteridge, Haskins, and Davey 1990; 1991). These excavations, and excavations at an additional six sites identified during the course of works, were undertaken by Wolfe and Associates and were published as an interim report in 1992 (Wolfe and Associates 1992). The final report was published in 1993 (Bower and Staniforth).

Two of the eleven sites excavated by Wolfe and Associates are relevant to this study (Figure 3.3). These are the sites identified as 'The Shell Oil Refinery Jetties, Silverwater', and 'The Industrial Wharf, Camellia'. Prior to the excavations, the Oil Refinery Jetties were identified as the possible location of the 1883 wharf of the Redbank-Parramatta tramway. The report states that communications with the Maritime Services Board revealed that at some point between 1970 to 1990 the river bed adjacent to both sites was dredged to a depth of over two metres, to facilitate the berthing of lighters. However, this claim could not be substantiated in 1992 as the board was unable to provide access to records.

The site of the Shell Refinery Jetties was identified by Wolfe and Associates as the location of three timber jetties which, the authors stated dated from 1925 and associated with the construction of

the Shell Oil Refinery (Figure 3.4). These were demolished in the 1980s, but in 1992 the jetty piles were still visible. It was suspected that these represented the site of an 'earlier jetty, or wharf, which was built in the 1880s to service the Parramatta Tram'. A series of circular searches of the river bottom were made, during which two timber piles, 1.17m from the bank at the base of the central jetty were identified. At the base of each of the three jetties, 1m from the bank, a caisson was located, and the silts were excavated to a depth of two metres. The sediment was reported to be heavily contaminated with an unidentified oil-like substance and plastic rubbish. The diver employed to excavate at the site suffered minor skin burns to his upper body, which were attributed to contact with the oil-like substance. It was concluded that 'no evidence could be found to suggest the presence of maritime/ underwater archaeological material. Further, no physical evidence of historical evidence could be found to suggest that this site was the river terminus for the Parramatta Tramway, or the embarkation or disembarkation point for the Sydney ferry' (Wolfe and Associates 1992: 9).

The site identified as the 'Camellia Industrial Wharf' comprised an extant timber jetty, noted to be in poor repair and incorporated into a later timber wharf structure. The jetty was 10m wide and 13.56m long. The report states that the history of the jetty and wharf was unknown. However, the authors examined an undated plan of the tramline to suggest that this wharf was the location of the Redbank Terminus (Wolfe and Associates 1992: 9-12).

Although Wolfe and Associates identify The Camellia Wharf as the location of the Redbank Terminus, this may not be the case. Wolfe and Associates rely on an undated plan of the Tramway, which may have been drawn in 1980 (Wolfe and Associates 1992 84, Map 2, reproduced from Manny and Irwin 1980; reproduced in this report as Figure 2.4). However, historic maps including the 1885-1889 auction advertisement, and the 1943 aerial photograph clearly show that the Redbank Terminus and wharves are located further to southeast, at the location identified by Wolfe as 'Shell Refinery Jetties' (see Figure 2.3 and Figure 2.13 above). In addition, the form and size of the extant Camellia Wharf is very different to the Redbank Wharf as shown in historic photographs (Figure 2.5, Figure 2.6 above).

The dating of the three Shell Refinery Jetties is not certain. Although, Wolfe and Associates identify them as having been built in 1925, they may be earlier (Wolfe and Associates 1992: 9). The southernmost jetty, which lay adjacent to the study area, is similar in location and size to the 1883 Redbank Wharf as shown on historic plans and images. It is possible that this is the Redbank Wharf, especially as no evidence of earlier wharves was found by Wolfe and Associates. The central and northern wharves, which lie outside the study area, were likely constructed in the early twentieth century, when the tramway was increasingly used by industry in the area as separate wharves for cargo. The wharves were demolished in the 1980s, but in 1992 the substantial timber pilings of all three wharves were extant. A recent inspection of the site confirms that timber piles are extant at the site (Figure 3.5).

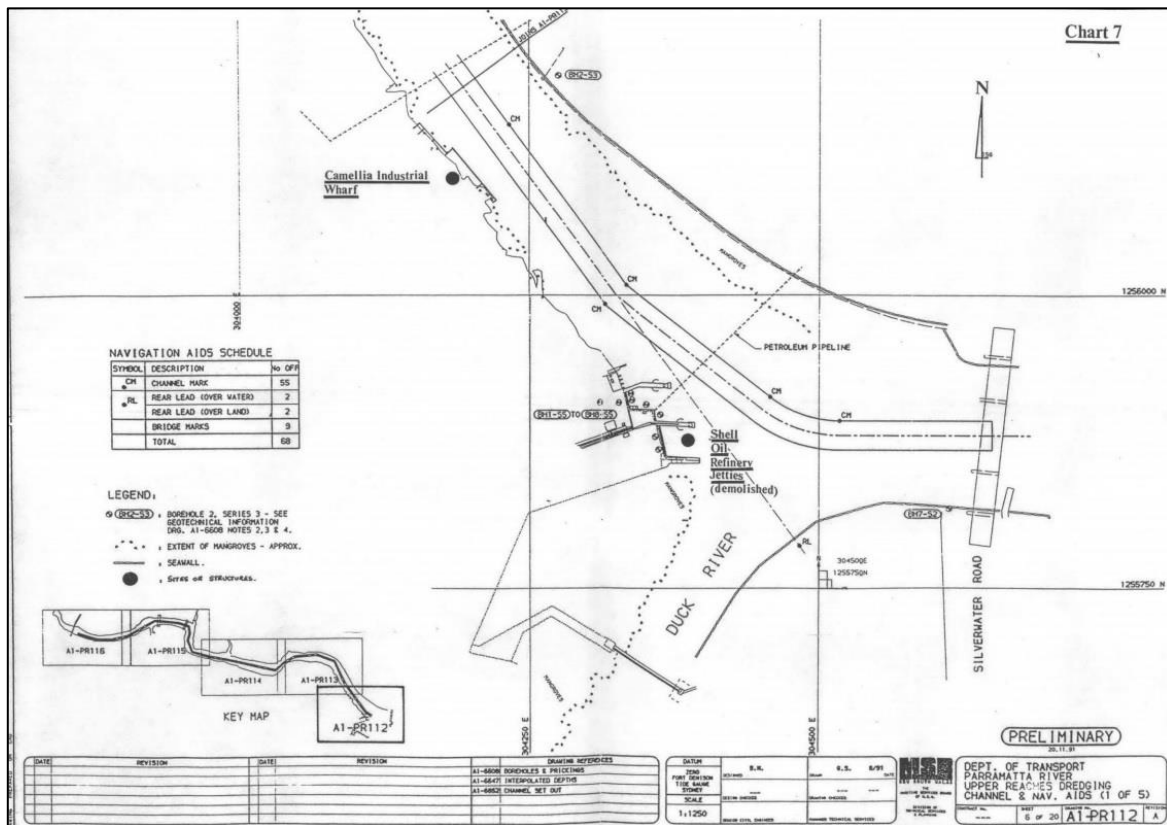


Figure 3.3 Map showing the locations of the Shell Oil Refinery Jetties and Camellia Industrial Wharf (Wolfe and Associates 1992: 72).



Figure 3.4 Photograph taken in 1992 of timber wharf piling at the Shell Refineries Jetties location, looking southwest. The southernmost jetty base is at the back, and the central jetty base to the front. (Wolfe and Associates 1992: 90)



Figure 3.5 Recent photograph of timber piles at the Shell Refineries Jetties location

At its peak the Sydney tramway system was the second largest in the British Empire and the Southern Hemisphere. In its busiest years in the mid-1940s over 404 million fares were sold, but network was eventually dismantled and the last tram in Sydney ran in 1961. The Sydney tram network has since become the subject of academic interest (Howard 2012). Sections of former tramline in Sydney and other cities in Australia have been exposed archaeologically, and are often of research and local interest. On 03 March 2017 the Sydney Light Rail project uncovered 70 metres of former track at ANZAC Parade, Kensington, which was removed and taken to the Australian Tramway Museum (Sydney Tramway Museum 2017). In addition, a section of tram track was also exposed in 2017 by Umwelt in Newcastle (Figure 3.6).



Figure 3.6 Photographs showing the Burwood rail line and Hunter Street tram track intersection, Newcastle, in 1940 (left), and as excavated by Umwelt in 2017 (right). Retrieved online from Umwelt at <http://www.umwelt.com.au/inner-city-archaeology/> and http://www.umwelt.com.au/wp-content/uploads/Oct2017_News_E-726x368.jpg

4 Assessment of Heritage Impact

Within the footprint of the Clyde Barging Facility are parts or sections of local heritage Items 6 (the tramway alignment listed on the LEP, Item 35, the Shell Oil Refinery Wharf, listed on the SREP and PAMUs 2967, 2972 and 2996 (PHALMS). As identified in this report, there is potential for physical remains of early wharfage and tram tracks associated with the local heritage items and PAMUs to be extant. These items can be identified as associated with the Redbank Terminus.

The proposed works have the potential to remove archaeological remains of local significance relating to the Redbank-Parramatta tramway, terminus and wharf.

In 2009, the *Heritage Act 1977* was amended with changes to the definition of a 'Relic'. The Tramway, Terminus and wharf are now classified as 'works'; however, that the tramway and wharf are identified local heritage items on the LEP and SREP, consideration should be given to their protection.

As described in the scope of works, earthworks will remove relatively shallow overburden which, or not, expose tramway track, and the wharf extension will entail piling around the existing piles, which would be retained in situ.

As such, it is unlikely that significant relics associated with the tramway will be exposed and the it is recommended that an Unexpected Heritage Finds Procedure is implemented.

4.1 Consultation

Under Section 111 of the EP&A Act, Transport for NSW, as proponent and determining authority for the project, must examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity. Clause 228(2)(e) of the *Environmental Planning and Assessment Regulation 2000* states that, for the purposes of Part 5 of the EP&A Act, the factors to be taken into account when consideration is being given to the likely impact of an activity on the environment include:

any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations.

Parramatta Local Council should be consulted regarding impacts on local heritage items, provided that the impact is not minor or inconsequential. This report has concluded that impacts to the local heritage items would be minor. As such Transport for NSW is not required to consult with Council regarding these heritage items.

Bibliography

Australia ICOMOS (2013) *Burra Charter: The Australia ICOMOS charter for the conservation of places of cultural significance*, 2013 Burwood, VIC.

Bradley, W (1802) *A Voyage to New South Wales* Drawing 11: 'The Channel to Rose Hill from the beginning of the flats at the head of Port Jackson from the wharf where Stores are landed for Rose Hill: Survey'd 1 Jan'y 1790.', accessed online at The State Library of New South Wales, at <http://archival.sl.nsw.gov.au/Details/archive/110314967>

Bower, R and Staniforth, M. (1993) *Report of the maritime archaeological survey of areas of the upper Parramatta River affected by dredging for the Rivercat ferry service*. Department of Transport, Marine and Air Division; Sydney.

Charles, M. (1986) *Old Parramatta*. Atrand, Sydney.

Dictionary of Sydney, n.d.

King's Wharf (https://dictionaryofsydney.org/structure/kings_wharf_parramatta)

Queen's Wharf (https://dictionaryofsydney.org/structure/queens_wharf_parramatta)

Camellia (<https://dictionaryofsydney.org/entry/camellia>)

Gutteridge, Haskins and Davey (1990) *Environmental impact statement for the extension of ferry services on the Parramatta River, west of Silverwater bridge*.

Gutteridge, Haskins and Davey (1991) *Environmental impact Statement for the dredging of the Parramatta River to permit the operation of the Parramatta River ferry service*. Two volumes.

Heritage Branch Department of Planning (2009) *Assessing Significance for Historical Archaeological Sites and 'Relics'*.

Howard, P (2012) *A 'Tram Massacre': Institutionalised destruction in Sydney, 1955–1961*. Archaeology in Oceania: volume 47, issue 2.

Kass, T, Liston, C and McClymont, J (1996) *Parramatta: A Past Revealed*. Parramatta City Council.

Manny, BL, and Irwin, B S (1980) *Past and Present: The Story of the Trams of Parramatta*.

McClymont J and Kass, T (2015) *Pictorial History: Parramatta and District*. Kingsclear Books.

NSW Office of Environment and Heritage (n.d.) State Heritage Inventory

PAMU 2967

<http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=2242967>

PAMU2972

<http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=2242972>

PAMU2996

<http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=2242996>

TROVE National Library of Australia (<http://trove.nla.gov.au/?q=>)

Sydney Tramway Museum. (2017) Online at: <https://www.sydneytramwaymuseum.com.au/tramfans/recovery-of-old-sydney-tramway-rails-from-kensington/>

Wolfe and Associates. (1992) *The Parramatta River maritime archaeological works project: interim report*, prepared for the Department of Transport, New South Wales.

Appendix E– Aboriginal heritage assessment



Sydney Metro, City & Southwest: Clyde Barging Facility Aboriginal Heritage Due Diligence Assessment

Prepared by AMBS Ecology & Heritage
for John Holland CPB Ghella Joint Venture

Final

December 2017

AMBS Reference: 16315

Document Information

Citation:	AMBS Ecology & Heritage (2017) <i>Sydney Metro, City & Southwest: Clyde Barging Facility Aboriginal Heritage Due Diligence Assessment</i> . Consultancy report to John Holland CPB Ghella Joint Venture.
AMBS Ref:	16315
Versions:	Version 1: Draft Report issued 1 December 2017 Version 2: Draft Report issued 6 December 2017 Version 3: Final Report issued 8 December 2017
Recipient:	Robert Muir, Senior Environment Coordinator, John Holland CPB Ghella JV
Approved by:	Christopher Langeluddecke, Director Aboriginal Heritage, AMBS Ecology & Heritage

Contents

1	Introduction	1
1.1	Study Area & Proposed Works.....	1
1.1.1	Site Establishment Works.....	1
1.2	Methodology & Authorship.....	1
2	Statutory Context	6
2.1	Environment Protection and Biodiversity Conservation Act 1999	6
2.2	National Parks and Wildlife Act 1974 & National Parks and Wildlife Amendment Regulation 2010	6
2.2.1	Aboriginal Heritage Information Management System.....	6
2.3	Heritage Act 1977	7
2.4	Environmental Planning and Assessment Act 1979.....	7
2.4.1	Parramatta Local Environmental Plan 2011	7
2.4.2	Parramatta Development Control Plan 2011.....	7
2.4.3	Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005.....	7
2.5	Non-Statutory Registers.....	8
2.5.1	Register of the National Estate	8
3	Environmental Context	9
3.1	Soils, Hydrology & Vegetation	9
3.2	Previous Land Use & Disturbance.....	10
4	Aboriginal Heritage Context	13
4.1	Ethnographic Context	14
4.1.1	Living as Australia’s Earliest Inhabitants.....	14
4.1.2	Surviving as Indigenous People in a White-Dominated Economy	14
4.2	Regional Archaeological Context	14
4.3	Local Archaeological Context.....	15
4.3.1	Registered Aboriginal Sites.....	16
4.4	Aboriginal Heritage Site Prediction Modelling.....	17
5	Conclusion & Recommendations	19
	Bibliography	20

Tables

Table 4.1	Description of Aboriginal site features (after OEH 2012:8-10).....	13
Table 4.2	Numbers of Aboriginal sites previously recorded near the study area.....	16
Table 5.1	Due diligence process and results summary (after OEH 2010:10-13).....	19

Figures

Figure 1.1	Study area extent and location.....	3
Figure 1.2	Clyde Barging Facility location and access via Grand Avenue.....	4
Figure 1.3	Clyde Barging Facility site and impact footprint.....	5
Figure 2.1	Parramatta Development Control Plan 2011 Aboriginal sensitivity map (Parramatta DCP Figure A11.1)	8
Figure 3.1	Soil landscapes in the vicinity of the study area (soil landscape information from Chapman and Murphy et al 2009).....	9
Figure 3.2	Estuarine areas prior to land reclamation and development in the vicinity of the study area, indicated in red (McLoughlin 2000:598).....	10
Figure 3.3	An 1885-1889 sale advertisement for 380 acres of land within the area of Elizabeth Farm. Retrieved online from The National Library of Australia, Map F158, at http://nla.gov.au/nla.map-f158	11
Figure 4.1	Location of Aboriginal sites previously recorded near the study area.....	17

1 Introduction

The Sydney Metro & City Southwest project is a 30km-long new rail system from Chatswood to Sydenham. Transport for NSW (TfNSW) is delivering the Project on behalf of the NSW Government and has commissioned John Holland CPB Ghella Joint Venture (JHCPBG) to undertake the TSE works.

The Clyde Barging Facility is the subject of a Review of Environmental Factors (REF) under Part 5 of *the Environmental Planning and Assessment Act 1979* (EP&A Act) being prepared by JHCPBG. AMBS Ecology & Heritage (AMBS) has been commissioned by JHCPBG to prepare this Aboriginal Heritage Due Diligence Assessment as supporting documentation to the REF.

1.1 Study Area & Proposed Works

The Clyde Barging Facility will be located on previously reclaimed land within the former Shell refinery site, adjacent to the Parramatta River. The site lies at the confluence of the Parramatta River with the Duck River, within the Parramatta Local Government Area. It is approximately 15km west of the Sydney Central Business District (see Figure 1.1).

The facility will be used to receive laden spoil barges from the Barangaroo and Blues Point TSE Worksites, and to transfer plant and equipment including TBM components, water treatment plants and other static plant and equipment. It will be accessed by barges from the Parramatta River via an upgraded wharf, and by trucks along an upgraded access road which runs along the boundary of the former refinery. Site establishment is planned to commence in early 2018 and take two months, and the facility would operate from approximately mid 2018 to early 2020.

1.1.1 Site Establishment Works

- Installing concrete barriers, fencing and environment controls
- Removing some casuarinas along the access road and small stands of trees within the worksite
- Upgrading the access road involving earthworks, and upgrading drainage
- Minor earthworks to level the loading area
- Upgrading the existing wharf to cater for the barges.
- Installing a site office, amenities and a weighbridge at the site entry on Grand Avenue.

1.2 Methodology & Authorship

This report has been prepared in accordance with current heritage best practice and OEH guidelines, as specified in the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (DECCW 2010). As such, the assessment has addressed the following requirements:

- identification of any previously recorded Aboriginal sites;
- development of a predictive model for local Aboriginal archaeological sites, including any landscape features within the study area which are likely to indicate the presence of Aboriginal objects; and
- identification of any constraints resulting from Aboriginal objects that may be present within the study area, and any requirements for additional Aboriginal heritage investigations.

The following tasks have been undertaken to fulfil the above requirements:

- a search and review of the NSW OEH Aboriginal Heritage Information Management System (AHIMS) database, to identify the location and type of any Aboriginal sites recorded within the study area or its vicinity;
- a review of relevant environmental information and the Aboriginal heritage context;
- a review of available relevant previous Aboriginal heritage reports, to determine the extent of past archaeological research into the local area; and
- the preparation of a report outlining the results of the background research; detailing whether the proposed works are likely to impact on identified Aboriginal sites or areas of potential archaeological sensitivity; identifying appropriate recommendations for avoidance of impacts to identified Aboriginal heritage sites and areas of archaeological potential; and, if required, identifying triggers for additional archaeological assessments and recommendations for Aboriginal heritage management within the study area.

This impact assessment does not include consultation with representatives of the local Aboriginal community as per OEH's *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*, and therefore does not address the cultural or spiritual significance of the project area. Assessments of cultural significance – the values of a site to the Aboriginal community itself – can only be carried out by the relevant Aboriginal communities. If the results of this assessment determine that there is potential for Aboriginal objects to be present within the study area, additional cultural heritage assessment with representatives of the local Aboriginal community in accordance with OEH requirements will be required as a component of an Aboriginal Cultural Heritage Assessment.

This report has been prepared by Christopher Langeluddecke, AMBS Director Aboriginal Heritage.



New South Wales



Regional Map


 Study Area



Figure 1.1 Study area extent and location.



Figure 1.2 Clyde Barging Facility location and access via Grand Avenue.



Figure 1.3 Clyde Barging Facility site and impact footprint.

2 Statutory Context

The conservation and management of Aboriginal heritage items is undertaken in accordance with relevant Commonwealth, State or local government legislation. Listings relevant to the study area are summarised below.

2.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) aims to protect and manage places of national environmental significance. Several heritage lists, including the National Heritage List (NHL) and the Commonwealth Heritage List (CHL), are addressed by the EPBC Act. The NHL lists places that have outstanding value to the nation, while the CHL includes items and places owned or managed by Commonwealth agencies. Ministerial approval is required for controlled actions which would have a significant impact on items and places on the NHL or CHL.

There are no Aboriginal heritage items or places listed on the NHL or CHL within the study area or its vicinity.

2.2 National Parks and Wildlife Act 1974 & National Parks and Wildlife Amendment Regulation 2010

The *National Parks and Wildlife Act 1974* (NPW Act) specifies that the Director-General of the National Parks and Wildlife Service (NPWS; now OEH) is responsible for the care, control and management of various natural and cultural areas, including Aboriginal places and objects throughout NSW. Under this Act, all Aboriginal Objects are protected regardless of significance or land tenure. Such Aboriginal Objects include pre-contact features like scarred trees, middens and open camp sites, and post-contact features such as Aboriginal fringe camps. The Act also protects Aboriginal Places, which can only be declared by the Minister administering the NPW Act; these are defined as being a place that *is or was of special significance with respect to Aboriginal culture*.

There are no declared Aboriginal Places within the study area or its vicinity.

Under Section 90 of the NPW Act, it is an offence to destroy, deface, damage or desecrate an Aboriginal Object or Aboriginal Place, unless an Aboriginal Heritage Impact Permit (AHIP) has been issued by the Environmental Protection and Regulation Division (EPRD) of OEH. The Act requires that reasonable precautions and due diligence be undertaken to avoid impacts on Aboriginal Objects.

The *National Parks and Wildlife Amendment Regulation 2010* excludes activities carried out in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* from the definition of harm in the NPW Act, meaning that test excavations may be carried out in accordance with this Code of Practice, without requiring an AHIP. The Regulation also outlines Aboriginal community consultation requirements (*Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*), and a Due Diligence Code of Practice which specifies activities that are low impact, thus providing a defence to the strict liability offence of harming an Aboriginal object.

2.2.1 Aboriginal Heritage Information Management System

The Aboriginal Heritage Information Management System (AHIMS) is part of the regulatory framework for the implementation of the NPW Act. Maintained by OEH, the AHIMS includes a database of Aboriginal heritage sites, items, places and other objects that have been reported to OEH, as well as site cards describing Aboriginal sites registered in the database, and associated

Aboriginal heritage assessment reports. Section 89A of the NPW Act requires individuals and corporations to notify OEH of the location of Aboriginal sites identified during field investigations, regardless of land tenure or any likely impacts to such sites. Nevertheless, the AHIMS is not a comprehensive list of all Aboriginal heritage sites in NSW; it only includes information that has been reported to OEH. The accuracy of site co-ordinates in the database therefore varies depending on the method used to record locations.

The results of a site search for the local area are presented in Section 4.3.1.

2.3 Heritage Act 1977

The *Heritage Act 1977* protects heritage places, buildings, works, moveable objects, precincts and archaeological sites that are important to the people of NSW. Items that have particular importance to the State of NSW are listed on the State Heritage Register (SHR). Such items can include those of Aboriginal and non-Aboriginal heritage significance.

There are no Aboriginal heritage items or places within the study area listed on the SHR.

2.4 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) regulates land use planning and development in NSW, including the making of environmental planning instruments (EPIs). The two types of EPIs are State Environment Planning Policies (SEPPs), which cover areas of State or regional environmental planning significance; and Local Environmental Plans (LEPs), which cover Local Government Areas (LGAs). SEPPs and LEPs identify and provide for the protection of local heritage items and heritage conservation areas. Division 6 of Part 3 of the EP&A Act introduces requirements for Development Control Plans to supplement the LEPs and provide more detailed provisions to guide development.

2.4.1 Parramatta Local Environmental Plan 2011

Part 5, Clause 5.10 'Heritage Conservation' of the Parramatta LEP is consistent with current heritage best practice guidelines, and provides for the protection of heritage items, places, conservation areas, and archaeological sites. Schedule 5 'Environmental heritage' does not include any Aboriginal objects or places of heritage significance within the study area or its vicinity.

2.4.2 Parramatta Development Control Plan 2011

Section 3.5.3 of the Parramatta Development Control Plan provides design principles to ensure that development impacts to known or potential Aboriginal archaeological sites or sites of cultural or historical significance are considered appropriately. Appendix 11 of the DCP identifies areas of Aboriginal sensitivity in the LGA, and indicates the Project area is an "Area of Aboriginal Association", but that it is considered to have "no sensitivity" (Figure 2.1).

2.4.3 Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005

The *Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005* (Harbour REP) establishes a set of planning principles to be used by Councils for the preparation of planning instruments. It aims to recognise, protect, enhance and maintain the Sydney Harbour waterways, its islands, and its foreshores as an outstanding natural asset and as a public asset of national heritage significance. Division 3 of the Harbour REP addresses the protection of places of potential heritage significance, and requires consideration of Aboriginal heritage prior to the granting of consent for development that is likely to have an impact on a place, or potential place, of Aboriginal heritage significance.

There are no Aboriginal heritage items in or near the current study area listed in Schedule 4 of the Harbour REP.

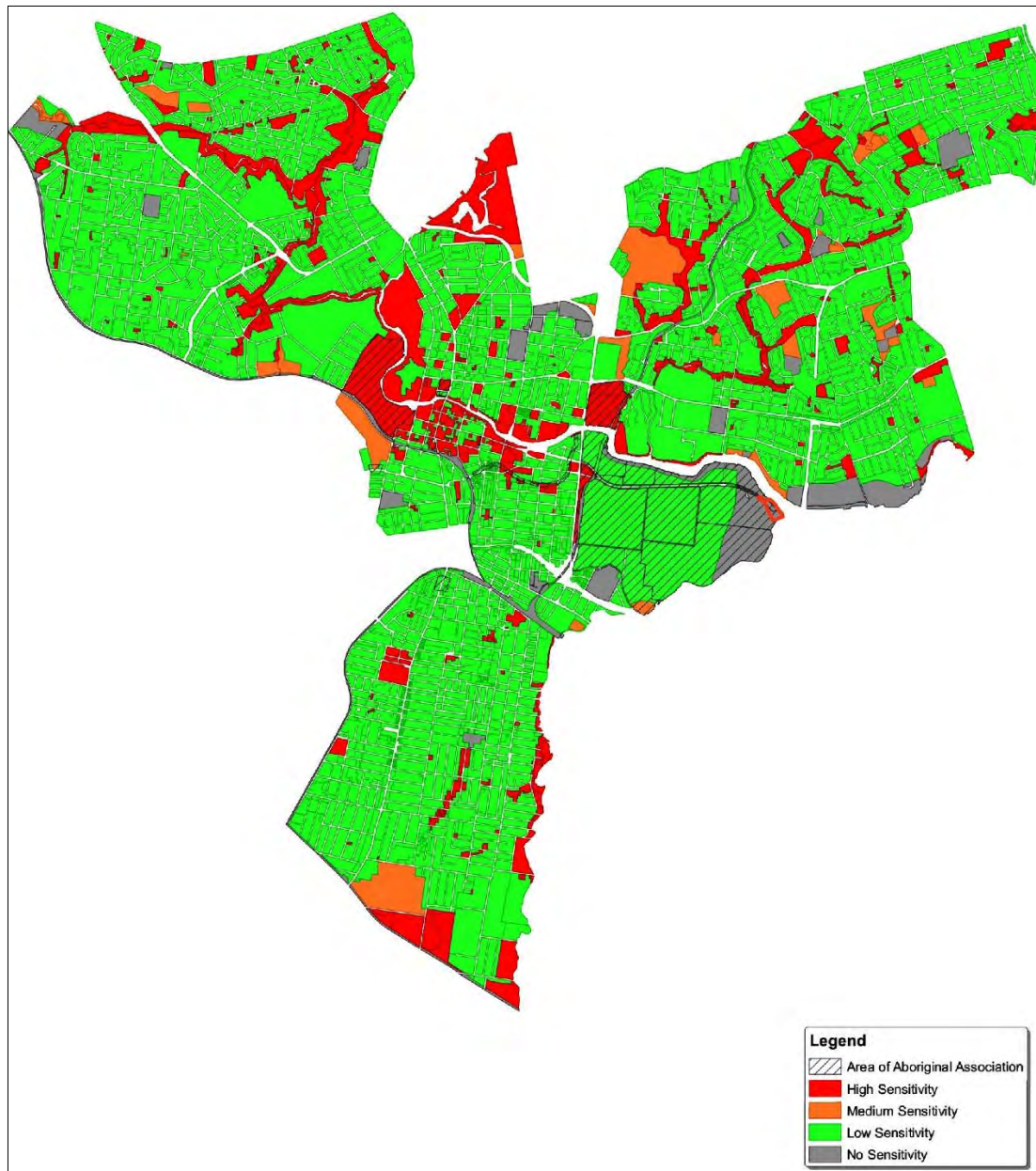


Figure 2.1 Parramatta Development Control Plan 2011 Aboriginal sensitivity map (Parramatta DCP Figure A11.1)

2.5 Non-Statutory Registers

2.5.1 Register of the National Estate

The Register of the National Estate (RNE) was originally established under Section 22 of the *Australian Heritage Commission Act 1975* (AHC Act). Since the establishment of the NHL and CHL, there is now a considerable level of overlap between the RNE and heritage lists at the national, state and territory, and local government levels. In February 2012, all reference to the RNE was removed from the EPBC Act and the AHC Act. The RNE is now maintained on a non-statutory basis as a publicly available archive.

There are no Aboriginal heritage items in or near the current study area listed on the Register of the National Estate.

3 Environmental Context

Environmental factors in the local landscape can inform an understanding of past human occupation of an area. Analysing the nature of the local landscape, specifically factors which affect patterns of past human occupation including topography, geology, soils, hydrology and vegetation, contributes to predictive modelling of archaeological sites, contextualises archaeological material and enables the interpretation of past human behavioural patterns.

3.1 Soils, Hydrology & Vegetation

Soils within the study area are classified as Disturbed Terrain, comprising level plain extensively disturbed by human activity through land reclamation and levelling (Figure 3.1). The landform was originally an estuarine area adjacent to the junction of the Paramatta and Duck Rivers, and original landforms and environments in the study area comprised low-lying mudflats, salt marsh and mangroves (Figure 3.2) (McLoughlan 2000:598). Dominant soils in the area comprise loose black sandy loam, variable transported fill and dark dredged muds and sands (Chapman and Murphy 1989:132:133). Vegetation communities in the local area are regrowth, due to extensive clearance since European settlement. Such clearing also impacts the integrity of archaeological deposits, and will have removed any trees modified (scarred or carved) by Aboriginal people in the past.

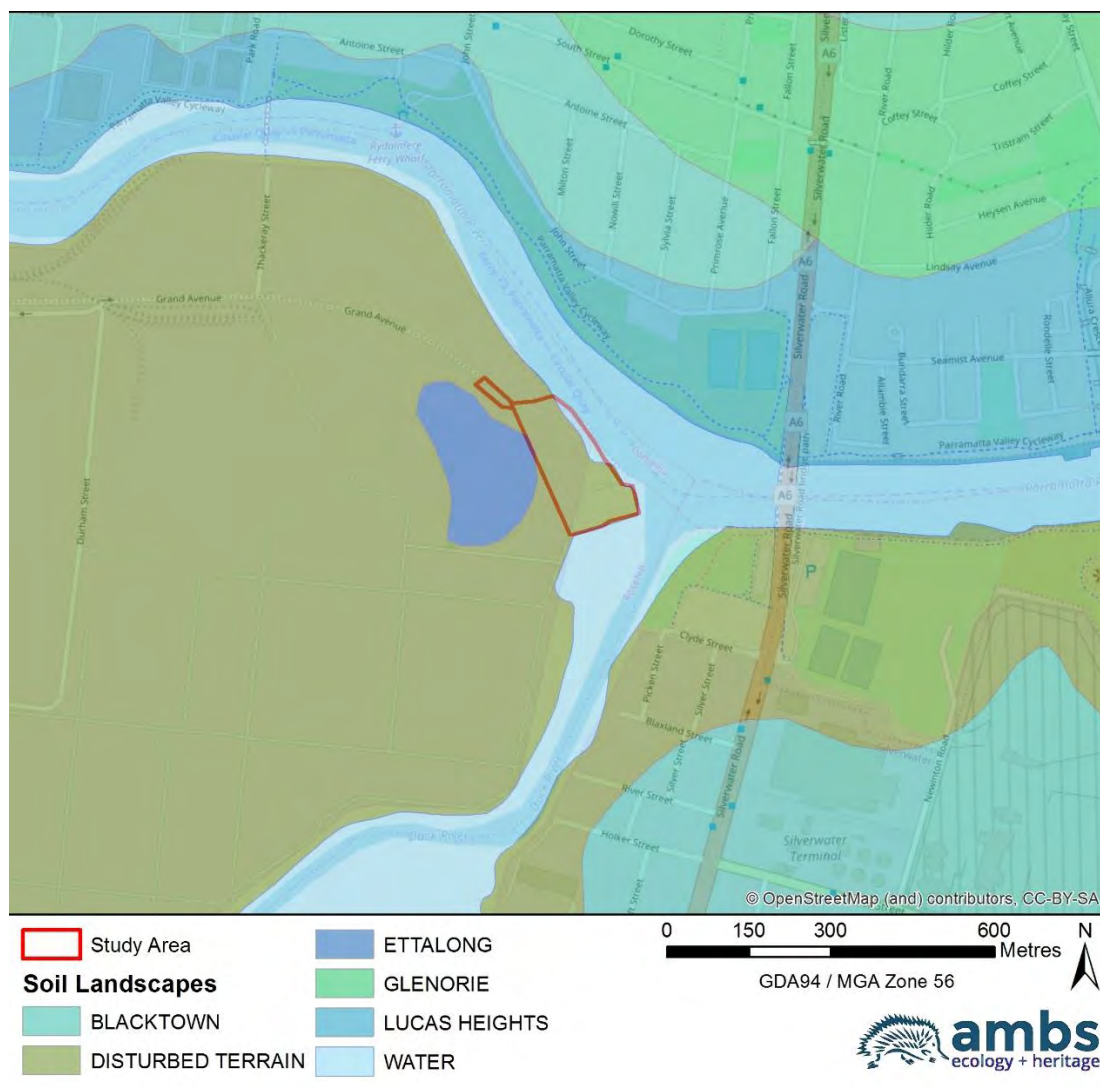


Figure 3.1 Soil landscapes in the vicinity of the study area (soil landscape information from Chapman and Murphy *et al* 2009).

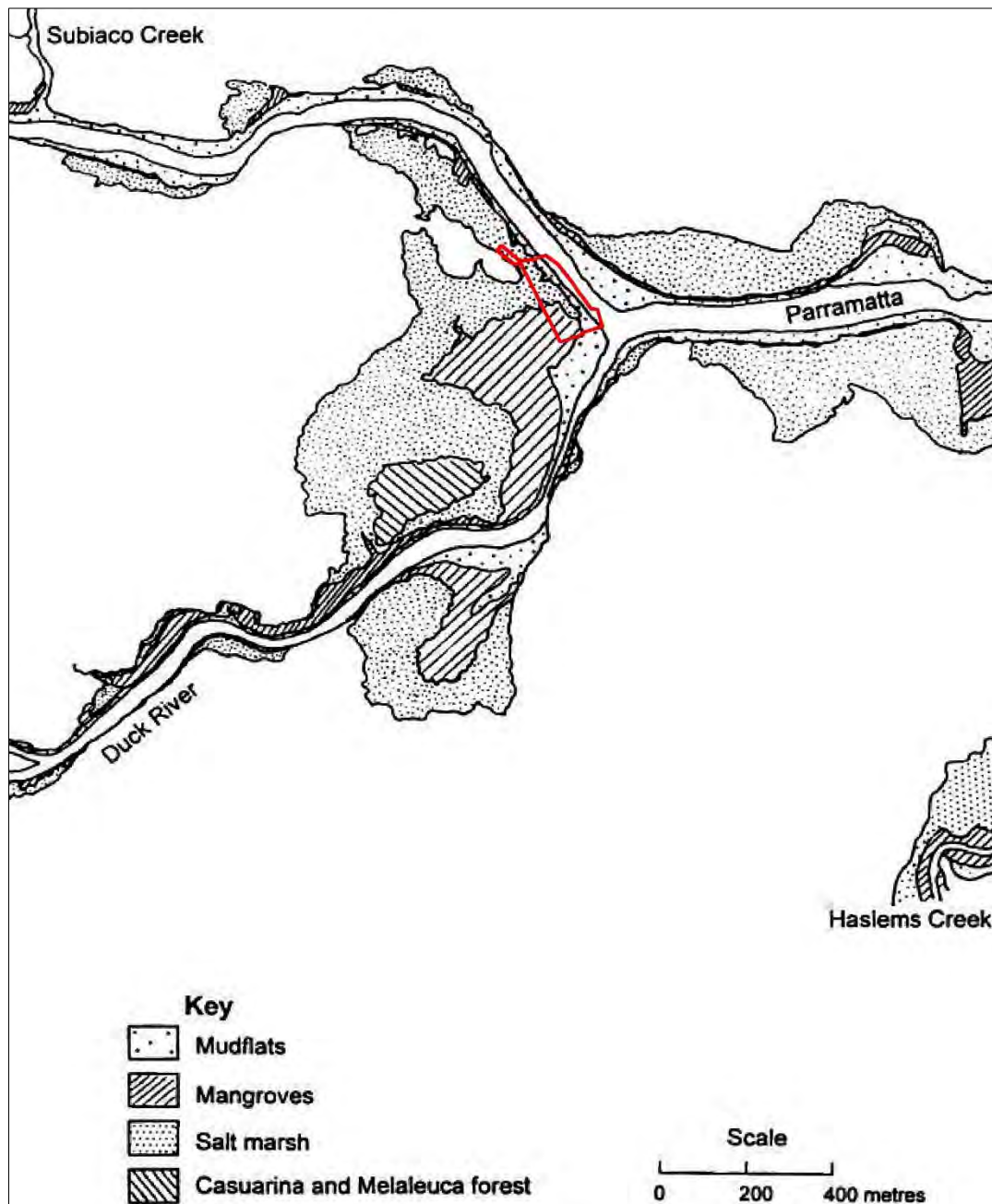


Figure 3.2 Estuarine areas prior to land reclamation and development in the vicinity of the study area, indicated in red (McLoughlin 2000:598).

3.2 Previous Land Use & Disturbance

The site is currently owned by Viva Energy Australia Ltd and was previously used to receive fuel barges and transfer of equipment. The proposed barging facility location is a fenced and largely level cleared area comprising of predominately compacted road base and a concrete hard stand with sparse vegetation. The Gore Bay fuel pipeline is located along the northern boundary of the site, with Duck River located on the southern boundary, and the Parramatta River directly adjacent to the east.

The site is accessed via a single lane access road which runs along the boundary of the former refinery and there is an easement to Grand Avenue located between Hymix and a waste processing facility. There is an existing concrete vehicle bridge over the decommissioned watermain to provide access between the site and the existing access track. A Caltex fuel pipeline is located on

the northern eastern side of the access road and there is a wetland located to the west of the access track.

The study area was part of Elizabeth Farm, which comprised lands granted and acquired from 1793 by John Macarthur. The farming estate included a dairy, gardens, various crops, horses, cattle, and sheep, and continued until 1880, when the farm was sold, and the estate subsequently subdivided and sold off in portions. Gradual silting of the Parramatta River past the confluence of the Parramatta and Duck Rivers, affected the ability of ferries to sail to the Queen's Wharf from the early 1840s, and in the late 1800s a series of wharves were constructed at Redbank, to the northwest of the study area.

In 1883 a tramway was constructed accessing the area, from the Domain gates in Parramatta to a wharf and associated facilities established at Redbank, at the confluence of the Parramatta and Duck Rivers. It ran along a right of way leased from the Elizabeth Farm Estate, crossing a specially built bridge over Clay Cliff Creek (Dictionary of Sydney: Camelia). The tramway was closed on 31 March 1943. An 1885-1889 sale advertisement for the area of the Elizabeth Farm Estate later occupied by the shell oil refinery shows the tramway running from Redbank Wharf, which is shown as a single wharf, west to Parramatta (Figure 3.3).



Figure 3.3 An 1885-1889 sale advertisement for 380 acres of land within the area of Elizabeth Farm. Retrieved online from The National Library of Australia, Map F158, at <http://nla.gov.au/nla.map-f158>

After the First World War traffic on the tramway increased due to demand from factories established in the region, and a large number of goods sidings were constructed running off the main tramway and into industrial factories. It is likely that a second wharf, to the north of the original wharf, was constructed specifically for goods during this time. An undated plan of Redbank Wharf shows that it later comprised two wharves, one for passengers and one for freight, and several buildings (Figure 3.4).

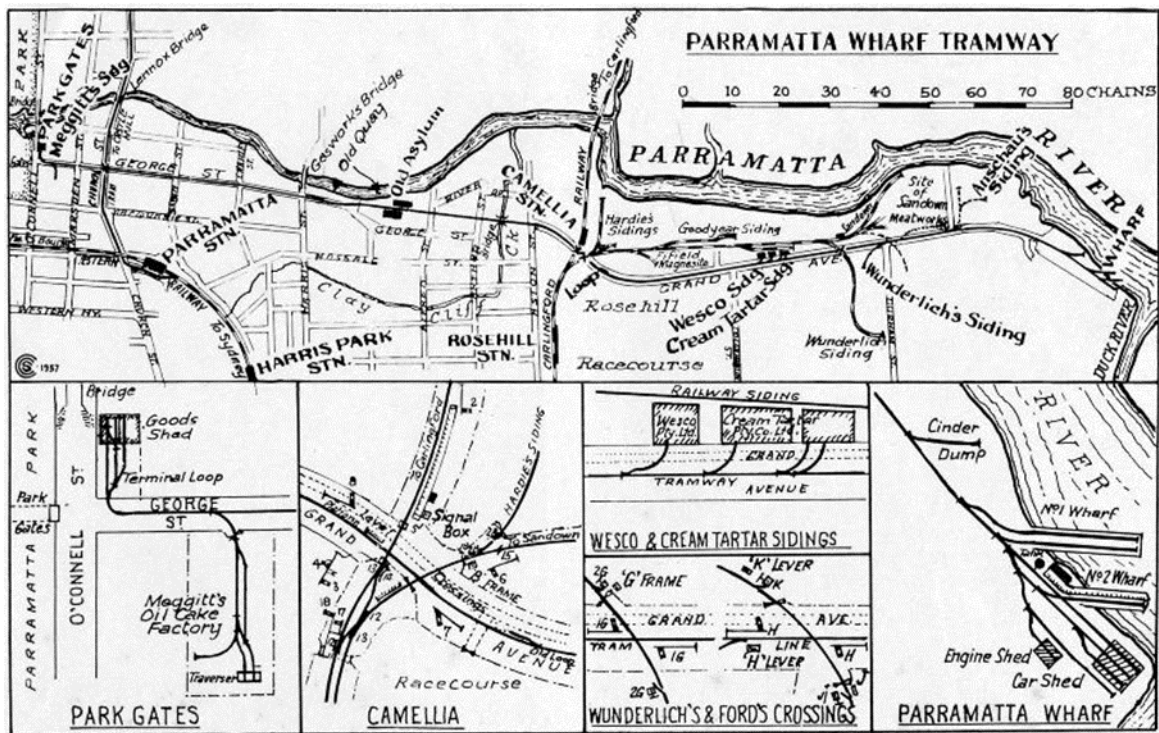


Figure 3.4 Undated map showing the route of the Redbank-Parramatta tramway. Note the detail in the bottom-right corner showing the layout of Redbank Wharf; here titled as ‘Parramatta Wharf’. The map may have been drawn in 1980. (Charles 1986:75).

The Shell Oil Refinery was established in 1928, and the company gradually expanded to acquire lands from the surrounding industrial landholders. The refinery continued operating until 2011, when it ceased operations. As per other 20th century industries in the local area, the refinery made use of the wharves in the current study area for movement of goods and equipment.

Past levelling and land reclamation of the area during establishment of wharves, tramway, and the adjacent Shell Oil Refinery comprised cut and fill across the site, and deposition of dredged local estuarine sand and mud, rocks, demolition rubble, and industrial and household waste (Chapman and Murphy 1989:132:133, McLoughlan 2000:598).

Additional information on site history is detailed in ‘Clyde Barging Facility Statement of Heritage Impact’ prepared by AMBS Ecology and Heritage for JHCPBG December 2017.

4 Aboriginal Heritage Context

This section describes the nature of the known Aboriginal archaeology of the study area, based upon a search of previously recorded sites in the AHIMS database, and a review of relevant archaeological reports. This review further enables the development of a predictive model for potential Aboriginal sites within the study area. A description of relevant Aboriginal heritage site features is provided in Table 4.1.

Table 4.1 Description of Aboriginal site features (after OEH 2012:8-10).

Site Feature	Description
Aboriginal Ceremony & Dreaming	Spiritual/story places, which may not include physical evidence of previous use of the place, e.g. natural unmodified landscape features, ceremonial/spiritual areas, men's/women's sites, dreaming (creation) tracks, marriage places.
Aboriginal Resource & Gathering	Places related to everyday activities such as food gathering or hunting, or collection/manufacture of materials/goods for use or trade.
Art	May be found in shelters, overhangs or across rock formations. Techniques may include painting, drawing, scratching, carving/engraving, pitting, conjoining or abrading. A range of binding agents or natural pigments obtained from clays, charcoal and plants may have been used.
Artefacts	Object(s) such as stone tools, and associated flaked material, spears, manuports, grindstones, discarded stone flakes, modified glass or shell, which provide evidence of Aboriginal use of the area.
Burials	Pre- or post-contact burial of an Aboriginal person, which may occur outside of designated cemeteries and may or may not be marked by stone cairns/carvings/mounds, e.g. in caves or sand areas, along creek banks etc.
Ceremonial Ring	Raised earth ring(s) associated with ceremony.
Conflict	Sometimes referred to as massacre sites, these are places where confrontations occurred between Aboriginal and non-Aboriginal people, or between different Indigenous groups.
Earth Mound	Round or oval-shaped mounded deposit containing baked clay lumps, ash and charcoal, and often black or dark grey sediment. Deposit may be compacted or loose and ashy, and may contain various economic remains such as mussel shell, bone or stone artefacts. Occasionally may contain burials.
Fish Trap	Modified area in a watercourse where fish were trapped for short-term storage and gathering.
Grinding Grooves	Groove(s) in a rock surface resulting from the manufacture of stone tools such as ground edge hatchets and spears; or rounded depressions resulting from grinding of seeds and grains.
Habitation Structure	Structures built by Aboriginal people for short- or long-term shelter. May include historic camps of contemporary significance. More temporary structures are commonly preserved away from the NSW coastline. Smaller structures may make use of natural materials such as branches, logs and bark sheets, or manufactured materials such as corrugated iron. May include archaeological remains of a former structure such as a chimney/fireplace, raised earth building platform, excavated pits, rubble mounds etc.
Hearth	Cultural deposit usually containing charcoal and sometimes marked by hearth stones. May also contain heat-treated stone fragments.
Modified Tree	Scarred trees show modification marks resulting from cutting of bark from the trunk for foot holds; for use in the production of shields, canoes, boomerangs, burials shrouds etc; or for medicinal purposes. Carved trees have had the heartwood of the tree intentionally carved to form a permanent marker, which may indicate ceremonial use/significance of a nearby area, or which may have functioned as territorial or burial markers.
Non-Human Bone & Organic Material	Object(s) found within Aboriginal cultural deposits such as fish or mammal bones, ochres, or cached objects which may otherwise have broken down such as resin, twine, dilly bags, nets etc.
Ochre Quarry	Source of ochre used for ceremonial occasions, burials, trade and artwork.
Potential Archaeological Deposit (PAD)	Area where Indigenous objects are considered likely to occur below the ground surface.
Shell	Accumulation/deposit of shellfish from beach, estuarine, lacustrine or riverine species resulting from Aboriginal gathering and consumption, usually found in association with other objects like stone tools, fish bones, charcoal, fireplaces/hearths or burials. May vary greatly in size and components.
Stone Arrangement	Human-produced arrangements of stone usually associated with ceremonial activities; used as markers for territorial limits; or used to mark/protect burials.

Stone Quarry	Source of (usually) good quality stone, which is quarried and used in the manufacture of stone tools.
Waterhole	Source of fresh water for Aboriginal groups, which may have traditional ceremonial or dreaming significance, and which may also be used to the present day as a rich resource gathering area, e.g. waterbirds, eels, clays, reeds etc.

4.1 Ethnographic Context

4.1.1 Living as Australia's Earliest Inhabitants

At the time of European settlement, the Aboriginal people of the Sydney region were organised into named territorial groups. Those groups local to the study area are likely to have spoken the Darug (Dharruk) dialect (Attenbrow 2010:23, 32; Dallas 1982:5). The anthropologist and linguist RH Mathews identified the area they occupied as follows:

The Dharruk speaking people adjoined the Thurrawal on the north [of Port Hacking], extending along the coast to the Hawkesbury River, and inland to what are now Windsor, Penrith, Campbelltown, and intervening towns (Mathews 1901:155).

Mathews' descriptions of tribal boundaries are based on the distribution of language groups in this area, which are derived largely from his work with members of Indigenous communities in the Sydney region in the late nineteenth and early twentieth centuries (Attenbrow 2010:16). As many as fifteen known clans or 'wood tribes' were reportedly living on the Cumberland Plain before 1788 but the boundaries of these distinct groups are not entirely known (Dallas 1982:4; Jo McDonald Cultural Heritage Management [JMCHM] 2002:8; Kohen 1986:Fig 4.2).

Creeks and other water resources were foci for Aboriginal occupation, providing fresh water, fish, shellfish, eels, waterbirds and plant foods, in addition to terrestrial animals drawn to the water (Attenbrow 2010:70-71). Trees provided shade, habitat for animals and birds, and bark for shelters (huts), canoes, paddles, shields, baskets and bowls. Stone outcrops provided material with which to make tools. When overhanging they provided shelter from the elements, and flat stone surfaces and shelters were sometimes engraved or painted by Aboriginal artists, although shelters and art sites mainly occur around the periphery of the Cumberland Plain in sandstone geology (Attenbrow 2010:105, 113-116, 120-122).

4.1.2 Surviving as Indigenous People in a White-Dominated Economy

Aboriginal groups and their traditional way of life underwent many changes following European settlement. It is unclear how many people lived in the vicinity of the study area at the time of European contact, although the population of the 'interior' (the Cumberland plain west of Parramatta) was considered by settlers to be less dense than along the coast (Attenbrow 2010:17). In 1788, Captain John Hunter observed that *we find the sea-coast more fully inhabited than the interior, or that part of the country which we have had an opportunity of visiting more remote from the sea* (Hunter 1793). In 1789, a small pox epidemic spread beyond the boundary of the colony in Sydney, greatly affecting the local Aboriginal population (Attenbrow 2010:17). Governor Phillip wrote that the disease must have been spread to a considerable distance, as well inland as along the coast, and he estimated that one-half of those who inhabit this part of the country died (Phillip 1789).

4.2 Regional Archaeological Context

Aboriginal occupation of the Sydney region is likely to have spanned at least 20,000 years, although dates of more than 40,000 years have been claimed for artefacts found in gravels of the Cranebrook Terrace on the Nepean River (Nanson et al. 1987; Stockton 2009; Stockton & Holland 1974). Late Pleistocene occupation sites have been identified on the fringes of the Sydney basin and from rock shelter sites in adjoining areas. Dates obtained from these sites were 14,700 Before

Present (BP) at Shaws Creek in the Blue Mountain foothills (Kohen et al. 1984), c.15,000-c.11,000 BP at on a levee near Pitt Town adjacent to the Hawkesbury River (Williams et al. 2012), c.11,000 BP at Loggers Shelter in Mangrove Creek (Attenbrow 1981, 2004), and c.20,000 BP at Burrill Lake on the South Coast (Lampert 1971). The majority of sites in the Sydney region, however, date to within the last 5,000 years, with some researchers proposing that occupation intensity increased from this period (Kohen 1986; McDonald 1994; McDonald & Rich 1993); although it has recently been argued that this is part of a longer trend in stepwise population growth and diversification of economic activity evident in south east Australia from the Early to Mid-Holocene (Williams 2013). This increase in sites may reflect an intensity of occupation that was influenced by rising sea levels, which stabilised approximately 6,500 years ago. Older occupation sites along the now submerged coastline would have been flooded, with subsequent occupation concentrating on and utilising resources along the current coastlines and in the changing ecological systems of the hinterland (Attenbrow 2010:55-56).

A number of predictive models relating to Aboriginal occupation patterns and site locations have been formulated through archaeological investigations in the Cumberland Plain (Dallas 1989; Haglund 1980; Kohen 1986; Smith 1989). More recent works have contributed to refining these models (Australian Museum Business Services 2000, 2002; JMCHM 1997, 1999, 2001; McDonald 1999). However, it should be noted that archaeological investigations still reveal site information in contradiction to the current, general predictive model for the area, and it is expected that further archaeological work will continue to refine the model, and therefore provide a better understanding of past occupation of the region by Aboriginal people. The following key trends have been seen in archaeological investigations of the Cumberland Plain region:

- Site frequency and density are directly related to the location of sites within the landscape.
- Complex sites are usually located close to permanent water sources, with major confluences being a key requirement for occupation sites, and would have been used intensively by larger groups, or used repeatedly by smaller groups over a longer period of time.
- Sites with large numbers of artefacts can occur on ridge tops and hill crests.
- Sites situated in alluvial soils retain the potential for stratified deposits.
- Potential Archaeological Deposits (PADs) are most likely to be located along valley floors and low slopes in well-drained areas; and surface artefact distribution does not accurately reflect the composition or density of subsurface archaeological deposits. PADs with few or no surface manifestations have often been shown to contain subsurface archaeological deposits.
- Artefact scatters are most commonly linked to the close proximity of permanent water sources in areas such as creek and river banks and alluvial flats. The majority of these sites are located within 100-200m of permanent fresh water.
- Artefact assemblages generally comprise a small proportion of formal tool types with the majority of assemblages dominated by unretouched flakes and debitage.
- High concentrations of artefacts are more likely to be located within resource rich areas.
- Silcrete is the dominant raw material used for tool manufacture, followed by chert (also known as tuff). Silcrete sources are located in the north western Cumberland Plain at places such as St Marys, Plumpton Ridge, Marsden Park, Schofields, Riverstone, Deans Park, Llandilo and Ropes Creek. Other raw materials include indurated mudstone from Nepean River gravels, basalt, and quartz porphyry and hornfels, which may be derived from Rickabys Creek gravels.

4.3 Local Archaeological Context

The study area has been previously subject to Aboriginal Cultural Heritage Assessment undertaken by AECOM Australia Pty Ltd (AECOM) on behalf of Shell Company of Australia Ltd for the Clyde Terminal Conversion project (AECOM 2013). The assessment included background research and

archaeological inspection of areas proposed to be impacted by the conversion project, as well as Aboriginal community consultation in accordance with the OEH *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*. The assessment did not include formal archaeological survey, as it was concluded that it was unnecessary due to the level of historic disturbance across the refinery site and assessed level of archaeological potential.

Archaeological inspection carried out by AECOM and the project’s Registered Aboriginal Parties (RAPs) identified no Aboriginal sites within the refinery study area, and the assessed impact areas were identified as grossly disturbed due to levelling and development of the area for the installation of the refinery (AECOM 2013: 29).

While it was identified that there was no potential for Aboriginal surface objects or archaeological deposits to be present in the assessed study area, Aboriginal community stakeholders consulted with during the archaeological inspection commented that the area was likely to have been rich in faunal resources prior to development, due to its association with estuarine environments along Parramatta and Duck Rivers (AECOM 2013: 29).

4.3.1 Registered Aboriginal Sites

An extensive search of the OEH AHIMS database was undertaken on 20 November 2017 (AHIMS Client Service ID 313438), which identified 16 previously recorded Aboriginal sites within the following coordinates: Datum GDA Zone 56, Eastings 316000-321000, Northings 6253000-6258000. The search results summarised in Table 4.3 and presented in Figure 4.1.

Table 4.2 Numbers of Aboriginal sites previously recorded near the study area.

Site Types	Total	Percentage
Artefact	10	62.50%
Artefact, PAD	1	6.25%
PAD	4	25.00%
Resource and Gathering, PAD	1	6.25%
Grand Total	16	100.00%

The majority of previously recorded sites identified by the AHIMS search of the local area are artefact sites, one with associated Potential Archaeological Deposit (PAD). No Aboriginal heritage sites or areas of PAD have previously been recorded within the study area, and the nearest previously recorded site is a PAD located on the northern side of Paramatta River, approximately 1km east of the study area.

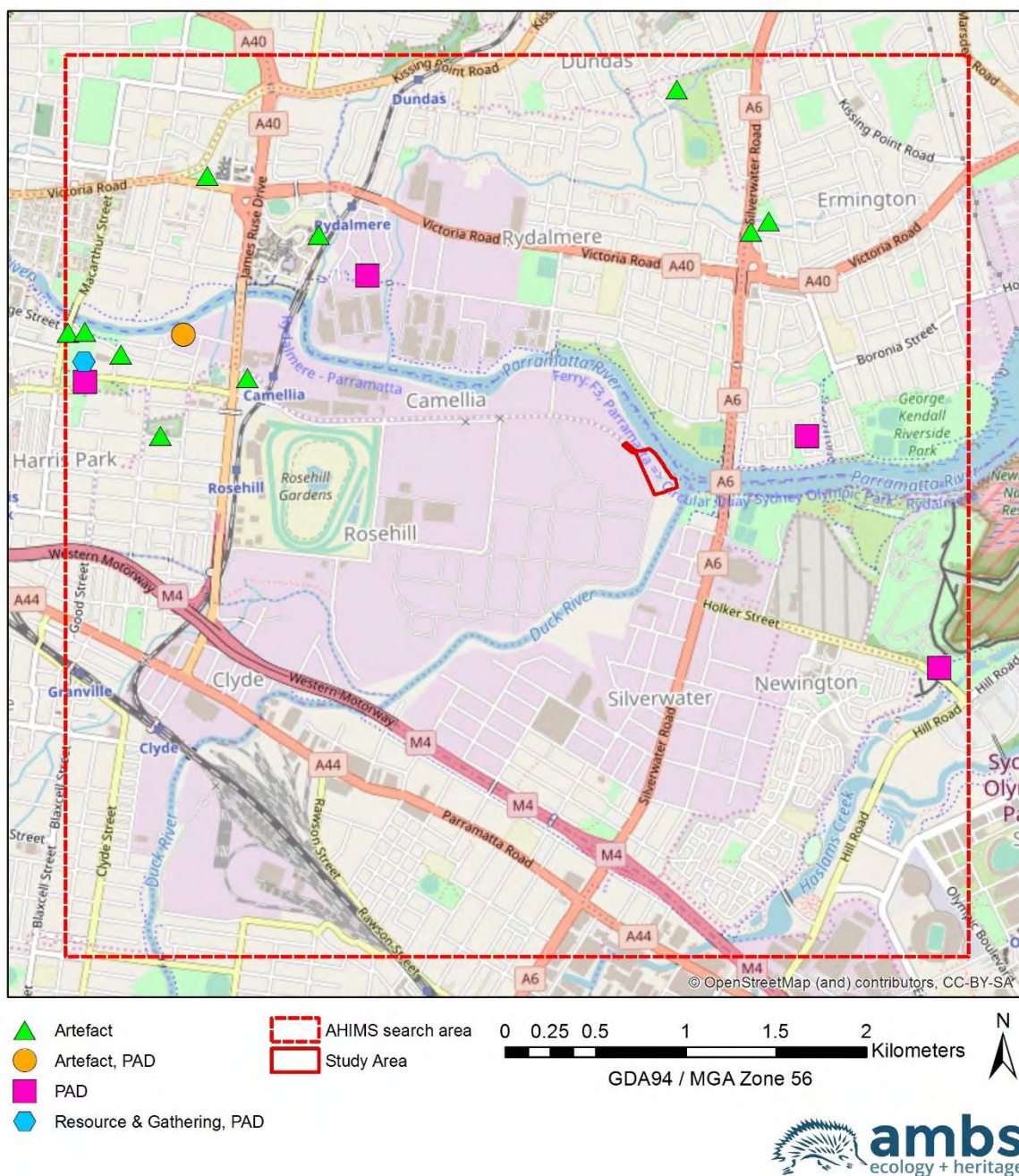


Figure 4.1 Location of Aboriginal sites previously recorded near the study area.

4.4 Aboriginal Heritage Site Prediction Modelling

On the basis of the registered archaeological sites in the region, the environmental context of the study area, and the review of previous archaeological studies, the following conclusions can be drawn regarding the potential presence and location of Aboriginal heritage sites in and around the study area:

- Stone artefact sites are the most common site type occurring in the local region, predominantly located on well-drained, level or gently sloping ground such as creek and river banks and alluvial flats, in association with water sources. Stone artefact sites are found in all environmental contexts, but are most readily identified in areas where vegetation is limited and ground surface is visible.
- The pre-disturbance environment of the study area and surrounds comprised low-lying mudflats, salt marsh and mangroves, which are likely to have represented a significant

faunal resource area for Aboriginal peoples, but are unlikely to have been suitable for ongoing occupation which could have created Aboriginal heritage sites.

- Past levelling and land reclamation of the area during establishment of wharves, the tramway, and the adjacent Shell Oil Refinery has resulted in the removal or extensive disturbance of natural soils. As such, there is no potential for Aboriginal heritage objects to remain in the study area.
- Wide scale vegetation clearance has resulted in the removal of all original native vegetation, and there is therefore no potential for culturally modified trees to survive in the study area.
- Stone quarry sites, axe grinding grooves, stone engravings/art and shelter sites are highly unlikely to be found in the study area due to the lack of suitable stone outcrops.
- Burials and ceremonial sites (including stone arrangements) are unlikely to be present in the area given the disturbance caused by levelling and land reclamation.

5 Conclusion & Recommendations

The following recommendation is based on the statutory requirements, review of the environmental and Aboriginal heritage context of the study area, and current heritage best practice, in accordance with the OEH *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW*. A summary of this assessment's compliance with the Code of Practice is presented in Table 5.1.

No Aboriginal heritage sites have previously been recorded on AHIMS or any other statutory heritage register within the study area, and the nearest recorded AHIMS site is located approximately 1km east of the study area on the northern side of the Parramatta River. The pre-disturbance environment of the study area comprised low-lying estuarine mudflats, salt marsh and mangroves which are likely to have represented a significant faunal resource area for Aboriginal people, but which would not have been suitable for prolonged occupation. Past levelling and land reclamation of the local area during establishment of wharves, the tramway, and the adjacent Shell Oil Refinery has resulted in the removal or extensive disturbance of natural soils with potential to retain Aboriginal heritage objects across the entire study area.

Based on the research undertaken, the Aboriginal archaeological potential of the Clyde Barging Facility area is assessed as low. As such, the implementation of an unexpected finds protocol will provide an appropriate Aboriginal archaeological risk mitigation, and additional controls such as Aboriginal archaeological monitoring are not required.

Table 5.1 Due diligence process and results summary (after OEH 2010:10-13).

Due Diligence Assessment Process	Response
Step 1. Will the activity disturb the ground surface or any culturally modified trees?	The proposed development will disturb the ground surface in the study area (see Section 1.1). No culturally modified trees are present in the study area. Proceed to Step 2a.
Step 2a. Are there any relevant confirmed site records or other associated landscape feature information on the AHIMS database?	No previously recorded Aboriginal heritage sites are recorded on the AHIMS database in the vicinity of the study area (see Section 4.3.1). Proceed to Step 2b.
Step 2b. Are there any other sources of information of which a person is already aware? Other sources of information can include previous studies, reports or surveys which you have commissioned or are otherwise aware of.	Archaeological assessments relating to the local area have been reviewed (see Section 4.3). Proceed to Step 2c.
Step 2c. Are there landscape features present likely to indicate presence of Aboriginal objects?	The study area and surrounds have been significantly impacted by past levelling and land reclamation during establishment of wharves, a tramway, and the adjacent Shell Oil Refinery, resulting in the removal or extensive disturbance of natural soils (see Section 3). Proceed to Step 3.
Step 3. Can harm to Aboriginal objects listed on AHIMS or identified by other sources of information be avoided, and/or can the carrying out of the activity at the relevant landscape features be avoided?	No Aboriginal objects listed on AHIMS are present in the study area, and no identified Aboriginal objects, or landforms with potential to retain Aboriginal objects, were identified within the study area by other sources of information (see Sections 3 and 4.4). Proceed to Step 4.
Step 4. Does a desktop assessment and visual inspection confirm that there are Aboriginal objects or that they are likely?	The desktop assessment has identified that, given the identified level of disturbance, it is unlikely that Aboriginal objects are present within the study area (see Section 4.4). No visual inspection has been undertaken for this assessment.

Bibliography

AECOM (2013) *Clyde Terminal Conversion Project Aboriginal Cultural Heritage Assessment*. Report to The Shell Company of Australia Ltd

Attenbrow V (1981) Mangrove Creek Dam – Salvage Excavation Project. Consultancy report to NSW National Parks and Wildlife Service on behalf of the Department of Public Works.

Attenbrow V (2010) *Sydney's Aboriginal Past, 2nd edition*. University of New South Wales Press Ltd, Sydney.

Australian Museum Business Services (2000) *Mungerie Park Town Centre Archaeological Salvage Excavations Near Kellyville, Cumberland Plain, NSW*. Report to the Department of Urban Affairs and Planning.

Australian Museum Business Services (2002) *Proposed Parklea Leisure Centre: Stanhope Gardens Archaeological Salvage Excavations*. Report to Blacktown City Council.

Chapman GA and Murphy CL, (1989) *Soil Landscapes of the Sydney 1:100,000 Sheet report*. Department of Conservation and Land Management, Sydney.

Chapman GA, Murphy CL, Tille PJ, Atkinson G and Morse RJ, (2009), *Soil Landscapes of the Sydney 1:100,000 Sheet map*. Ed. 4, Department of Environment, Climate Change and Water, Sydney.

Charles, M. (1986). *Old Parramatta*. Atrand, Sydney.

Dallas M (1982) *An Archaeological Survey at Riverstone, Schofields and Quakers Hill, NSW*. Report to Land Commission of NSW.

Dallas M (1989) *Archaeological Study of the Land within the City of Blacktown within the Parklea Release Area*. Report to Baulkham Hills Shire Council.

Dictionary of Sydney, n.d.

Camellia (<https://dictionaryofsydney.org/entry/camellia>)

Department of Environment, Climate Change and Water [DECCW] (2010) *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales*. Sydney

Hunter J (1793) *An Historical Journal of the Transactions at Port Jackson and Norfolk Island, With the Discoveries That Have Been Made in New South Wales and the Southern Ocean Since the Publication of Phillip's Voyage*. John Stockdale, London.

Jo McDonald Cultural Heritage Management Pty Ltd (JMCHM) (1997) *Interim Heritage Management Report: ADI Site St. Marys. Volume 1: Text*. Report to Lend Lease-ADI Joint Venture in Response to the Section 22 Committee Interim Report.

JMCHM (1999) *Test Excavation of PAD 5 (RH/SP9) and PAD 31 (RH/CC2) for Rouse Hill (Stage 2) Infrastructure Project at Rouse Hill and Kellyville, NSW*. Report to Rouse Hill Infrastructure Consortium (RHIC).

JMCHM (2001) *Salvage Excavation of Six Sites along Caddies, Second Ponds, Smalls, and Cattai Creeks in the Rouse Hill Development Area, NSW*. Report to RHIC.

JMCHM (2002) *Archaeological Reassessment of Indigenous Cultural Heritage Values in Seconds Ponds Creek*. Report to Landcom.

Kohen J (1986) *Prehistoric Settlement in the Western Cumberland Plain: Resources, Environment and Technology*. Unpublished PhD Thesis, School of Earth Sciences, Macquarie University, Sydney.

Kohen JL, ED Stockton MA & Williams (1984) "Shaws Creek KII rockshelter, a prehistoric occupation site in the Blue Mountains piedmont, eastern New South Wales". *Archaeology in Oceania* 19(2):57-72.

Lampert RJ (1971) *Burrill Lake and Currarong : coastal sites in southern New South Wales*. Dept. of Prehistory, Research School of Pacific Studies, Australian National University, Canberra.

McDonald J (1994) *Dreamtime Superhighway: An Analysis of Sydney Rock Art and Prehistoric Information Exchange*. Unpublished PhD thesis, Department of Prehistory and Anthropology, Australian National University, Canberra.

McDonald J (1999) *Survey for Archaeological Sites: Proposed Rouse Hill Stage 2 Infrastructure Works at Rouse Hill, Parklea and Kellyville, NSW*. Report to GHD for RHIC.

McDonald J & E Rich (1993) *Archaeological Investigations for the Rouse Hill Infrastructure Project (Stage I) Works along Second Ponds and Caddies Creeks, Rouse Hill and Parklea, NSW. Final Report on Test Excavation Program. 2 volumes*. Report to Rouse Hill (Stage I) Pty Ltd.

McLoughlin, LC. (2000) "Estuarine wetlands distribution along the Parramatta River, Sydney, 1788-1940: implications for planning and conservation". *Cunninghamia* 6(3): 579-610.

Nanson, G.C., R.W. Young and E.D. Stockton (1987) "Chronology and palaeoenvironment of the Cranebrook Terrace, near Sydney, containing artefacts more than 40,000 years old" *Archaeology in Oceania* 22:72-78.

Phillip A (1789) *The Voyage of Governor Phillip to Botany Bay: with Contributions from Other Officers of the First Fleet and Observations on Affairs of the Time by Lord Auckland*. London: Debrett [Republished 1970 by Angus & Robertson in assoc. with Royal Australian Historical Society].

Stockton E (2009) "Archaeology of the Blue Mountains". In E Stockton & J Merriman (Eds), *Blue Mountains Dreaming: The Aboriginal Heritage*, 2nd edition, pp41-72. Blue Mountains Education and Research Trust, Lawson.

Stockton E & W Holland (1974) "Cultural sites and their environment in the Blue Mountains". *Archaeology and Physical Anthropology in Oceania* 9(1):36-65.

Williams AN (2013) "A new population curve for prehistoric Australia". *Proceedings of the Royal Society* 280:20130486. Available from <http://dx.doi.org/10.1098/rspb.2013.0486>