Melbourne Metro Rail Project

MMR-AJM-PWAA-RP-NN-000832

Aquatic Ecology and River Health Impact Assessment

20 April 2016

Revision: C1

Reference: CMS332569

Melbourne Metro Rail Authority

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Report title		Aquatic Ecology and River Health Impact Assessment				
Document ID		MMR-AJM-PWAA-RP-NN-000832		**Contract No.**	CMS332569	
File path						
Client		Melbourne Metro Rail Authority		**Client contact**	Daniel Cullen	
Rev	**Date**	**Revision details/status**	**Prepared by**	**Author**	**Verifier**	**Approver**
C1	20/04/2016	Final issued for Exhibition	Josh Hale	Simon Treadwell	Peter Zahnleiter	Lisa Ryan
Current revision		**C1**				

Approval			
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Glossary and Abbreviations

Abbreviation	Definition
ANZECC	Australian and New Zealand Environment and Conservation Council
CMA	Catchment Management Authority
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEDJTR	Department of Economic Development, Jobs, Transport and Resources
DELWP	Department of Environment, Land, Water and Planning
DEPI	Department of Environment and Primary Industries (now DELWP)
DSE	Department of Sustainability and Environment (now DELWP)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FO	Floodway Overlay
EPA	Environment Protection Authority
FFG Act 1988	*Flora and Fauna Guarantee Act 1988*
LSIO	Land Subject to Inundation Overlay
MNES	Matters of National Environmental Significance
PMST	Protected Matters Search Tool
PTV	Public Transport Victoria
SEPP	State Environment Protection Policy
SMP	Sustainability Management Plan
VicAdv	DELWP Victorian Advisory Lists
VBA	Victorian Biodiversity Atlas
VPP	Victoria Planning Provisions
WoV	Waters of Victoria

Executive Summary

This report documents the outcomes of an assessment of the potential impacts on water quality, stream health and aquatic biodiversity in waterways from activities associated with construction and operation of the Melbourne Metro Rail Project (Melbourne Metro). Other aspects, including drainage and flood-related issues, groundwater, ground movement and terrestrial flora and fauna aspects are covered in the following Technical Appendices:

- Technical Appendix I *Noise and Vibration*
- Technical Appendix N *Surface Water*
- Technical Appendix O *Groundwater*
- Technical Appendix P *Ground Movement and Land Stability*
- Technical Appendix T *Terrestrial Flora and Fauna.*

Aquatic Ecology and River Health Context

The Melbourne Metro comprises two nine-kilometre-long rail tunnels from Kensington to South Yarra, travelling underneath Swanston Street in the CBD, as part of a new Sunbury to Cranbourne/Pakenham line to form the new Sunshine-Dandenong Line; including five new stations and associated works.

The focus for the assessment is the natural and man-made waterways that lie within the tunnels alignment or that could be impacted by stormwater runoff from associated construction and operational activities. Relevant major waterways in the study area include:

- Maribyrnong River, which is approximately 500 m from the western portal
- Moonee Ponds Creek, under which the tunnels would run and which is approximately 100 m from the Arden station
- Yarra River, under which the tunnels would run, is approximately 120 m from the CBD South station, and could also potentially receive runoff via the stormwater system from the eastern portal at South Yarra
- Albert Park Lake, which could potentially receive runoff via the stormwater system from the Domain station
- Stony Creek, which could potentially receive runoff via the stormwater system from the western turnback.

Methodology

The methodology for the aquatic ecology and river health impact assessment included:

- Review of available data on current water quality, fish survey data information, desk top review of relevant literature including databases (Victorian Biodiversity Atlas, Protected Matters Search Tool)
- Review of relevant legislation and guidelines
- Site inspections.

Risk Assessment

The risk assessment considered the following potential consequences across the study area, in the absence of specific mitigation measures:

- Inputs of surface sediments, chemicals and rubbish from construction zones into waterways
- Disposal of groundwater to waterways during construction
- Inputs of portal drainage to waterways during operations

- Input of tunnel seepage to waterways during operations
- Disturbance of Yarra bed sediments if grouting is required for stabilisation noise and vibration on Yarra River and Moonee Ponds Creek during construction and operation
- Subsidence of riverbed and consequent alteration flow regimes
- Inputs to surface water drainage system and waterways from sediments and pollutants from runoff from roads travelled by trucks (as opposed to general construction site runoff)
- Input of potentially toxic substances from the Arden electrical substation if transformers leak or are flooded.

Impact Assessment

The impact assessment considered the nature of risks and the potential for these risks to result in an impact on waterway water quality and aquatic flora and fauna. This report identifies a range of performance measures that in all instances minimise impacts to the water quality of waterways and aquatic flora and fauna. On this basis, project risks to water quality and aquatic flora and fauna are considered low.

Benefits and Opportunities

The Concept Design involves tunnelling under the Yarra River and Moonee Ponds Creek. Tunnelling would avoid direct impacts on waterways and associated aquatic flora and fauna and minimise potential indirect impacts.

Environmental Performance Requirements

The following Environmental Performance Requirements are recommended.

Environmental Performance Requirements
Fully integrate the stormwater treatment system into the design of Melbourne Metro for construction [all precincts] to ensure that stormwater entering a receiving water body complies with SEPP (Waters of Victoria). The best practice performance objectives for achieving compliance with SEPP (Waters of Victoria) during the construction phase are described below:

Pollutant type	Receiving water objective	Current best practice performance objective[1]
Suspended solids	Comply with SEPP	Effective treatment of 90% of daily run-off events (e.g. <4 months ARI). Effective treatment equates to a 50 percentile suspended solids concentration of 50 mg/L. This can be achieved by installing a sediment pond(s) to remove 95% of sediment down to 125 µm for a 1 year ARI.
Litter	Comply with SEPP	Prevent litter from entering the stormwater system.
Other pollutants	Comply with SEPP	Limit the application, generation and migration of toxic substances to the maximum extent practicable.

Notes:

1. Best practice performance objectives are based on the Best Practice Environmental Management Guidelines for Urban Stormwater – CSIRO

Best practice sedimentation and pollution control measures must be applied to protect waterways in accordance with Best Practice Environmental Management: Environmental Guidelines for Major Construction Sites – EPA publication 480 (1996) and in accordance with an approved construction environmental management plan. Measures should include: vehicle wheel wash and rumble bars at worksite egress points, appropriate placement of material stockpiles and chemical storages, covered loads, street sweeping and water quality monitoring, where required.
During construction, discharge tunnel, station box and portal construction water to sewer. Where groundwater interception during construction is predicted to occur, dewatering is to be managed so that

groundwater is not released to stormwater or sensitive surface water bodies (refer to related Technical Appendix O *Groundwater*).

Where ground treatment works are required in waterways, design and implement methods that prevent discharge of sediments into the water column.

Design the Arden electrical substation (as per SW1 in Technical Appendix N *Surface Water*) to provide appropriate protection against floodwaters during operation, to prevent the release of contaminants to Moonee Ponds Creek.

During operation, discharge tunnel drainage water to sewer, unless otherwise agreed by EPA and Melbourne Water.

Where groundwater interception during operation is predicted to occur, disposal is to be managed so that contaminated water is not released to stormwater or sensitive surface water bodies (refer to related in Technical Appendix O *Groundwater*).

Fully integrate the stormwater treatment system into the design of the western portal and eastern portal to ensure that stormwater entering a receiving water body complies with SEPP (Waters of Victoria). The best practice performance objectives for achieving compliance with SEPP (Waters of Victoria) during the operations phase are described below:

Pollutant type	Receiving water objective	Current best practice performance objective[1]
Suspended solids (SS)	Comply with SEPP (not to exceed the 90th percentile of 80 mg/L) (1)	80% retention of the typical urban annual load
Total phosphorus (TP)	Comply with SEPP (base flow concentration not to exceed 0.08 mg/L) (2)	45% retention of the typical urban annual load
Total nitrogen (TN)	Comply with SEPP (base flow concentration not to exceed 0.9 mg/L) (2)	45% retention of the typical urban annual load
Litter	Comply with SEPP (No litter in waterways) (1)	70% reduction of typical urban annual load (3)
Flows	Maintain flows at pre-urbanisation levels	Maintain discharges for the 1.5 year ARI at pre-development levels

Notes:

1. Best practice performance objectives are based on the Best Practice Environmental Management Guidelines for Urban Stormwater – CSIRO
2. An example using SEPP (Waters of Victoria), general surface waters segment
3. SEPP Schedule F7 – Yarra Catchment – urban waterways for the Yarra River main stream
4. Litter is defined as anthropogenic material larger than five millimetres.

Sedimentation and pollution control measures must be applied to protect waterways in accordance with industry best practice. This shall include water quality monitoring, where required.

1 Introduction

This report assesses the impacts of the Melbourne Metro Rail Project (Melbourne Metro) on aquatic ecology and river health. Related issues – surface water, groundwater, ground movement and terrestrial flora and fauna – are addressed the following Technical Appendices:

- Technical Appendix I *Noise and Vibration*
- Technical Appendix N *Surface Water*
- Technical Appendix O *Groundwater*
- Technical Appendix P *Ground Movement and Land Stability*
- Technical Appendix T *Terrestrial Flora and Fauna.*

1.1 Project Description

The Melbourne Metro comprises two nine-kilometre-long rail tunnels from Kensington to South Yarra, travelling underneath Swanston Street in the Central Business District (CBD), as part of a new Sunbury to Cranbourne/Pakenham line to form the new Sunshine-Dandenong Line.

The infrastructure to be constructed as part of the Melbourne Metro broadly comprises:

- Twin nine-kilometre rail tunnels from Kensington to South Yarra connecting the Sunbury and Cranbourne/ Pakenham railway lines (with the tunnels to be used by electric trains)
- Rail tunnel portals (entrances) at Kensington and South Yarra
- New underground stations at Arden, Parkville, CBD North, CBD South and Domain with longer platforms to accommodate longer High Capacity Metro Trains (HCMTs). The stations at CBD North and CBD South would feature direct interchange with the existing Melbourne Central and Flinders Street Stations respectively
- Train/tram interchange at Domain station.

The construction methods would involve bored and mined tunnels, cut-and-cover construction of station boxes at Arden, Parkville and Domain and portals, and cavern construction at CBD North and South. The project would require planning, environmental and land tenure-related approvals to proceed.

1.2 Purpose of this Report

The purpose of the aquatic ecology and river health impact assessment is to identify the risks and assess the impacts to water quality and aquatic flora and fauna ecology values in waterways within the project boundary.

1.3 Project Precincts

For assessment purposes, the area within the project boundary has been divided into precincts as outlined below. The precincts have been defined based on the location of project components and required construction works, the potential impacts on local areas and the character of surrounding communities.

The precincts are:

- Precinct 1: Tunnels (outside other precincts)
- Precinct 2: Western Portal (Kensington)
- Precinct 3: Arden station (including substations)
- Precinct 4: Parkville station
- Precinct 5: CBD North station

- Precinct 6: CBD South station
- Precinct 7: Domain station
- Precinct 8: Eastern Portal (South Yarra)
- Precinct 9: Western Turnback.

The nine precincts are shown in Figure 1-1.

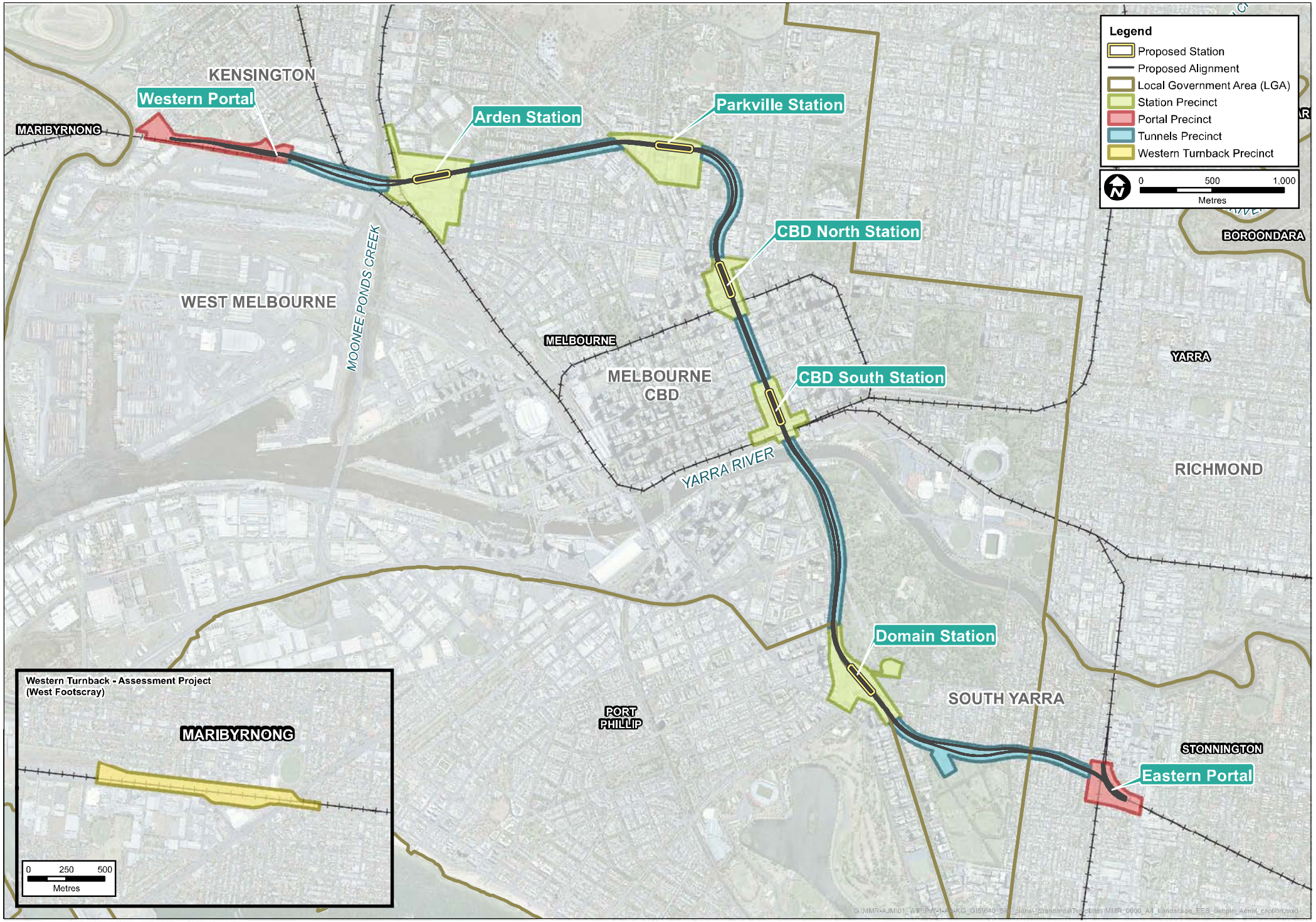
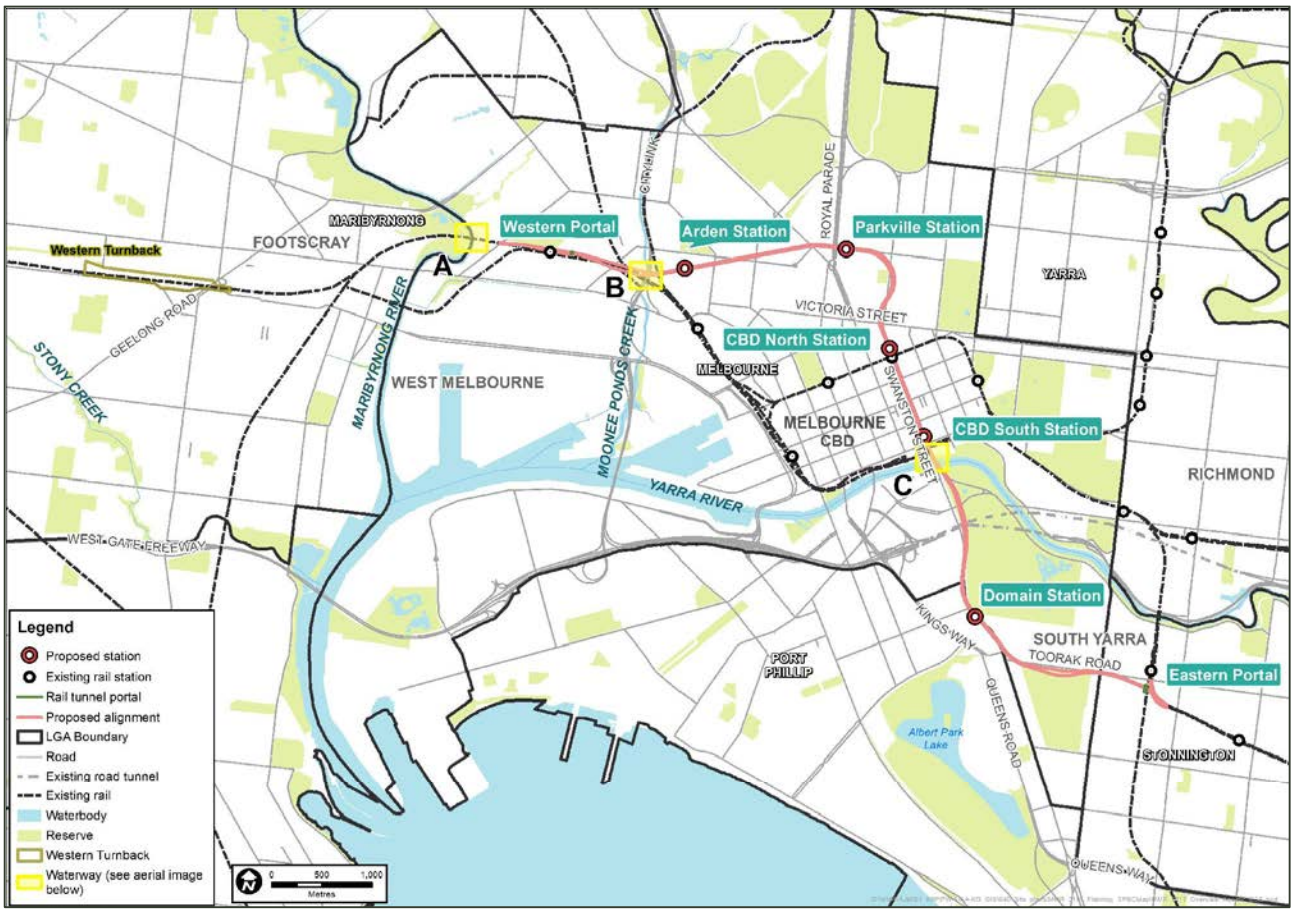


Figure 1-1 Melbourne Metro precincts

1.4 Study Area

The focus for this assessment is the Yarra River, Maribyrnong River and Moonee Ponds Creek in the vicinity of the project boundary (Figure 1-2). The study area itself extends along the entire alignment because of the possibility that stormwater runoff from portal and station precincts could enter the stormwater drainage system and ultimately discharge to the waterways listed above and also to Stony Creek and Albert Park Lake via the stormwater drainage system.



A – Maribyrnong River

B – Moonee Ponds Creek

C – Yarra River

Figure 1-2 Site map showing waterways in relation to the Concept Design

Table 1-1 summarises the relationships between precinct and relevant receiving waterway.

Table 1-1 Relationship between precinct and relevant receiving waterway

Precinct	Yarra River	Moonee Ponds Creek	Maribyrnong River	Albert Park Lake	Stony Creek
1 - Tunnels	X	X		X	
2 - Western Portal		X	X		
3 - Arden station (including substation)		X			
4 - Parkville station		X			
5 - CBD North station	X				
6 - CBD South station	X				
7 - Domain station	X			X	
8 - Eastern Portal	X				
9 - Western Turnback					X

2 Scoping Requirements

2.1 EES Objectives

The following draft evaluation objectives (Table 2-1 and Table 2-2) are relevant to aquatic ecology and river health and identify the desired outcomes in the context of potential project effects. The draft evaluation objectives provide a framework to guide an integrated assessment of environmental effects of the project, in accordance with the *Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978*.

Table 2-1 Draft hydrology, water quality and waste management evaluation objective

Draft evaluation objective	Key legislation
Hydrology, water quality and waste management: To protect waterways and waterway function and surface water and groundwater quality in accordance with statutory objectives, to identify and prevent potential adverse environmental effects resulting from the disturbance of contaminated or acid-forming material and to manage excavation spoil and other waste in accordance with relevant best practice principles.	*Environment Protection Act 1970* State Environment Protection Policy: Waters of Victoria (SEPP (WoV))

Table 2-2 Biodiversity draft evaluation objective

Draft evaluation objective	Key legislation
Biodiversity: To avoid or minimise adverse effects on native terrestrial and aquatic flora and fauna, in the context of the project's components and urban setting.	*Flora and Fauna Guarantee Act 1988* *Wildlife Act 1975*

2.2 EES Scoping Requirements

The following extracts from the Scoping Requirements, issued by the Minister for Planning, are relevant to the aquatic ecology and river health impact assessment (Table 2-3 and Table 2-4).

Table 2-3 Scoping Requirements for water quality

Aspect	Relevant response
Key Issues	• Potential for project works to affect waterways and hydrology, including with respect to flooding. • Potential for contaminated runoff or other water, including groundwater, to be discharged into surface waters or groundwater.
Priorities for characterising the existing environment	• Identify existing surface water quality and stream condition parameters and trends, as relevant.
Design and mitigation measures	• Identify measures to avoid or mitigate project effects on waterways and flood behaviour and management. • Identify design, management and mitigation measures to be used to protect surface water quality, especially during the construction phase, in the light of relevant SEPP objectives and other relevant standards and guidelines.
Assessment of likely effects	• Assess potential for project works to affect waterways and hydrology, including with respect to flood behaviour and management. • Assess potential for the project to affect water quality in receiving waters, having regard to existing water quality conditions, mitigation measures and relevant SEPP standards.
Approach to manage	• Describe principles to be adopted for setting programs for monitoring flooding events during construction (if they occur), surface water and groundwater quality and

Aspect	Relevant response
performance	groundwater levels. • Describe principles to be adopted for developing contingency measures to be implemented if unexpected adverse effects are identified.

Table 2-4 Scoping Requirements for biodiversity

Aspect	Relevant response
Key Issues	• Use of waterways that might be affected by project works and activities by aquatic flora and fauna.
Priorities for characterising the existing environment	• Identify and describe significant aquatic flora and fauna that could be affected by project works (if any).
Design and mitigation measures	• Describe measures to protect significant terrestrial and (if relevant) aquatic flora and fauna values • If relevant, describe measures to offset identified adverse effects on flora and fauna values.
Assessment of likely effects	• In the context of the project's urban and highly modified setting, assess the potential adverse residual effects of the project on biodiversity values.
Approach to manage performance	• Describe principles to be adopted to develop monitoring programs to measure adverse effects on significant flora and fauna values resulting from the project • Describe the approach to develop contingency measures to be implemented in the event of adverse residual effects on flora and fauna values requiring further management.

3 Legislation, Policy and Guidelines

Table 3-1 summarises the primary legislation that is relevant to this assessment as well as the implications, required approvals and interdependencies and information requirements associated with obtaining approvals. Descriptions of all relevant legislation are contained in Appendix A of this report.

Table 3-1 Primary legislation relevant to this assessment and associated information

Legislation / policy	Key policies/ strategies	Implications for this project	Approvals required	Timing / interdependencies
Commonwealth				
***Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*)**	The *EPBC Act* has significant implications for natural resource and environmental management in Australia. This Act provides for the listing of threatened species, threatened ecological communities and key threatening processes. It also relates to actions likely to have a significant impact on Matters of National Environmental Significance (MNES).	The project has the potential to impact one MNES relevant to Aquatic Ecology: the *EPBC* listed Australian grayling (*Prototroctes maraena*). The common dolphin and Australian fur seals are occasional visitors to the Yarra River estuary, but it does not provide suitable habitat for resident populations.	MMRA referred the project to the Commonwealth Department of Environment in relation to potential impacts on the Australian grayling in the Yarra River and matters associated with Commonwealth land.	It has been determined by the delegate of the Commonwealth Minister for the Environment on 22 September 2015 that the Concept Design is a not a 'controlled action' subject to being undertaken in the manner set out in the delegate's decision (the matters relate to heritage related issues on Commonwealth land).
State				
Water Act 1989	The *Water Act 1989* is the primary legislation covering the management of the State's water resources.	The reaches of the Maribyrnong River, Moonee Ponds Creek and the Yarra River in the immediate vicinity of the Melbourne Metro alignment are designated waterways of Melbourne Water.	Works on Waterways approval may be required if the bed and banks are impacted by construction activities.	An assessment under the *Environment Effects Act 1978* would inform decision making under other legislation.
***State Environment Protection Policy: Waters of Victoria* (SEPP (WoV))**	The SEPP WoV provides the legal framework for the protection and rehabilitation of Victoria's surface waters.	To protect beneficial uses and environmental values, the SEPP WoV sets out water quality and nutrient objectives.	No approval is required, however, compliance with the SEPP is required, which is given effect under the *Environment Protection Act 1970.*	N/A
***Flora and Fauna Guarantee Act 1988* (*FFG Act 1988*)**	The *FFG Act 1988* provides a framework for biodiversity conservation in Victoria.	Determine if any *FFG*-listed flora or fauna species are likely to be affected or threatening processes	Australian grayling are listed under the Act.	An assessment under the *Environment Effects Act 1978* would inform decision making

Legislation / policy	Key policies/ strategies	Implications for this project	Approvals required	Timing / interdependencies
	Threatened species and communities of flora and fauna, as well as threatening processes, are listed under this Act. A number of non-threatened flora species are also listed as protected under the Act. A Permit to Take is required to remove these species from public land.	occur by the works within the study area on public land. Public land includes the Yarra, Moonee Ponds and Maribyrnong estuaries. Where listed flora and fauna species are identified or threatening processes likely, recommend mitigation measures to avoid and reduce impact. If listed flora and fauna species are to be removed, a Permit to Take may need to be obtained.		under the *Flora and Fauna Guarantee Act 1988*.
DELWP (formally DEPI) Victorian Advisory Lists (VicAdv)	The DELWP Victorian Advisory Lists (VicAdv) are not a statutory list of threatened species, but rather list species for which conservation management is recommended by DELWP. The VicAdv Lists are comprised of the *Advisory List of Rare or Threatened Plants in Victoria – 2014* (DEPI, 2014), the *Advisory List of Threatened Vertebrate Fauna in Victoria – 2013* (DSE, 2013) and the *Advisory List of Threatened Invertebrate Fauna in Victoria – 2009* (DSE, 2009). The presence, or likely presence, of a species listed on the VicAdv Lists is used to determine whether species-specific habitat is required to be offset.	Australian grayling have been identified within the study area.	If an impact is likely then identify mitigation measures to protect grayling migration.	Mitigation plan, if necessary.

4 Methodology

4.1 Existing Conditions

Existing conditions were determined through a review of available data on current water quality, fish survey data information, desk top review of relevant literature and a site inspection on 14 May 2015.

Specifically, a review of the following databases was undertaken to provide information on threatened aquatic flora and fauna species and vegetation communities previously identified or predicted to occur within the study area and on existing water quality conditions:

- **Victorian Biodiversity Atlas (DELWP 2015)** – This database comprises historical records of flora and fauna species from across the State. Records are added opportunistically, as flora and fauna surveys are conducted within Victoria for a variety of purposes. Records from the relevant waterways have been assessed for this report
- **Protected Matters Search Tool (DoE 2015b)** – The Protected Matters Search Tool lists any MNES relevant to the *EPBC Act* that could occur within an area
- **Water Quality Data (Melbourne Water)** – Melbourne Water collects routine water quality data from each of the relevant waterways within the study area. Monthly data collected from the last three years has been reviewed in order to develop an understanding of the background water quality in each system.

A site inspection was carried out of the waterways at the points where the tunnels would pass underneath the Yarra River and Moonee Ponds Creek and at the Maribyrnong River, to the west of the western portal. Visual assessments of the condition of the beds and banks were carried out at this time. Given that tunnelling under these waterways would result in limited, if any, works within the waterway, this inspection was sufficient to establish baseline conditions. Further assessment and consultation could be required, depending on the extent of any departure from the Concept Design.

4.2 Risk and Impact Assessment

4.2.1 Overview

An Environmental Risk Assessment has been completed for impacts of Melbourne Metro. The risk-based approach is integral to the EES as required by Section 3.1 of the Scoping Requirements for the EES. Importantly, an environmental risk is different from an environmental impact.

The overall risk assessment process adopted was based on AS/NZS ISO 31000:2009, as illustrated in Figure 4-1.

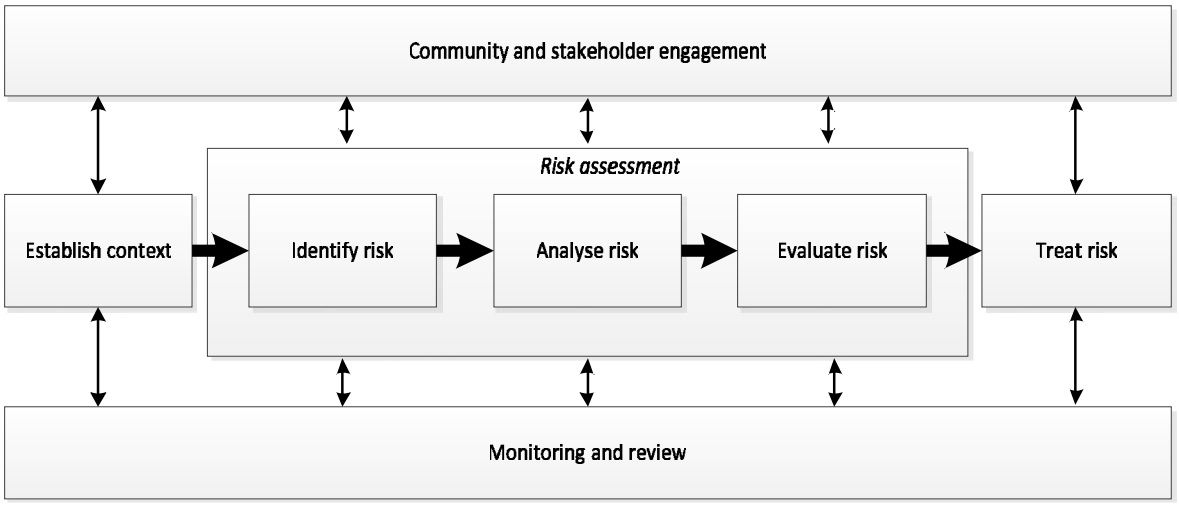


Figure 4-1 Overview of AS/NZS ISO 31000-2009 Risk Process

The following tasks were undertaken to determine the impact pathways and assess the risks:

- Setting of the context for the environmental risk assessment
- Development of consequence and likelihood frameworks and the risk assessment matrix
- Review of project description and identification of impact assessment pathways by specialists in each relevant discipline area
- Allocation of consequence and likelihood categories and determination of preliminary initial risks
- Workshops with specialist team members from different yet related discipline areas and focussing on very high, high and moderate initial risks to ensure a consistent approach to risk assessment and to identify possible interactions between discipline areas
- Follow-up liaison with specialist team members and consolidation of the risk register.

A more detailed description of each step in the risk assessment process is provided in Technical Appendix B *Environmental Risk Assessment Report.*

4.2.2 Context

The overall context for the risk assessment and a specific context for each specialist study is described in Technical Appendix B *Environmental Risk Assessment Re*port. The context describes the setting for evaluation of risks arising from the Melbourne Metro. The specific context for the aquatic ecology and river health impact assessment is provided below:

> *Melbourne Metro is located wholly within the urbanised central area of Melbourne. With approximately 180 years of urban development associated with the evolution of the city, much of the original biodiversity values of its waterways, wetlands and riparian areas have been significantly disturbed, modified or destroyed. The infilling of large areas of estuarine habitat in land reclamation programs in low lying areas and the realignment of water courses to facilitate drainage have all contributed to major changes in the natural character of the area. This has greatly altered, and in large part removed altogether, habitat that supported the rich diversity of species that originally inhabited the area. Relevant major waterways in the study area include:*

- *Maribyrnong River, which is approximately 500 m from the western portal*
- *Moonee Ponds Creek, under which the tunnels would run and which is approximately 100 m from the Arden station*

- *Yarra River, under which the tunnels would run and which is approximately 120 m from the CBD South station. The Yarra River could potentially receive runoff via the stormwater system from the eastern portal at South Yarra*
- *Albert Park Lake, which could potentially receive runoff via the stormwater system from the Domain station*
- *Stony Creek, which could potentially receive runoff via the stormwater system from the Western Turnback.*

Melbourne Metro would involve tunnelling under the estuarine section of the Yarra River and Moonee Ponds Creek (bored tunnels with no direct impacts on the waterways). The project boundary is also near to the Maribyrnong River. However, the portal construction, station construction, the western turnback and other works would result in open construction sites with potential for runoff to local drainage systems and hence, to waterways within or beyond the project boundary. All discharges to waterways would require compliance with the State Environment Protection Policy (Waters of Victoria).

The likelihood rating criteria used in the risk assessment by all specialists is shown in Table 4-1.

Table 4-1 Likelihood rating criteria

Level	Description
Rare	The event is very unlikely to occur but may occur in exceptional circumstances.
Unlikely	The event may occur under unusual circumstances but is not expected.
Possible	The event may occur once within a five-year timeframe.
Likely	The event is likely to occur several times within a five-year timeframe.
Almost Certain	The event is almost certain to occur one or more times a year.

The consequence criteria framework used in the risk assessment is below (Table 4-2). Each specialist has used this framework to develop criteria specifically for their assessment.

Table 4-2 Consequence framework

Level	Qualitative description of biophysical / environmental consequence	Qualitative description of socio-economic consequence
Negligible	No detectable change in a local environmental setting.	No detectable impact on economic, cultural, recreational, aesthetic or social values.
Minor	Short-term (days to weeks), reversible changes, within natural variability range, in a local environmental setting.	Short-term (days to weeks), localised impact on economic, cultural, recreational, aesthetic or social values.
Moderate	Long-term (months to years) but limited changes to local environmental setting that are able to be managed.	Significant and/or long-term (months to years) change in quality of economic, cultural, recreational, aesthetic or social values in local setting. Limited impacts at regional level.
Major	Long-term (months to years), significant changes resulting in risks to human health and/or the environment beyond the local environmental setting.	Significant, long-term (months to years) change in quality of economic, cultural, recreational, aesthetic or social values at local, regional and state levels. Limited impacts at national level.
Severe	Irreversible, significant changes resulting in widespread risks to human health and/or the environment at a regional scale or broader.	Significant, permanent impact on regional economy and/or irreversible changes to cultural, recreational, aesthetic or social values at regional, state and national levels.

The consequence rating criteria used in the risk assessment specifically for the aquatic ecology and river health assessment is shown in Table 4-3.

Table 4-3 Consequence rating criteria

Level of consequence	Consequence criteria
Negligible	• No detectable change in water quality. • No impact/disturbance to riverbed or banks. • No loss of ecosystem structure or function. • No downstream impacts.
Minor	• Minor disturbance to riverbed or bank. • Transient/ephemeral/short-term (days to weeks) impact to riverbed, banks and downstream environments with sufficient resilience retained by the ecosystem to fully bounce back from minor disturbance. • Small and short-term (days to weeks) degradation of water quality. Water quality remains within the long-term historical background range and returns to pre-impact conditions quickly.
Moderate	• Moderate disturbance of river-bed or bank resulting in some diminished capacity of moderate value moderate condition instream habitat. • Environment stress observed, short-term (days to weeks) disruption to breeding cycles for aquatic biota and ecological processes. • Ecosystem resilience is reduced and moderately difficult or expensive rehabilitation is required. • Water quality impact that exceeds background conditions for an extended period of time (weeks to months) and extends downstream beyond the immediate impact zone.
Major	• Major disturbance to bed and banks resulting in significantly diminished capacity of high value stream segment to maintain habitat and support of flora/fauna. • Significant harm to instream habitat, uncertain whether enough resilience retained to allow restoration to pre-disturbance conditions. • Water quality exceeds background conditions and exceeds SEPP guidelines for an extended period of time and area downstream of the immediate impact zone.
Severe	• Widespread habitat destruction, irreversible damage, potential loss of species/functional groups/guilds, catastrophic shift in ecosystem processes. • Extinction of rare or threatened aquatic flora/fauna, habitat lost for spawning/nesting/roosting/critical refuge. • Loss of recruitment/regeneration ability (eg through construction of barrier to fish passage). • Total loss of biological functions and processes, possibly irreversible, long-term harm to native flora and fauna. Ecosystem is unable to recover and rehabilitation to previous condition is not possible.

The environmental risk assessment matrix used by all specialists to determine levels of risk from the likelihood and consequence ratings is shown in Table 4-4.

Table 4-4 Risk Assessment Matrix

		Consequence ratings				
		Negligible	Minor	Moderate	Major	Severe
Likelihood rating	Rare	Very Low	Very Low	Low	Medium	Medium
	Unlikely	Very Low	Low	Low	Medium	High
	Possible	Low	Low	Medium	High	High
	Likely	Low	Medium	Medium	High	Very High
	Almost Certain	Low	Medium	High	Very High	Very High

Initial risk ratings were estimated for potential project risk events related to aquatic ecology and river health. The risk ratings were discussed and reviewed in a workshop with other EES technical specialists of related disciplines. Following the formulation of the recommended Environmental Performance Requirements during preparation of this report, the risk ratings were revised to account for implementation of the Environmental Performance Requirements and listed as residual risks. Section 6 provides a summary of the aquatic ecology and river health risks assessed as part of the EES.

4.2.3 Additional Aquatic Ecology Studies

No additional assessments were conducted or are required to be conducted, unless the Concept Design changes significantly.

4.3 Assumptions

Assumptions relevant to the risk assessment are identified throughout this report.

4.4 Stakeholder Engagement

As part of this assessment, the following specific engagement with stakeholders was undertaken.

Table 4-5 Summary of stakeholder engagement

Activity	When	Matters discussed / issues raised	Consultation outcomes
Discussion with Melbourne Water	17 June 2015	Introduction to project and request for water quality data.	Melbourne Water provided relevant water quality data.
Discussion with Parks Victoria	26 October 2015	Introduction to project and request for water quality data.	Parks Victoria provided requested water quality data for Albert Park Lake.

In addition to the specific agency and TRG engagement and the engagement listed in the table above, general engagement and consultation with the community was also conducted as part of this assessment. Written feedback was obtained through feedback forms and the online engagement platform, and face-to-face consultation occurred at the drop-in sessions (refer to Technical Appendix C *Community and Stakeholder Feedback Summary Report* of the EES for further information). Although the community was given the opportunity to offer feedback in regards to aquatic ecology and river health, no comments or concerns were provided.

4.5 Limitations

The limitations associated with this assessment are as follows:

- The assessment was based on the Concept Design and the alternative design options. If design details change, further assessment and consultation could be required and the outcomes of this report may potentially require updating
- The assessment was based on available information provided at the time indicated in the relevant sections of this report
- This report should be read in association with the surface water, groundwater, ground movement and land stability and terrestrial flora and fauna impact assessments.

5 Regional Context and Existing Condition of Waterways

5.1 Regional Context

The Melbourne Metro tunnels would pass under the estuarine section of the Yarra River and Moonee Ponds Creek, a tributary of the Yarra River. The project boundary also adjoins the Maribyrnong River, which is a tributary of the Yarra River.

The Yarra Estuary (that part of the river in which the current meets the sea's tides) extends a distance of 22 km from approximately 500 m below Dights Falls in Abbotsford to the Yarra mouth at Williamstown where it discharges to Hobsons Bay. The estuary flows through the inner eastern suburbs of Melbourne, the Melbourne CBD and the Docklands and Port precincts before reaching the bay and can be broken into three sections:

- The upper reach, upstream of Grange Road in Toorak
- The middle reach, between Grange Road and Spencer Street Bridge in the CBD
- The lower or port reach, downstream of Spencer Street Bridge.

A number of tributary streams enter the estuary including Gardiners Creek in the upper section and Moonee Ponds Creek, the Maribyrnong River and Stony Creek in the Port of Melbourne.

For most of its length, the banks of the Yarra estuary have been stabilised with rock beaching. Some remnant riparian and littoral vegetation exists in the upper reaches. Downstream of Punt Road (the middle reach), banks are manicured grassed areas or pavement and rockwalls. Downstream of the Spencer Street Bridge, the estuary has been significantly modified to form a series of docks and wharves.

The Moonee Ponds Creek estuary extends from Macaulay Road, North Melbourne, to the Yarra River downstream of the Docklands development (a distance of approximately 2.5 km). The estuary flows through an earthen channel, albeit significantly modified over many years of activities in the area. Sections of the channel have been stabilised with rock beaching, although there are sections where the banks support a band of emergent macrophytes that may provide habitat for aquatic fauna.

The Maribyrnong River estuary extends from Avondale Heights over 20 km to join the Yarra River at Yarraville. The section through Kensington and Footscray, adjacent to the study area, flows through an urban and industrial landscape.

Stony Creek rises in the Sunshine area and enters the Yarra River at Yarraville, downstream of the confluence with the Maribyrnong River. The lower reaches of Stony Creek, through West Footscray and Yarraville, comprise constructed earthen and concrete-lined channels. The estuary is an earthen channel that runs alongside the West Gate Freeway. Stony Creek receives stormwater runoff via the local drainage system from the Footscray area where the Western Turnback would be located.

Albert Park Lake is located to the south east of the study area and could receive stormwater runoff from the Domain station.

The tunnels pass under the Yarra River just upstream of Princes Bridge and under Moonee Ponds Creek downstream of Arden Street.

The tunnels do not cross the Maribyrnong River. At the western portal, the project boundary extends near to the eastern bank of the Maribyrnong River, upstream of Dynon Road, although at this point the existing rail infrastructure is used and there would be no construction activity in the immediate vicinity of the Maribyrnong River bank.

Although the crossings of the Yarra River and Moonee Ponds Creek are via bored tunnel with no direct impacts on the waterways, portal construction, station construction, the western turnback and early works would result in open construction work sites with potential for runoff to local drainage systems and, hence, to the following waterways:

- Western portal construction may involve runoff to Maribyrnong River and/or Moonee Ponds Creek
- Arden station construction may involve runoff to Moonee Ponds Creek
- Parkville station construction may involve runoff to the Moonee Ponds Creek
- CBD North and South station construction may involve runoff to the Yarra River
- Domain station construction may involve runoff to Albert Park Lake
- Eastern portal construction may involve runoff to the Yarra River
- Western turnback construction (West Footscray) may involve runoff to Stony Creek.

5.2 The Yarra River – Existing Conditions

5.2.1 Water Quality

Melbourne Water measures water quality in the Yarra River on a monthly basis at Princes Bridge. This data was assessed to develop an understanding of the background water quality in the Yarra River within the vicinity of the project boundary. The long-term Melbourne Water quality monitoring location at Princes Bridge is adjacent to the tunnels and therefore the data is directly useful for assessing background water quality relevant to the project.

The water quality variables measured by Melbourne Water have been compared against the relevant water quality guidelines. These guidelines are stipulated primarily by the *State Environment and Protection Policy* (SEPP) *Waters of Victoria* (WoV) and the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000).

The Yarra River is covered under Schedule F7 of the SEPP, Waters of the Yarra Catchment (refer to the Victoria Government Gazette, 1999). The tunnels alignment would pass beneath the Yarra River in the Upper Estuary segment. The Moonee Ponds Creek, south of Macaulay Road, Flemington, is within the Yarra Port segment. The Maribyrnong River, at the location west of the western portal, is part of the Estuaries and Inlets segment. In addition to the SEPP guidelines, ANZECC (2000) guidelines have been used for nutrients and toxicants. It should be noted that the toxicant guidelines for freshwater have been used (as ANZECC (2000) does not provide specific guidelines for estuaries).

The relevant guideline concentrations as stipulated by SEPP and ANZECC (2000) are provided in Table 5-1.

Table 5-1 Water quality guidelines relevant to the Yarra River within the area affected by Melbourne Metro and monthly water quality data collected by Melbourne Water

Water quality variable	SEPP Schedule F7 (Upper Estuary)	SEPP WoV – Marine and estuarine waters	ANZECC (2000) freshwater 95% species level protection	Long term monitoring data – Yarra River
pH	6.5 – 8.5			7.35 – 7.65
Salinity (mg/L)	-		-	7800 (50^{th}%ile) 12500 (75^{th}%ile)
Dissolved Oxygen (% sat)	> 60			86.8 (50^{th}%ile) 67 (min)
Turbidity (NTU)	< 30 (50^{th}%ile)			13 (50^{th}%ile)
	< 80 (90^{th}%ile)			34 (max)

Water quality variable	SEPP Schedule F7 (Upper Estuary)	SEPP WoV – Marine and estuarine waters	ANZECC (2000) freshwater 95% species level protection	Long term monitoring data – Yarra River
***E. coli* (org/100ml)**	< 1000			530 (50th%ile)
Total Phosphorus (mg/L)		< 0.03 (75th)		0.062 (50th%ile) 0.071 (75th%ile)
Total Nitrogen (mg/L)		< 0.3 (75th)		0.88 (50th%ile) 1.03 (75th%ile)
Arsenic			0.013 (AsV)	0.001 (50th%ile) 0.001 (75th%ile)
Cadmium			0.0002	< 0.0001
Chromium			0.001	0.00075 (50th%ile) 0.00175 (75th%ile)
Copper			0.0014	0.002 (50th%ile) 0.0035 (75th%ile)
Lead			0.0034	0.001 (50th%ile) 0.002 (75th%ile)
Nickel			0.011	0.001 (50th%ile) 0.0015 (75th%ile)
Zinc			0.008	0.017 (50th%ile) 0.0435 (75th%ile)

Water quality in the Yarra River has been compared against the relevant SEPP and ANZECC (2000) guidelines for data in 2014 (refer to Table 7-2). Data collected between 2011 and 2014 is compared against relevant guidelines in Appendix A of this report.

Water quality in the Yarra Estuary is influenced by the volume of freshwater inflows and tidal cycles. Over the time period for which data is available, water quality has been generally consistent from year to year. Dissolved oxygen and pH were always within guideline levels. For most of the time from 2011-2014, turbidity and E. coli also met relevant guidelines. There are no relevant guidelines for salinity in the Upper Estuary segment of the Yarra River, although being estuarine, salinity varies significantly depending on the volume of freshwater inflow to the estuary and tidal cycles. Total Nitrogen and Total Phosphorus were consistently above guideline concentrations. Most heavy metals were within values of the guidelines, except zinc and copper which were consistently above guidelines.

EPA (2013) examined the origin, dispersion and fate of toxicants in the lower Yarra River over three decades, and reached the following conclusions. '*Toxicants within the Yarra Estuary have been studied for over three decades. Although there is some spatial bias in the sampling, the following conclusions can be made:*

- *Concentrations of arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, PAH, PCB, TBT and DDT (dichloro-diphenyl-trichloroethane) in sediments have each exceeded the ANZECC (2000) and ARMCANZ Interim Sediment Quality Guidelines (ISQG)-Low levels on occasion*
- *Concentrations of arsenic, lead, mercury, nickel, zinc and DDT in sediments have exceeded ISQG-High levels in the last decade*

- *Concentrations of some metals (arsenic, cadmium, chromium, lead, mercury nickel and zinc) in the water column have exceeded SEPP objectives on at least one occasion in the last decade. However, on average they are generally within SEPP objectives*
- *The majority of metals in the water column are in particulate form, with the exception of arsenic and nickel, which are mostly in dissolved forms*
- *Concentrations of organic toxicants in the water column are below detection or reporting limits*
- *Concentrations of metals within fish are within guideline levels*
- *Concentrations of organic toxicants in fish are mostly within guideline levels, with the exception of a few short-finned eels sampled that exceeded guideline values for PCBs*
- *The Yarra Estuary contains comparable concentrations of most toxicants to other estuaries nationally and globally. However, compared to results reported for estuaries worldwide, the Yarra contains higher concentrations of arsenic and nickel, and higher concentrations of DDT in the sediments*
- *Urban and industrial stormwater entering the estuary from the city and the catchment is the dominant source of toxicants. Most of the toxicants enter during high flow events following heavy rainfall*
- *Natural sources are likely for arsenic (and possibly nickel) rather than human activities in the catchment*
- *The sediment is the major sink of toxicants in the estuary with the greatest concentrations in the surficial fine, unconsolidated sediments. Evidence from the lower estuary indicates that disturbance of the sediment does not result in the release of high concentrations of bioavailable toxicants into the water column*
- *Results of toxicity testing indicate that surficial sediments (in the lower estuary) are toxic to marine biota. However, the sediments that were tested were largely removed from the estuary during the Channel Deepening Project (CDP*).

5.2.2 Aquatic Flora and Habitat

An inspection of the waterway was carried out on 14 May 2015. Visual assessments of the condition of the bed and bank were carried out where the rail alignment would cross beneath the waterways. The purpose of the assessment was to confirm the presence and quality of aquatic habitat. Terrestrial vegetation has been considered as part of Technical Appendix T *Terrestrial Flora and Fauna*.

The northern bank of the Yarra River in the area upstream of the Princes Bridge is a bluestone block construction and does not support any aquatic macrophytes or littoral vegetation. The southern bank supports cultivated lawn with some littoral/emergent macrophytes, namely spiny rush (*Juncus acuta*) present along the river's edge (refer to Figure 5-1). Spiny rush is an introduced plant that is a declared noxious weed in Victoria. The overall aquatic habitat at this location is limited, with the small amount of fringing vegetation not likely to provide high habitat value for aquatic species.

Figure 5-1 Vegetation present on the north (right) and south (left) banks of the Yarra River

5.2.3 Aquatic Fauna

The aquatic biota previously recorded within the study area was determined by examining records in the VBA (refer to DELWP 2015) and fish survey reports from Arthur Rylah Institute (ARI). Table 5-2 summarises the species recorded in the Yarra River. This list is based on available survey data and may not be exhaustive. Dates for latest recorded surveys have been included, but do not mean those species are no longer present in the system. Surveys may not have been recently undertaken or recent data not included in relevant databases.

Table 5-2 Aquatic fauna records from the Victorian Biodiversity Atlas for Yarra River (downstream of Dights Falls) (accessed 19 May 2015 and 29 October 2015)

Asset / value	Conservation status	Yarra River estuary
Australian anchovy (*Engraulis australis*)		1991
Australian bass (*Macquaria novemaculeata*)		1991
Australian grayling (*Prototroctes maraena*)	*EPBC* (V); *FFG* (L); VicAd (V)	2014
Australian mudfish (*Neochanna cleaveri*)	*FFG* (L); VicAd (CE)	1991
Australian smelt (*Retropinna semoni*)		1994
Black bream (*Acanthopagrus butcheri*)		2005
Bluenose cod (trout cod) (*Maccullochella macquariensis*)	*EPBC* (E); *FFG* (L); VicAd (CE)	1881
Bony herring (*Nematalosa erebi*)		Undated
Bottlenose dolphin (*Tursiops truncatus*)		1988
Bridled goby (*Arenigobius bifrenatus*)		2005
Broadfin galaxias (*Galaxias brevipinnis*)		1995
Brown trout (*Salmo trutta*)	Introduced	1994
Carp (*Cyprinus carpio*)	Introduced	2008
Common galaxias (*Galaxias maculatus*)		2005
Common yabby (*Cherax destructor destructor*)		1936
Congolli (*Pseudaphritis urvillii*)		1991
Crabeater seal (*Lobodon carcinophagus*)		1954
Eared seals (subo. *Caniformia* fam. *Otariidae*)		2014

Asset / value	Conservation status	Yarra River estuary
Eastern Australian salmon (*Arripis trutta*)		2002
Eastern gambusia (*Gambusia holbrooki*)	Introduced	1995
Eastern snake-necked turtle (*Chelodina longicollis*)	Data Deficient	1991
Estuary perch (*Macquaria colonorum*)		1867
Flat-headed gudgeon (*Philypnodon grandiceps*)		2005
Freshwater shrimp (*Paratya australiensis*)		2005
Galaxias (subf. *Galaxiinae* gen. *Galaxias*)		1994
Golden perch (*Macquaria ambigua*)	VicAd (NT)	1993
Goldfish (*Carassius auratus*)	Introduced	1981
Greenback flounder (*Rhombosolea tapirina*)		1991
Macquarie perch (*Macquaria australasica*)	*EPBC* (E); *FFG* (L); VicAd (E)	2007
Mirror carp (*Cyprinus carpio* var. *mirror*)	Introduced	Undated
Mullets (ord. *Mugiliformes* fam. *Mugilidae*)		1981
Mulloway (*Argyrosomus japonicus*)		2005
Murray cod (*Maccullochella peelii*)	*EPBC* (V); *FFG* (L); VicAd (V)	1920
Oriental weatherloach (*Misgurnus anguillicaudatus*)	Introduced	2007
Ornate mountain galaxias (*Galaxias ornatus*)		1964
Platypus (*Ornithorhynchus anatinus*)		1985
Pouched lamprey (*Geotria australis*)		1994
Rainbow trout (*Oncorhynchus mykiss*)	Introduced	1996
Redfin (*Perca fluviatilis*)	Introduced	2008
River blackfish (*Gadopsis marmoratus*)		1911
Roach (*Rutilus rutilus*)	Introduced	1996
Sea mullet (*Mugil cephalus*)		2005
Short-finned eel (*Anguilla australis*)		2008
Shorthead lamprey (*Mordacia mordax*)		1996
Silver trevally (*Pseudocaranx georgianus*)		1991
Smallmouthed hardyhead (*Atherinosoma microstoma*)		1872
Southern blue-spotted goby (*Pseudogobius olorum*)		1989
Southern elephant seal (*Mirounga leonina*)	*EPBC* (V)	1975
Southern sand flathead (*Platycephalus bassensis*)		1991
Spotted galaxias (*Galaxias truttaceus*)		1996
Tamar river goby (*Afurcagobius tamarensis*)		2005
Tupong (*Pseudaphritis urvillii*)		1996
Water rat (*Hydromys chrysogaster*)		1986
Yarra pygmy perch (*Nannoperca obscura*)	*EPBC* (V); *FFG* (L); VicAd (V)	1872
Yellow-eye mullet (*Aldrichetta forsteri*)		2005
Yellowfin goby (*Acanthogobius flavimanus*)	Introduced	1996

In addition to survey data, a search of the *EPBC Act 1999* Protected Matters Search Tool was undertaken to identify species of national conservation significance that could be present in the relevant waterways based on modelled distributions. These species have not necessarily been recorded, but based on their recorded distribution they could be present, if suitable habitat was available. Also, the Protected Matters Search Tool includes a buffer to the search zone, which means some species may be identified in the study area, but only because the buffer zones cover a location with suitable habitat that is actually outside the study area. This is a common issue where searches of estuarine systems return results for marine systems that fall within the buffer zone. Table 5-3 lists the riverine/estuarine species reported by the Protected Matters Search Tool and their likelihood of occurrence based on habitat requirements. Marine species reported by the Protected Matters Search Tool with a very low likelihood of being present are listed in Appendix A of this report.

Table 5-3 *EPBC Act 1999* PMST assessment for listed threatened species, migratory species and marine species for waterways in the study area estuary[#]

Asset / value	*EPBC* listing and search tool assessment	Assessment of probability of occurrence in potential impacted area
LISTED THREATENED SPECIES		
Australian grayling (*Prototroctes maraena*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Likely** to occur in study area. Known from the Yarra River estuary (Koster and Dawson 2013, 2014). It is not a resident estuarine species, but uses the estuary as a migratory pathway.
Eastern dwarf galaxias (*Galaxiella pusilla*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur in study area. Most commonly found in well vegetated, still or slow flowing backwaters or drains in freshwater reaches, not deep, swiftly flowing un-vegetated channels (Allen et al. 2002). Suitable habitat has not been recorded at the investigation site in the Yarra River.
Murray cod (*Maccullochella peelii*)	Vulnerable. Species or species habitat **may** occur within area.	**Very unlikely** to occur in study area. They are generally found in locations with undercut banks, dense vegetation and large snags. The Murray Cod completes their entire life cycle in freshwater and therefore does not need to migrate to the ocean. They are located in the freshwater reaches of the Yarra River, occasionally including a short stretch downstream of Dights Falls, but have not been recorded from the lower estuary in the vicinity of the tunnels alignment. Suitable habitat has not been recorded at the investigation site in the Yarra River.
Macquarie perch (*Macquaria australasica*)	Endangered. Species or species habitat **likely** to occur with the area.	**Very unlikely** to occur in the study area**.** Most of the important populations and breeding sites are known from the middle and upper Yarra River (King and Mahoney 2010; Tonkin et al. 2014). Are located in the freshwater reaches of the Yarra River, occasionally including a short stretch downstream of Dights Falls, but have not been recorded in the lower estuary in the vicinity of the tunnel alignment. Suitable habitat has not been recorded at the impacted area in the Yarra River.
Yarra pygmy perch (*Nannoperca obscura*)	Vulnerable. Species or species habitat **likely** to occur with the area.	**Very unlikely** to occur in the study area. Last record on the VBA downstream of Dights Falls was in 1872. They are usually associated with dense emergent aquatic vegetation and woody debris in freshwater reaches. They complete their life cycle in freshwater (Sadlier and Hammer 2010) and therefore fish caught in the estuary are likely to be vagrants. Only known population in the Melbourne region is from the upper reaches of Deep Creek in the Maribyrnong catchment.

Asset / value	*EPBC* listing and search tool assessment	Assessment of probability of occurrence in potential impacted area
LISTED MIGRATORY SPECIES		
Australian fur seal (*Arctocephalus pusillus*)	Species or species habitat **may** occur within area.	**Possible.** Not a resident species, may occasionally venture into the estuary. Last record in the Yarra River in the study area is August 2015 (S. Treadwell pers. obs). Previous record was July 2014 in the Yarra River (http://www.theage.com.au/victoria/now-seal-here-playful-marine-mammal-journeys-14km-from-port-phillip-bay-to-yarra-river-20140728-zxmjj.html). Media reports of observations in the Maribyrnong River in recent years.
Common dolphin (*Delphinus delphis*)	Species or species habitat **may** occur within area.	**Possible.** Not a resident species, may occasionally venture into the estuary. Last recorded in the Yarra River estuary in 2009. (http://www.heraldsun.com.au/news/dolphins-spotted-in-yarra-between-punt-rd-and-church-st-bridges/story-e6frf7jo-1225743362954)

[#] *Species shaded in blue are likely to, or could possibly, occur within the potential impact area.*
(Ref: *EPBC Act 1999* PMST; accessed 19 May 2015)

5.2.4 Summary of Biodiversity Values

As indicated above, there is a range of species that can potentially inhabit the Yarra River estuary. There are also occasional visitors from marine environments. Each of these is discussed below.

Resident Estuarine Fish Species

Resident estuarine species include black bream, mulloway, yellow-eye mullet and occasionally snapper. Parts of the estuary provide important habitat for breeding, nursery areas for juveniles and foraging habitat for adults. For example, black bream spawn in the estuary at various locations depending on salinity, which in turn is driven by tidal influences and the volume of freshwater entering the estuary from the Yarra River upstream.

These species move up and down the estuary from Docklands through to the upper reaches (ie through the Melbourne Metro project boundary) at various times throughout the year.

Migratory Fish Species

The upper estuary and freshwater reaches of the Yarra River (and Maribyrnong River) are home to a number of species that migrate through the estuary for various life history requirements. A summary of their movement requirements is provided in Table 5-4 and a movement calendar is provided in Table 5-5. All species listed in Table 5-4 and Table 5-5 are likely to move through the estuary in any one year.

Table 5-4 Movement requirements of migratory fish in the Yarra River

Common name	Movement / migratory patterns
Short-finned eel	Adults migrate to sea during summer and autumn at around 10-35 years of age. Spawning occurs in the Coral Sea and larvae return to coastal waterways and undertake upstream migration as elvers and sub-adult eels during spring and early summer.
Climbing galaxias	Adults do not appear to migrate, with spawning occurring adjacent to adult habitats. Newly hatched larvae are swept downstream and into the sea, where they live for five to six months before returning to freshwater during spring. Juveniles/adults can 'climb' steep natural and artificial barriers to access upstream reaches.
Common galaxias	Adults reside in freshwater reaches and migrate to downstream in autumn to spawn in estuaries. Eggs are laid on flooded vegetation at upper tidal limit. Juveniles migrate into river mouths and then upstream into freshwater reaches during spring and

Common name	Movement / migratory patterns
	summer.
Spotted galaxias	Similar to common galaxias. Adults move downstream in autumn to spawn in lower freshwater reaches/estuary. Juvenile return to freshwater reaches in spring/summer.
Pouched lamprey	Adults migrate from the sea during winter/early spring to spawn in headwaters of coastal streams in spring/early summer. Larvae (ammocoetes) remain in freshwater for four years before metamorphosing in summer and then migrating downstream to the sea during the next winter. Adults mature at sea before returning to freshwater 18 months later in the following spring to spawn.
Short-headed lamprey	Similar to pouched lamprey, although upstream migration tends to occur later in spring or early summer.
Australian grayling (*EPBC Act* and *FFG* listed)	Adults migrate downstream towards the estuary in autumn to spawn. Larvae are swept to sea and juveniles return to freshwater reaches in spring. Adults are short-lived (three to five years), so upstream migration of juveniles is required every year to maintain a viable population.
Tupong	Adult females migrate downstream to estuaries in autumn-winter. Spawning occurs in the estuary or at sea. Juveniles spend some time maturing in marine environments before making upstream movements into freshwater reaches during summer.
Australian smelt	Previously thought to be a wholly freshwater species, however recent research shows that in coastal streams a portion of the population shows evidence of estuarine or marine occupation as larvae/juveniles. This research suggests that eggs and/or adults may be swept to estuaries and juveniles return to freshwater reaches. This upstream movement appears to occur over a protracted period through summer and autumn.
Australian mudfish (*FFG* listed)	Spawning is thought to occur during mid-winter in freshwater areas. It is thought that either eggs or larvae are washed down to the sea and by spring a juvenile 'white bait' phase begins migrating from the sea into freshwater habitats.

Although movements of migratory species can occur in all months, the most critical times for movement tend to be from late winter to early summer. This period, which coincides with increased river flows and increasing water temperature, provides cues for triggering upstream movement of juveniles from marine environments through the estuary to the freshwater reaches of the Yarra River. Of these species, only the *EPBC Act 1999* and *Flora and Fauna Guarantee Act 1988* listed Australian grayling and the *Flora and Fauna Guarantee Act 1988* listed Australian mudfish as being of conservation significance.

Table 5-5 Movement calendar for migratory species in the Yarra River

Migratory species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Short-finned eel	Adults move downstream through estuary.								Elvers move upstream through estuary.			
Climbing galaxias					Larvae swept to sea.				Juveniles move upstream through estuary.			
Common galaxias				Adults move downstream to spawn in estuary.					Juveniles move upstream through estuary.			
Spotted galaxias				Adults move downstream to spawn in estuary.					Juveniles move upstream through estuary.			
Pouched lamprey					Juveniles migrate to sea.			Adults migrate from sea.				

Migratory species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Short-headed lamprey					Juveniles migrate to sea.					Adults migrate from sea.		
Australian grayling (*EPBC*)			Adults spawn in lower freshwater reaches, larvae are swept to sea.						Juveniles move upstream through estuary.			
Tupong	Juveniles move upstream through estuary.				Females move downstream through estuary to spawn.							
Australian smelt	Juveniles move upstream through estuary.							Adults, larvae or eggs swept to sea.				
Australian mudfish (*FFG*)						Larvae or eggs swept to sea.			Juveniles move upstream through estuary.			

Infrequent Marine Visitors

A number of marine species occasionally visit the Yarra Estuary. In July 2014, an Australian fur seal was recorded as far upstream as Burnley[1]. A seal was also observed in the Yarra River around Queens Street Bridge in August 2015 (S. Treadwell, AJMJV, pers. obs.). In 2009, dolphins were recorded around Richmond.[2]

The estuary does not contain suitable long-term habitat for these species and they only appear to remain in the estuary for a few days at a time. However, when present in the estuary, they have been observed feeding.

5.3 Maribyrnong River – Existing Conditions

5.3.1 Water Quality Analysis

Melbourne Water measures water quality in the Maribyrnong River on a monthly basis at the end of Newson Road in Ascot Vale. This data was assessed to develop an understanding of the background water quality in the Maribyrnong River within the project boundary. The location of the long-term water quality monitoring is about 3.2 km upstream of the project alignment, meaning the tidal influence in the two locations is likely to be quite different. The background water quality, in particular regarding salinity concentrations, needs to be interpreted in light of this.

Water quality in the Maribyrnong River measured in 2014 has been compared against the relevant SEPP and ANZECC (2000) guidelines (Table 5-6; see Appendix A of this report for data from 2011-2014). The Maribyrnong River, at the location of the western portal, is addressed by the Estuaries and Inlets segment of the SEPP. In addition to the SEPP guidelines, ANZECC (2000) guidelines have been adopted for nutrients and toxicants. It should be noted that the toxicant guidelines for freshwater have been used, as ANZECC (2000) does not provide specific guidelines for estuaries.

[1] http://www.theage.com.au/victoria/now-seal-here-playful-marine-mammal-journeys-14km-from-port-phillip-bay-to-yarra-river-20140728-zxmjj.html
[2] http://www.smh.com.au/national/yarras-unusual-visitors-cause-a-stir-20090629-d2jh.html

Table 5-6 Water quality guidelines for the Maribyrnong River within the project boundary and monthly water quality data collected by Melbourne Water

Water quality variable	SEPP WoV (Estuaries and Inlets)	SEPP WoV – Marine and estuarine waters	ANZECC (2000) freshwater 95% species level protection	Long term monitoring data – Maribyrnong River
pH	6.5 (25th%ile) – 8.5 (75th%ile)			7.7 – 7.9
Salinity (mg/L)	-		-	37000 (50th%ile) 46000 (75th%ile)
Dissolved Oxygen (% saturation)	Ann. min 80 Ann. max 110			62 (min), 75 (25th%ile) 86 (75th%ile), 109 (max)
Turbidity (NTU)	<30 (50th%ile)			5 (50th)
	<80 (90th%ile)			9 (max)
***E. coli* (org/100ml)**	Prim. cont. <150 Secon. cont. <1000			41 (50th%ile)
Total Phosphorus (mg/L)	<0.03*	< 0.03 (75th)		0.13 (50th%ile) 0.14 (75th%ile)
Total Nitrogen (mg/L)	<0.3*	< 0.3 (75th)		0.6 (50th%ile) 0.8 (75th%ile)
Arsenic			0.013 (AsV)	0.002 (50th%ile) 0.002 (75th%ile)
Cadmium			0.0002	<0.0001
Chromium			0.001	0.0005 (50th%ile) 0.001 (75th%ile)
Copper			0.0014	0.0005 (50th%ile) 0.002 (75th%ile)
Lead			0.0034	0.0005 (50th%ile) 0.001 (75th%ile)
Nickel			0.011	0.002 (50th%ile) 0.002 (75th%ile)
Zinc			0.008	0.015 (50th%ile) 0.021 (75th%ile)

Dissolved oxygen complies with guidelines about 50 per cent of the time, whereas pH, turbidity and E coli. comply with SEPP guidelines. As with other locations, total nitrogen and total phosphorus were consistently above SEPP guideline concentrations. Most heavy metal concentrations were within SEPP/ANZECC (2000) guideline values except zinc which is elevated.

5.3.2 Aquatic Flora and Habitat

An inspection of the waterway was carried out on 14 May 2015. Visual assessments of the condition of the bed and bank were carried out near the project alignment. The purpose of the assessment was to confirm the presence and quality of aquatic habitat.

There is limited aquatic habitat in the vicinity of the project boundary near the Maribyrnong River. Both the eastern and western banks have been lined with rocks to stabilise the bank (Figure 5-2). There are no

emergent macrophytes in this area and the rock embankments appear to have been sprayed with herbicide to control weed growth (evidenced by the brown, dead grass along the top edge of the rocks).

Figure 5-2 Maribyrnong River west of the Melbourne Metro area

5.3.3 Aquatic Fauna

The aquatic biota previously recorded within the study area was determined by examining records on the VBA (refer to DELWP, 2015) and fish survey reports from ARI. Table 5-7 summarises the species recorded in the Maribyrnong River. Note, this list is based on available survey data and may not be exhaustive. Dates for latest recorded surveys have been included, but do not mean those species are no longer present in the system, rather dates reflect the most recent surveys.

Table 5-7 Aquatic Fauna records from the Victorian Biodiversity Atlas for Maribyrnong River (downstream of Steele Creek) (accessed 19 May and 29 October 2015)

Asset / value	Conservation status	Maribyrnong River
Australian anchovy (*Engraulis australis*)		2000
Australian smelt (*Retropinna semoni*)		1992
Black bream (*Acanthopagrus butcheri*)		2009
Bluenose cod (trout cod) (*Maccullochella macquariensis*)	*EPBC* (E); *FFG* (L); VicAd (CE)	1908
Bridled goby (*Arenigobius bifrenatus*)		2008
Carp (*Cyprinus carpio*)	Introduced	2009
Common galaxias (*Galaxias maculatus*)		2009
Congolli (*Pseudaphritis urvillii*)		1993
Eastern gambusia (*Gambusia holbrooki*)	Introduced	2009
Flat-headed gudgeon (*Philypnodon grandiceps*)		2009
Flat-tailed mullet (*Liza argentea*)		1991
Freshwater shrimp (*Paratya australiensis*)		2009
Goldfish (*Carassius auratus*)	Introduced	1993
Largemouth goby (*Redigobius macrostoma*)		1995
Little penguin (*Eudyptula minor*)		1995
Macquarie perch (*Macquaria australasica*)	*EPBC* (E); *FFG* (L); VicAd (E)	1908
Mulloway (*Argyrosomus japonicas*)		1991
Oriental weatherloach (*Misgurnus anguillicaudatus*)	Introduced	2009
Sandy sprat (*Hyperlophus vittatus*)		1991

Asset / value	Conservation status	Maribyrnong River
Short-finned eel (*Anguilla australis*)		2009
Silver trevally (*Pseudocaranx georgianus*)		1991
Southern blue-spotted goby (*Pseudogobius olorum*)		2000
Southern elephant seal (*Mirounga leonina*)	*EPBC* (V)	1975
Spotted galaxias (*Galaxias truttaceus*)		2009
Tamar river goby (*Afurcagobius tamarensis*)		2008
Tupong (*Pseudaphritis urvillii*)		2009
Water rat (*Hydromys chrysogaster*)		2008
Yellow-eye mullet (*Aldrichetta forsteri*)		2008
Yellowfin goby (*Acanthogobius flavimanus*)	Introduced	1991

In addition to survey data, a search of the *EPBC Act 1999* Protected Matters Search Tool was undertaken to identify species of national conservation significance that could be present in the Maribyrnong River based on modelled distributions. These species have not necessarily been recorded, but based on their recorded distribution they could be present, if suitable habitat was available. Also, the Protected Matters Search Tool includes a buffer to the search zone, which means some species may be identified in the search zone, but only because the buffer zones cover a location with suitable habitat. This is a common issue where searches of estuarine systems return results for marine systems that fall within the buffer zone. Table 5-8 lists the riverine/estuarine species reported by the Protected Matters Search Tool and their likelihood of occurrence based on habitat requirements. Marine species reported by the Protected Matters Search Tool with a very low likelihood of being present are listed in Appendix A of this report.

Table 5-8 *EPBC Act 1999* PMST assessment for listed threatened species, migratory species and marine species for the waterways in the study area estuary[#]

Asset / value	*EPBC* listing and search tool assessment	Assessment of probability of occurrence in potential impacted area
LISTED THREATENED SPECIES		
Australian grayling (*Prototroctes maraena*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Likely** to occur in study area. Known from the Yarra River estuary (Koster and Dawson 2013, 2014). It is not a resident estuarine species, but uses the estuary as a migratory pathway. Although predominantly found in the Yarra River, they could migrate up the Maribyrnong River as well.
Eastern dwarf galaxias (*Galaxiella pusilla*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur in study area. Most commonly found in well-vegetated, still or slow-flowing backwaters or drains in freshwater reaches, not deep, swiftly-flowing un-vegetated channels (Allen et al. 2002). Suitable habitat has not been recorded at the investigation site in the Maribyrnong River.
Murray cod (*Maccullochella peelii*)	Vulnerable. Species or species habitat **may** occur within area.	**Very unlikely** to occur in study area. They are generally found in locations with undercut banks, dense vegetation and large snags. The Murray cod completes its entire life cycle in freshwater and therefore does not need to migrate to the ocean. It is located in the freshwater reaches of the Yarra River, occasionally including a short stretch downstream of Dights Falls, but has not been recorded from the lower estuary in the vicinity of the tunnels alignment. Suitable habitat has not been recorded at the investigation site in the Maribyrnong River.
Macquarie perch (*Macquaria australasica*)	Endangered. Species or species habitat **likely** to occur with the area.	**Very unlikely** to occur in the study area**.** Most of the important populations and breeding sites are known from the middle and upper Yarra River (King and Mahoney 2010; Tonkin et al. 2014).

Asset / value	*EPBC* listing and search tool assessment	Assessment of probability of occurrence in potential impacted area
		Are located in the freshwater reaches of the Yarra River, occasionally including a short stretch downstream of Dights Falls, but have not been recorded from the lower estuary in the vicinity of the tunnel alignment. Suitable habitat has not been recorded at the impacted area in the Maribyrnong River.
Yarra pygmy perch (*Nannoperca obscura*)	Vulnerable. Species or species habitat **likely** to occur with the area.	**Very unlikely** to occur in the study area. Last record on the VBA downstream of Dights Falls was in 1872. They are usually associated with dense emergent aquatic vegetation and woody debris in freshwater reaches. They complete their life cycle in freshwater (Sadlier and Hammer 2010) and therefore fish caught in the estuary are likely to be vagrants. Only known population in the Melbourne region is from the upper reaches of Deep Creek in the Maribyrnong catchment.
LISTED MIGRATORY SPECIES		
Australian fur seal (*Arctocephalus pusillus*)	Species or species habitat **may** occur within area.	**Possible.** Not a resident species, may occasionally venture up into the estuary.
Common dolphin (*Delphinus delphis*)	Species or species habitat **may** occur within area.	**Possible.** Not a resident species, may occasionally venture up into the estuary.

[#] *Species shaded in blue are likely, or could possibly occur within the potential impact area.*
(Ref: *EPBC Act 1999* PMST; accessed 19 May 2015.)

5.3.4 Summary of Biodiversity Values

As indicated above, there is a range of species that can potentially inhabit the Maribyrnong River estuary. There are also occasional visitors from marine environments. Each of these is discussed below.

Resident Estuarine Fish Species

Resident estuarine species in the Maribyrnong River are similar to those recorded in the Yarra River and include black bream, mulloway and yellow-eye mullet. Parts of the estuary may provide important habitat for breeding, nursery areas for juveniles and foraging habitat for adults. For example, black bream may spawn in the estuary at various locations depending on salinity, which in turn is driven by tidal influences and the volume of freshwater entering the estuary from upstream reaches.

Migratory Fish Species

Similar to the Yarra River, the upper estuary and freshwater reaches of the Maribyrnong River are home to a number of species that regularly migrate through the estuary for various life history requirements. A summary of their movement requirements is provided in Table 5-9 (and see Table 5-5 for a movement calendar for relevant species).

Table 5-9 Movement requirements of migratory fish in the Maribyrnong River

Common name	Movement / migratory patterns
Short-finned eel	Adults migrate to sea during summer and autumn at around 10-35 years of age. Spawning occurs in the Coral Sea and larvae return to coastal waterways and undertake upstream migration as elvers and sub-adult eels during spring and early summer.
Common galaxias	Adults reside in freshwater reaches and migrate to downstream in autumn to spawn in estuaries. Eggs are laid on flooded vegetation at upper tidal limit. Juveniles migrate into river mouths and then upstream into freshwater reaches during spring and summer.

Common name	Movement / migratory patterns
Spotted galaxias	Similar to common galaxias. Adults move downstream in autumn to spawn in lower freshwater reaches/estuary. Juvenile return to freshwater reaches in spring/summer.
Australian grayling (*EPBC* and *FFG* listed)	Adults migrate downstream towards the estuary in autumn to spawn. Larvae are swept to sea and juveniles return to freshwater reaches in spring. Adults are short-lived (three-five years), so upstream migration of juveniles is required every year to maintain a viable population.
Tupong	Adult females migrate downstream to estuaries in autumn-winter. Spawning occurs in the estuary or at sea. Juveniles spend some time maturing in marine environments before making upstream movements into freshwater reaches during summer.
Australian smelt	Previously thought to be a wholly freshwater species, however recent research shows that in coastal streams a portion of the population shows evidence of estuarine or marine occupation as larvae/juveniles. This research suggests that eggs and/or adults may be swept to estuaries and juveniles return to freshwater reaches. This upstream movement appears to occur over a protracted period through summer and autumn.

Although movements of migratory species can occur in all months, the most critical times for movement tend to be from late winter to early summer. This period, which coincides with increased river flows and increasing water temperature, provides cues for triggering upstream movement of juveniles from marine environments through the estuary to the freshwater reaches (see Table 5-5). Of these species, only the *EPBC Act 1999* and *Flora and Fauna Guarantee Act 1988* listed Australian Grayling as being of conservation significance.

Infrequent Marine Visitors

A number of marine species occasionally visit the Maribyrnong River. In 2009, dolphins were recorded in the Maribyrnong River (http://www.heraldsun.com.au/news/dolphins-find-new-home-in-maribyrnong-estate/story-e6frf7jo-1225750638018). Australian fur seals may also use the Maribyrnong River.

The estuary does not contain suitable long-term habitat for these species and they only appear to remain in the estuary for a few days at a time.

5.4 Moonee Ponds Creek – Existing Conditions

5.4.1 Water Quality

Routine water quality in the Moonee Ponds Creek is measured at Racecourse Road, Flemington by Melbourne Water. The location of the long-term water quality monitoring is about 1.5 km upstream of the project alignment, at the downstream end of the freshwater reach and therefore provides an indication of the quality of water entering the estuary, rather than the quality of the estuary itself. There is no routine water quality data available for the estuary. The background water quality, in particular regarding salinity concentrations, need to be interpreted in light of this, with actual quality likely to be more similar to the Yarra and Maribyrnong estuaries

The water quality parameters measured by Melbourne Water, where possible, have been compared against the relevant water quality guidelines. These guidelines are stipulated primarily by the *State Environment and Protection Policy* (SEPP) *Waters of Victoria* (WoV) and the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000).

Moonee Ponds Creek, south of Macaulay Road, Flemington, is within the Yarra Port segment. In addition to the SEPP guidelines, ANZECC (2000) guidelines have been used for nutrients and toxicants. It should be noted that the toxicant guidelines for freshwater have been used, as ANZECC (2000) does not provide specific guidelines for estuaries.

The relevant guideline concentrations as stipulated by SEPP and ANZECC (2000) are provided in Table 5-10.

Table 5-10 Water quality guidelines for Moonee Ponds Creek within the study area and monthly water quality data collected by Melbourne Water

Water quality variable	SEPP Schedule F7 (Yarra Port)	SEPP WoV – Marine and estuarine waters	ANZECC (2000) Estuary guidelines	ANZECC (2000) freshwater 95% species level protection	Long term monitoring data – Moonee Ponds Creek
pH	6.5 (25th) – 8.5 (75th)				8.1 – 8.3
Salinity (mg/L)	-		-	-	1400 (50th) 2075 (75th)
Dissolved Oxygen (% sat)	>60				24 (min) 84 (50th)
Turbidity (NTU)	<20 (50th)				8 (50th)
	<50 (90th)				9 (max)
***E. coli* (org/100ml)**	<1000				600 (50th)
Total Phosphorus (mg/L)		<0.03 (75th)	<0.03*		0.08 (50th) 0.13 (75th)
Total Nitrogen (mg/L)		<0.3 (75th)	<0.3*		1.9 (50th) 2.8 (75th)
Arsenic				0.013 (AsV)	0.001 (50th) 0.001 (75th)
Cadmium				0.0002	< 0.0001
Chromium				0.001	0.001 (50th) 0.003 (75th)
Copper				0.0014	0.004 (50th) 0.005 (75th)
Lead				0.0034	0.0015 (50th) 0.0023 (75th)
Nickel				0.011	0.0025 (50th) 0.003 (75th)
Zinc				0.008	0.0335 (50th) 0.0483 (75th)

** Guidelines not set as part of SEPP for the Upper Estuary and Yarra Port segments due to a lack of data. Guideline values taken from ANZECC (2000). R75 – Calculated as the 75th percentile of reference sites. For the purposes of the assessment, the guideline value for Schedule F7.*

Data from 2014 has been compared against the relevant SEPP and ANZECC (2000) guidelines (Table 5-10 and Appendix A for 2011-2014). Dissolved oxygen and pH were usually within SEPP and ANZECC (2000) guideline levels. Turbidity was within guideline levels. Total Nitrogen and Total Phosphorus were consistently above guideline concentrations. Zinc was frequently elevated compared to guidelines. Chromium occasionally exceeded guideline values, however, most other heavy metal concentrations were within guideline values. Salinity was relatively low (typically <2000 uS/cm). This is because the water quality monitoring site is at the downstream end of the freshwater reach and is not tidally influenced. The salinity range of the Moonee Ponds estuary would be similar to that recorded in the Yarra and Maribyrnong estuaries.

5.4.2 Aquatic Flora and Habitat

The riparian zone at Moonee Ponds Creek within the study area is made up primarily of weedy shrubs with no obvious aquatic macrophytes. The majority of the channel is shaded in this area by the CityLink tollway with limited instream habitat (Figure 5-3).

Upstream of the alignment, and away from the shading by the tollway, the channel is fringed by emergent macrophytes, mostly common reed (*Phragmites australis*). These relatively large reed beds may provide habitat for small-bodied fish, aquatic macroinvertebrates, common amphibian species and small birds, and represent an important habitat in the urban landscape.

Figure 5-3 Vegetation present at the Moonee Ponds Creek

The left panel shows bank condition at the alignment point; the right panel shows bank condition further upstream and away from the alignment point

5.4.3 Aquatic Fauna

The aquatic biota previously recorded within the study area was determined by examining records on the VBA (refer to DELWP, 2015) and fish survey reports from ARI. Table 5-11 summarises the species recorded in the Moonee Ponds Creek. Note; this list is based on available survey data and may not be exhaustive. surveys have been included, but do not mean those species are no longer present in the system, rather surveys may not have been recently undertaken or recent data not included in relevant databases.

Table 5-11 Aquatic fauna records from the VBA for Moonee Ponds Creek (downstream of Essendon) (accessed 19 May 2015 and 29 October 2015)

Asset / value	Conservation status	Moonee Ponds Creek
Black bream (*Acanthopagrus butcheri*)		1991
Bottlenose dolphin (*Tursiops truncatus*)		1977
Carp (*Cyprinus carpio*)	Introduced	2005
Common galaxias (*Galaxias maculatus*)		2005
Congolli (*Pseudaphritis urvillii*)		1995
Eastern gambusia (*Gambusia holbrooki*)	Introduced	2005
Flat-headed gudgeon (*Philypnodon grandiceps*)		2009
Freshwater shrimp (*Paratya australiensis*)		2005
Goldfish (*Carassius auratus*)	Introduced	1995
Platypus (*Ornithorhynchus anatinus*)		1980

Asset / value	Conservation status	Moonee Ponds Creek
Short-finned eel (*Anguilla australis*)		2005
Silver trevally (*Pseudocaranx georgianus*)		1991
Southern blue-spotted Goby (*Pseudogobius olorum*)		1995
Tamar river goby (*Afurcagobius tamarensis*)		2005
Tupong (*Pseudaphritis urvillii*)		1988

In addition to survey data, a search of the *EPBC Act 1999* Protected Matters Search Tool was undertaken to identify species of national conservation significance that could be present in the Moonee Ponds Creek based on modelled distributions. This does not mean these species are likely to be present, but that if habitat was suitable, they could be present based on their reported distribution. Also, the Protected Matters Search Tool includes a buffer to the search zone, which means some species may be identified in the study area, but only because the -ones cover a location with suitable habitat. Table 5-12 lists the riverine/estuarine species reported by the Protected Matters Search Tool and their likelihood of occurrence based on habitat requirements. Marine species reported by the Protected Matters Search Tool with a very low likelihood of being present are listed in Appendix A of this report.

Table 5-12 *EPBC Act 1999* PMST assessment for listed threatened species, migratory species and marine species for the Moonee Ponds Creek (accessed 19 May 2015)

Asset / value	*EPBC Act* listing and search tool assessment	Assessment of probability of occurrence in potential impacted area
LISTED THREATENED SPECIES		
Australian grayling (*Prototroctes maraena*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Unlikely** to occur**.** Known from the Yarra River and Maribyrnong River but not recorded from the Moonee Ponds Creek. Moonee Ponds Creek does not provide suitable habitat.
Eastern dwarf galaxias (*Galaxiella pusilla*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur in study area. Most commonly found in well vegetated, still or slow-flowing backwaters or drains in freshwater reaches, not deep, swiftly-flowing un-vegetated channels (Allen et al. 2002). Suitable habitat has not been recorded at the investigation site in the Moonee Ponds Creek.
Murray cod (*Maccullochella peelii*)	Vulnerable. Species or species habitat **may** occur within area.	**Very unlikely** to occur in study area. They are generally found in locations with undercut banks, dense vegetation and large snags. The Murray cod completes their entire life cycle in freshwater and therefore does not need to migrate to the ocean. Suitable habitat has not been recorded at the investigation site in the Maribyrnong River.
Growling grass frog (*Litoria raniformis*)	Vulnerable. Species or species habitat **may** occur within area.	**Very unlikely** to occur in study area. Growling grass frogs prefer slow flowing, well vegetated habitats. Suitable habitat not observed in the Moonee Ponds Creek at the location of potential impact.

5.4.4 Summary of Biodiversity Values

As indicated above, there is a range of species that can potentially inhabit the Moonee Ponds Creek. The species identified on the VBA are primarily freshwater species but there are may be occasional visitors from marine environments. Each of these is discussed as follows.

Migratory Fish Species

The upper estuary and freshwater reaches of the Moonee Ponds Creek are home to a number of species that migrate through the estuary for various life history requirements. A summary of their movement requirements is provided in Table 5-13 (and see Table 5-5 for a movement calendar for specific species).

Table 5-13 Movement requirements of migratory fish in the Moonee Ponds Creek

Common name	Movement / migratory patterns
Short-finned eel	Adults migrate to sea during summer and autumn at around 10-35 years of age. Spawning occurs in the Coral Sea and larvae return to coastal waterways and undertake upstream migration as elvers and sub-adult eels during spring and early summer.
Common galaxias	Adults reside in freshwater reaches and migrate to downstream in autumn to spawn in estuaries. Eggs are laid on flooded vegetation at upper tidal limit Juveniles migrate into river mouths and then upstream into freshwater reaches during spring and summer.
Tupong	Adult females migrate downstream to estuaries in autumn-winter. Spawning occurs in the estuary or at sea. Juveniles spend some time maturing in marine environments before making upstream movements into freshwater reaches during summer.

Infrequent Marine Visitors

Marine species may occasionally visit the Moonee Ponds Creek, although the last reliable record of a Bottlenose Dolphin from the Moonee Ponds Creek was from 1977 (the dolphin was caught near Arden Street and was released in Williamstown). So the likelihood of visitation is very low.

5.5 Albert Park Lake – Existing Conditions

5.5.1 Water Quality Analysis

Parks Victoria undertakes routine water quality analysis at three places in Albert Park Lake: the southern and northern ends of the lake, and in the middle. The water quality variables measured by Parks Victoria from between 1997 and 2013, where possible, have been compared against the relevant water quality guidelines. For simplicity, only the value from the middle of the lake has been presented, although this value is often similar to the other sampling locations.

These relevant guidelines are stipulated primarily by the *State Environment and Protection Policy* (SEPP) *Waters of Victoria* (WoV) and the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000). Albert Park Lake is within the Cleared Hills and Coastal Plans segment of the SEPP. In addition to the SEPP guidelines, ANZECC (2000) guidelines have been used for nutrients and toxicants.

The relevant guideline concentrations as stipulated by SEPP and ANZECC (2000) are provided in Table 5-14.

Table 5-14 Water quality guidelines relevant to the Albert Park Lake within the study area and routine water quality data collected by Parks Victoria (mean values provided for period 1997 to 2013)

Water quality variable	SEPP Waters of Victoria (Cleared Hills and Coastal Plains)	ANZECC (2000) freshwater 95% species level protection	Long term monitoring data – Albert Park Lake (middle of the lake)
pH	6.4 ($25^{th\%ile}$) – 8.3 ($75^{th\%ile}$)		8.6
Salinity (mg/L)	<1500	-	1566 µS/cm (approx. 850 mg/L)

Water quality variable	SEPP Waters of Victoria (Cleared Hills and Coastal Plains)	ANZECC (2000) freshwater 95% species level protection	Long term monitoring data – Albert Park Lake (middle of the lake)
Dissolved Oxygen (% sat)	> 85 ($25^{th\%ile}$) 110 (max)		9.4 mg/L (approx. 94%)
Turbidity (NTU)	< 5		12.5
***E. coli* (org/100ml)**	Prim. cont. < 150 Secon. cont. < 1000		642
Total Phosphorus (mg/L)	< 0.045		0.048
Total Nitrogen (mg/L)	< 0.6		0.815
Arsenic		0.013 (AsV)	Not recorded
Cadmium		0.0002	Not recorded
Chromium		0.001	Not recorded
Copper		0.0014	Not recorded
Lead		0.0034	Not recorded
Nickel		0.011	Not recorded
Zinc		0.008	Not recorded

Based on the available data, water quality in Albert Park Lake is indicative of an urban system that receives stormwater runoff. Dissolved oxygen and salinity generally meet guidelines. But pH total nitrogen, total phosphorus and turbidity are elevated compared to guidelines.

5.5.2 Aquatic Flora and Habitat

There would be no direct construction impacts on Albert Park Lake from Melbourne Metro. There is, however, a highly unlikely possibility that the water quality of the lake could be impacted by runoff from construction work sites, station entrances or from dewatering entering stormwater which discharges to the lake.

There is very limited aquatic habitat at the lake. The margins are nearly all concrete lined. Some aquatic habitat diversity would be provided by the fringing vegetation on the small islands to the eastern end of the lake.

5.5.3 Aquatic Fauna

The aquatic biota previously recorded within the study area was determined by examining records on the VBA (refer DELWP, 2015) and Department of Agriculture fish stocking records (http://agriculture.vic.gov.au/fisheries/recreational-fishing/fish-stocking). Table 5-15 summarises the species recorded for Albert Park Lake and indicates which species are only present due to stocking and which are likely to be resident species. Note: this list is based on available survey data and may not be exhaustive.

Table 5-15 Aquatic Fauna records for Albert Park Lake

Asset / value	Albert Park Lake
Golden perch (*Macquaria ambigua*)	Stocked
Trout cod (*Maccullochella macquariensis*)	Stocked
Brown trout (*Salmo trutta*)	Stocked

Asset / value	Albert Park Lake
Carp (*Cyprinus carpio*)	Resident
Silver perch (*Bidyanus bidyanus*)	Stocked
Estuary perch (*Macquaria colonorum*)	Stocked
Short-finned eel (*Anguilla australis*)	Resident

Ref: (Victorian Biodiversity Atlas, http://agriculture.vic.gov.au/fisheries/recreational-fishing/fish-stocking).

In addition to survey and stocking data, a search of the *EPBC Act 1999* Protected Matters Search Tool was undertaken to identify species of national conservation significance that could be present in Albert Park Lake based on modelled distributions. This does not mean these species are likely to be present, but that if habitat was suitable, they could be present based on their reported distribution. The Protected Matters Search Tool includes a buffer to the search zone, which means some species may be identified in the study area, but only because the buffer zones cover a location with suitable habitat. All threatened species identified by the Protected Matters Search Tool are not considered to be likely to be present based on their habitat requirements, or are present only due to stocking activities (ie trout cod). Species reported by the Protected Matters Search Tool with a very low likelihood of being present are listed in Appendix A of this report.

5.6 Stony Creek – Existing Conditions

5.6.1 Stormwater Drainage

Much of the area in the vicinity of the existing West Footscray station is covered by a Special Building Overlay (SBO). This is associated with overland flows in excess of the capacity of underground drains in the Graingers Road main drain system. Graingers Road main drain passes under the western end of Footscray West station, and flows from north to south. This system outfalls to Stony Creek downstream of Somerville Road.

5.6.2 Water Quality Analysis

Water quality in Stony Creek is measured by Melbourne Water on a monthly basis at Bena Street in Yarraville, approximately 2 km downstream of Sommerville Road. This data was assessed to establish an understanding of the background water quality in Stony Creek in the study area.

Water quality in Stony Creek measured in 2014 has been compared against the relevant SEPP and ANZECC (2000) guidelines. (Table 5-16, see Appendix A of this report for data from 2011-2014.) Stony Creek, at the location of the potential impact from the western turnback, is part of the Cleared Hills and Coastal Plans segment of the SEPP. In addition to the SEPP guidelines, ANZECC (2000) guidelines have been used for nutrients and toxicants.

Table 5-16 Water quality guidelines relevant to the Stony Creek within study area and monthly water quality data collected by Melbourne Water

Water quality variable	SEPP Waters of Victoria (Cleared Hills and Coastal Plains)	SEPP WoV – Marine and estuarine waters	ANZECC (2000) freshwater 95% species level protection	Long term monitoring data – Stony Creek
pH	6.4 (25^{th}) – 8.3 (75^{th})			7.8 – 9.5
Salinity (mg/L)	< 1500		-	400 (50^{th}) 570 (75^{th})
Dissolved Oxygen (% saturation)	>85 (25^{th}) 110 (max)			77 (25^{th}) 256 (max)
Turbidity (NTU)	<5			13 (50^{th}) 180 (max)

Water quality variable	SEPP Waters of Victoria (Cleared Hills and Coastal Plains)	SEPP WoV – Marine and estuarine waters	ANZECC (2000) freshwater 95% species level protection	Long term monitoring data – Stony Creek
***E. coli* (org/100ml)**	Primary contact < 150 Secondary contact <1000			685 (50th)
Total Phosphorus (mg/L)	<0.045			0.45 (50th) 0.64 (75th)
Total Nitrogen (mg/L)	<0.6	<0.03 (75th)		2.3 (50th) 13.2 (75th)
Arsenic		<0.3 (75th)	0.013 (AsV)	0.006 (50th) 0.0088 (75th)
Cadmium			0.0002	<0.0001
Chromium			0.001	0.001 (50th) 0.001 (75th)
Copper			0.0014	0.011 (50th) 0.0135 (75th)
Lead			0.0034	0.002 (50th) 0.003 (75th)
Nickel			0.011	0.003 (50th) 0.0043 (75th)
Zinc			0.008	0.075 (50th) 0.08 (75th)

Water quality in Stony Creek rarely meets guideline concentrations. Total nitrogen and total phosphorus in particular is elevated compared to guidelines. *E. coli* was also extremely high at times. Some of the heavy metal concentrations were within SEPP/ANZECC (2000) guideline values much of the time. Chromium, lead and zinc were frequently elevated compared to guidelines.

5.6.3 Aquatic Flora and Habitat

Stony Creek is a highly modified channel. South of Somerville Road the creek runs through an earthen channel within a linear park. Instream habitat consists of shallow pools and constructed rock riffles. The riparian verge consists of scattered native and exotic trees and grass. Near Francis Street the creek enters a concrete-lined channel before a short estuary that joins the Yarra River just north of the West Gate Freeway. A large tidal lagoon, Stony Creek Backwash, is located at the confluence with the Yarra River.

5.6.4 Aquatic Fauna

The aquatic biota previously recorded within the study area was reviewed by examining records on the VBA (refer DELWP, 2015). No fish species were recorded from Stony Creek on the VBA. The only aquatic species recorded was the common yabby (*Cherax destructor*). The concrete-lined channel at the lower reaches of the freshwater section would act as a barrier to fish movement for most species.

In addition to survey data, a search of the *EPBC Act 1999* Protected Matters Search Tool was undertaken to identify species of national conservation significance that could be present in Stony Creek based on modelled distributions. This does not mean these species are likely to be present, but that if habitat was suitable, they could be present based on their reported distribution. Also, the Protected Matters Search Tool includes a buffer to the search zone, which means some species may be identified in the study area, but only because the buffer zones cover a location with suitable habitat. Table 5-17 lists the riverine/estuarine

species reported by the Protected Matters Search Tool and their likelihood of occurrence based on habitat requirements. Marine species reported by the Protected Matters Search Tool with a very low likelihood of being present are listed in Appendix A of this report.

Table 5-17 *EPBC Act 1999* PMST assessment for listed threatened species, migratory species and marine species for the waterways in the study area estuary

Asset / value	*EPBC Act* listing and search tool assessment	Assessment of probability of occurrence in potential impacted area
LISTED THREATENED SPECIES		
Australian grayling (*Prototroctes maraena*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely to occur.** Known from the Yarra River and Maribyrnong River but not recorded from Stony Creek. Stony Creek does not provide suitable adult habitat, concrete lined channel would act as a barrier to upstream migration of juveniles.
Eastern dwarf galaxias (*Galaxiella pusilla*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely to occur.** Stony Creek does not provide suitable habitat.
Murray cod (*Maccullochella peelii*)	Vulnerable. Species or species habitat **may** occur within area.	**Very unlikely to occur** in study area. They are generally found in locations with deep pools, undercut banks, dense vegetation and large snags. Suitable habitat is very unlikely to occur in Stony Creek.
Growling grass frog (*Litoria raniformis*)	Vulnerable. Species or species habitat **may** occur within area.	**Very unlikely to occur** in study area. Growling Grass Frogs prefer slow or still flowing, well vegetated habitats. Suitable habitat not observed downstream of Somerville Road.

(Ref: *EPBC Act 1999* PMST; accessed 14 October 2015)

5.6.5 Summary of Biodiversity Values

Biodiversity values in Stony Creek are low and there is limited habitat suitable for native fish. The estuarine reach is relatively short and may support a number of small estuary species similar to those found in the Yarra River estuary.

6 Risk Assessment

Table 6-1 presents the aquatic ecology and river health risks associated with the project, based on a precinct basis. The environmental risk assessment methodology is outlined in Section 4.2.

The initial risk ratings were based on compliance with statutory requirements.

Section 7 provides a description of the activities associated with each precinct and lists the issues that could impact on aquatic ecology values. Section 8 then provides more detail on the impacts and level of risk to aquatic ecology values. The aquatic ecology and river health risks identified within the risk assessment primarily, focus on the three major waterways across which the Melbourne Metro traverses. The risk assessment takes into consideration potential impacts associated with changes to groundwater and surface water and how these would impact on aquatic ecology values. The aquatic ecology risk assessment also considers how Environmental Performance Requirements and mitigation measures to address impacts on groundwater and surface water would also mitigate potential impacts to aquatic ecology. The majority of initial risks have been classified as low, with the exception of potential water quality impacts associated with construction activity (turbid runoff from construction sites and from trucks carrying spoil) and potential operation of the electrical substation (release of transformer oil). The medium risks are reflective of potential for moderate impacts to the waterways, combined with likely or possible likelihood that they would be present in an unmitigated scenario. To address these risks, mitigation measures have been identified that are proven techniques to minimise the potential likelihood of a risk event occurring, thereby reducing all residual risks to either low or very low. These mitigation measures are considered business-as-usual steps that if effectively implemented are proven techniques for managing potential impacts associated with the identified hazard events against which a medium initial risk has been allocated.

Section 9 documents the project-specific performance requirements (Environmental Performance Requirements) which aim to reduce risks to determine the 'Residual Risk Rating'.

For further information, refer to Technical Appendix B *Environmental Risk Assessment Report* of the EES which includes the full Risk Register, with existing performance requirements and recommended Environmental Performance Requirements assigned to each risk.

Table 6-1 Risk register for impact assessment

Impact pathway		Precinct	Initial risk			Residual risk			Risk no.
Category	Event		C	L	Risk	C	L	Risk	
Construction									
Inputs of surface sediments, chemicals and rubbish from construction zones (including early works) into waterways, either directly or via stormwater drainage system during construction associated with rainfall runoff	Results in reduced water quality (increased turbidity, pollution event, oils and grease, etc.) at Moonee Ponds Creek, Maribyrnong River, Yarra River, Stony Creek and Albert Park Lake. This risk is present at all locations where there would be surface-based construction activities, even well away from water courses. This is due to the potential for runoff to the drainage system that ultimately discharges to waterways.	All	Moderate	Likely	Medium	Moderate	Unlikely	Low	**AE001**
Accidental disposal of untreated groundwater to waterways during construction	Tunnelling activities cause groundwater infiltration to tunnel, creating slurry. Accidental discharge of slurry to waterways could result in a short-term reduction in water quality due to turbidity, salinity, oils and greases etc.	1 - Tunnels	Moderate	Unlikely	Low	Moderate	Rare	Low	**AE002**
Stabilisation of Yarra River bed above tunnel using grout	Disturbance of the riverbed and the release of sediments or grout to the water column could degrade water quality.	1 - Tunnels	Minor	Possible	Low	Minor	Rare	Very Low	**AE003**
Stabilisation of Yarra River bed above tunnel using grout	Potential disruption to fish passage from barge presence and grouting operation (upstream passage of juvenile fish in spring, downstream passage of eggs and larvae in autumn).	1 - Tunnels	Minor	Rare	Very Low	Minor	Rare	Very Low	**AE004**
TBM-generated noise and vibration on Yarra River and Moonee Ponds Creek	Potential disruption to fish passage (behavioural) from ground-borne noise and vibration associated with TBM activity. The noise and vibration impact assessment indicates noise and vibration to be no more than background during construction (see Technical Appendix I *Noise and Vibration* Section 1.3.1).	1 - Tunnels	Negligible	Rare	Very Low	Negligible	Rare	Very Low	**AE005**

Impact pathway		Precinct	Initial risk			Residual risk			Risk no.
Category	Event		C	L	Risk	C	L	Risk	
Groundwater level drawdown causes subsidence and alters river flow patterns	Potential subsidence from changes in groundwater results in altered flow regime that impacts on river fauna. Technical Appendix O *Groundwater* and Technical Appendix P *Ground Movement and Land Stability* show drawdown and subsidence to be unlikely provided appropriate mitigation measures are adopted. Furthermore, river water regime is dominated by tidal process and not sensitive to changes in groundwater/surface water interactions.	1 - Tunnels	Minor	Possible	Low	Minor	Unlikely	Low	**AE006**
Inputs to surface water drainage system and waterways by trucks (spoil haulage and other construction, including early works)	Potential for reduced water quality (increased turbidity, pollution event, oils and grease, etc.) at Moonee Ponds Creek, Maribyrnong River and Yarra River. This risk is present along transport routes and other construction-related transport routes. The risk considers multiple construction sites, timeframe over which construction occurs and the large number of truck movements required.	All	Moderate	Likely	Medium	Moderate	Unlikely	Low	**AE007**
Inputs of surface sediments, chemicals and rubbish from construction zones (including early works) into waterways, either directly or via stormwater drainage system during construction associated with overland flooding	Potential for reduced water quality in receiving waterways where overland flooding inundated construction zones. Technical Appendix N *Surface Water* indicates that some construction areas are located within land subject to inundation. However flood protection measures are recommended to minimise likelihood of construction zone inundation.	All	Moderate	Possible	Medium	Moderate	Rare	Low	**AE008**
Operation									
Portal design or operational management practices are inadequate to treat stormwater runoff prior to discharge to waterways	Runoff from tunnel portal contains oils and greases and some sediment. Inadequate treatment of portal drainage runoff could result in short-term reduction in water quality for the duration of the rainfall event.	2 - Western portal 8 - Eastern portal	Moderate	Unlikely	Low	Minor	Unlikely	Low	**AE009**

Impact pathway		Precinct	Initial risk			Residual risk			Risk no.
Category	Event		C	L	Risk	C	L	Risk	
Tunnel drainage water to waterways during operations	Potential impact to water quality in receiving waterway due to the seepage of small volumes of saline groundwater (potentially with small quantities of grease and oil) into tunnels during operations. Fire-quelling water during an emergency may also collect in the tunnel drainage system. Groundwater salinity varies across the tunnel length, from 4,000 mg/l to 22,000 mg/l. Receiving waterways are estuarine and volume of discharge is likely to be very small compared with river flows. Consequently, there would be significant dilution, hence salinity is not a significant risk, but oils, grease, chemicals and other pollutants should be avoided.	1 - Tunnels	Negligible	Likely	Low	Negligible	Possible	Low	**AE010**
Train operations-generated noise and vibration on Yarra River and Moonee Ponds Creek	Potential disruption to fish passage (behavioural) from ground-borne noise and vibration associated with trains moving within the tunnels. The noise and vibration impact assessment indicates noise and vibration to be no more than background during operation (See Technical Appendix I *Noise and Vibration* Section 1.3.2).	1 - Tunnels	Negligible	Unlikely	Very Low	Negligible	Unlikely	Very Low	**AE011**
Input of potentially toxic substances from the substation	Potential leakage of transformer cooling liquids due to equipment faults or flooding has the potential to enter the Moonee Ponds Creek, especially during flood events. Technical Appendix N *Surface Water* identifies flooding as a low risk if appropriate flood protection is adopted.	3 - Arden station	Moderate	Unlikely	Low	Moderate	Rare	Low	**AE012**

7 Precinct Descriptions

7.1 Precinct 1: Tunnels

7.1.1 Project Components

The relevant components of the Concept Design in this precinct for this assessment are:

- The crossing under the Yarra River and Moonee Ponds Creek
- The alignment passing above the CityLink tunnels
- Access shaft within the CBD – Lonsdale Street access shaft
- TBM southern launch site at Fawkner Park open space and tennis courts
- Emergency access shafts:
  - Fawkner Park north east location
  - Queen Victoria Gardens, adjacent to Linlithgow Avenue.

The relevant components of the alternative design options in this precinct for this assessment are:

- The alignment passing underneath the CityLink tunnels
- The two options for the emergency access shaft locations
  - Fawkner Park – Use of the location of the Fawkner Park TBM launch site
  - Linlithgow Avenue – Located in Tom's Block, between Linlithgow Avenue and St Kilda Road.

7.1.1.1 Construction

The relevant construction activities for this report are:

- The Yarra River crossing and the Moonee Ponds Creek crossing
- Potential for groundwater seepage into the tunnels during construction and the disposal to an approved point of discharge
- The siting of the TBM launch site and emergency access shafts, in particular spoil-handling and material laydown areas being located at the surface.

The relevant construction activities for the alternative design options are similar to those for the Concept Design.

7.1.1.2 Operations

The lining of the tunnels would be constructed to minimise groundwater infiltration to the tunnels. Even so, a small amount of groundwater may still infiltrate the tunnels, which would be collected and disposed of via an approved point of discharge.

7.1.2 Existing Conditions

Existing conditions for Yarra River are described in detail in Section 5.2 and for Moonee Ponds Creek in Section 5.4.

7.1.3 Key Issues

As identified in the risk assessment (Table 6-1), the potential issues associated with the Concept Design are identified in Table 7-1. The Impact associated with these issues on aquatic values in the Yarra River and Moonee Ponds Creek are described in Section 8 of this report.

Table 7-1 Key issues associated with the Concept Design

Concept Design	Potential issue	Risk #
Yarra River Crossing – TBM under the river.	• Stabilisation of riverbed sediments. • Discharge of groundwater to waterways during construction. • Ground borne noise and vibration. • Groundwater drawdown impacts on river flow.	AE003/004 AE002 AE005 AE006
Yarra River.	• Discharge of groundwater to waterways during operation.	AE010
TBM southern launch site at Fawkner Park open space and tennis courts.	• Disposal of runoff from construction work site to stormwater system and waterway during rainfall runoff. • Runoff from roads travelled by trucks outside of construction zones. • Disposal of runoff from construction work site to stormwater system and waterway during overland flood flows.	AE001 AE007 AE008
Emergency Access shafts		
Fawkner Park north east location	• Disposal of runoff from construction work site to stormwater system and waterway during rainfall runoff. • Runoff from roads travelled by trucks outside of construction zones. • Disposal of runoff from construction work site to stormwater system and waterway during overland flood flows.	AE001 AE007 AE008
Queen Victoria Gardens, adjacent to Linlithgow Avenue.		
Access shaft within the CBD – Lonsdale Street access shaft.		

7.1.3.1

The key issues associated with the alternative design options are the same as those identified for the Concept Design.

7.1.4 Benefits and Opportunities

The Concept Design involves tunnelling under the Yarra River and Moonee Ponds Creek, so there are no direct impacts on waterways and no direct impacts on aquatic flora and fauna. This represents a significant benefit to aquatic ecology and river health compared to other possible construction techniques.

7.2 Precinct 2: Western Portal (Kensington)

7.2.1 Project Components

The relevant component of the Concept Design for this report is:

- The proximity of new infrastructure to the Maribyrnong River and Moonee Ponds Creek.

7.2.1.1 Construction

The main relevant construction activities relating to potential impacts on the Maribyrnong River and Moonee Ponds Creek include:

- Establishment of construction work sites
- Surface works such as construction of piled structures, the decline structure and the tunnel excavation and TBM retrieval (with the TBM driving first to the western portal from Arden station before being retrieved and relaunched from Arden station for the second drive to CBD North station)
- Track works and installation of rail systems

- A major construction work site to be located on Hobsons Road, Kensington, to support activities at the western portal. This site would be used for site offices and facilities, laydown areas and materials and equipment storage.

There is an alternative design option at the location of the western portal that places the portal further west although overlapping with the Concept Design portal location. The potential impacts associated with the alternative design option are no different to those associated with the Concept Design.

7.2.1.2 Operations

The relevant component during operation is the:

- management of stormwater runoff
- discharge rate into the existing drainage system.

7.2.2 Existing Conditions

Existing conditions for Maribyrnong River are described in detail in Section 5.3.

7.2.3 Key Issues

The key issues associated with the Concept Design are identified in Table 7-2. Impacts associated with these issues and recommended Environmental Performance Requirements are described in Section 8 of this report.

Table 7-2 Key issues associated with the Concept Design

Concept Design	Issue	Risk #
50 Lloyd Street Business Estate TBM retrieval box	• Disposal of runoff from construction site to stormwater system and waterway during rainfall runoff. • Runoff from roads travelled by trucks outside of construction zones. • Disposal of runoff from construction work site to stormwater system and waterway during overland flood flows. • Discharge of groundwater to waterways during portal construction.	AE001 AE007 AE008 AE002
Western portal decline	• Disposal of runoff from portal decline during operation.	AE009

7.2.4 Benefits and Opportunities

A benefit of the Concept Design and alternative design options is that works are avoided within the Maribyrnong River, hence minimising impacts on aquatic ecology and river health.

7.3 Precinct 3: Arden Station

7.3.1 Project Components

The relevant components of the Concept Design for this report are:

- The location of the station and substation in proximity to the Moonee Ponds Creek and within the Land Subject to Inundation Overlay (see Technical Appendix N *Surface water*)

7.3.1.1 Construction

The main relevant construction activities relating to potential impacts on the Moonee Ponds Creek include:

- Establishment of construction work sites
- Tunnels excavation and TBM launch (with the TBM driving first to the western portal before being retrieved and relaunched from Arden station for the second drive towards CBD North station)
- Siting of tunnels construction water treatment plant and water tanks, and a tunnel air ventilation and extraction plant
- Construction of electrical substation.

7.3.1.2 Operations

The station box lining would be constructed to minimise groundwater infiltration. Even so, a small amount of groundwater may still infiltrate the station box, which would be collected and disposed of via an approved point of discharge as part of tunnel operations.

7.3.2 Existing Conditions

Existing conditions for Moonee Ponds Creek are described in detail in Section 5.4.

7.3.3 Key Issues

The key issues associated with the Concept Design are identified in Table 7-3. Impacts associated with these issues and recommended Environmental Performance Requirements are described in Section 8 of this report.

Table 7-3 Key issues associated with the Concept Design Project

Concept Design	Issue	Risk #
Aligned between the alignment of Arden and Queensberry streets, in the publicly-owned (VicTrack) land	• Disposal of runoff from construction work site to stormwater system and waterway during rainfall runoff. • Runoff from roads travelled by trucks outside of construction zones. • Disposal of runoff from construction work site to stormwater system and waterway during overland flood flows. • Disposal of groundwater to waterways during station box construction. • Disposal of groundwater to waterways during operation.	AE001 AE007 AE008 AE002 AE010
Electrical substation	• Disposal of runoff from construction site to stormwater system and waterway. • Flooding during operations and discharge of potentially toxic compounds to Moonee Ponds Creek.	AE001 AE012

7.3.4 Benefits and Opportunities

No benefits or opportunities associated with the Concept Design or alternative design option have been identified for the precinct in relation to aquatic ecology or water quality.

7.4 Precinct 4: Parkville Station

7.4.1 Project Components

The relevant components of the Concept Design for this report are:

- the location of the station within the Moonee Ponds Creek catchment.

7.4.1.1 Construction

The main relevant construction activities relating to potential impacts on the Moonee Ponds Creek include:

- the use of the top down cut-and-cover construction method. Tunnel excavation takes place through the station box (cavern).

The alternative design option comprises construction using a bottom up cut-and-cover method.

7.4.1.2 Operations

The station box lining would be constructed to minimise groundwater infiltration. Even so, a small amount of groundwater could still infiltrate the station box, which would be collected and disposed of via an approved point of discharge as part of tunnel operations.

7.4.2 Existing Conditions

Existing conditions for Moonee Ponds Creek are described in detail in Section 5.4.

7.4.3 Key Issues

The key issue associated with the Concept Design and the alternative design options are identified in Table 7-4. Impacts associated with these issues and recommended Environmental Performance Requirements are described in Section 8.

Table 7-4 Key issues associated with the Concept Design

Concept Design	Issue	Risk #
Parkville station – located under Grattan Street, to the east of Royal Parade	• Disposal of runoff from construction site to stormwater system and waterway during rainfall runoff. • Runoff from roads travelled by trucks outside of construction zones. • Disposal of runoff from construction work site to stormwater system and waterway during overland flood flows. • Disposal of groundwater to waterways during station box construction. • Disposal of groundwater to waterways during operation.	AE001 AE007 AE008 AE002 AE010

7.4.4 Benefits and Opportunities

No benefits or opportunities associated with the Concept Design have been identified for the precinct in relation to aquatic ecology or water quality.

The alternative design option has a smaller surface construction footprint which reduces the potential for runoff from exposed construction surfaces. Mitigation measures would also be easier to achieve because the area of surface construction is smaller.

7.5 Precincts 5 and 6: CBD North and CBD South stations

7.5.1 Project Components

The relevant components of the Concept Design for this report are:

- The location of the stations within the stormwater drainage catchment of the Yarra River.

7.5.1.1 Construction

The main relevant construction activities relating to potential impacts on the Yarra River are:

- Establishment of construction work sites
- Establishment of site offices, materials storage and laydown at City Square
- Construction of station entrances and connections to Melbourne Central station (CBD North station) and Flinders Street Station and Federation Square (CBD South station).

7.5.1.2 Operations

The station box linings would be constructed to minimise groundwater infiltration. Even so, a small amount of groundwater may still infiltrate the station boxes, which would be collected and disposed of via an approved point of discharge as part of tunnel operations.

7.5.2 Existing Conditions

Existing conditions for the Yarra River are described in detail in Section 5.2.

7.5.3 Key Issues

The key issues associated with the Concept Design are identified in Table 7-5. Impacts associated with these issues and the recommended Environmental Performance Requirements are described in Section 8.

Table 7-5 Key issues associated with the Concept Design

Concept Design	Issue	Risk #
CBD North station		
Located under Swanston Street, between Franklin and La Trobe Streets	• Disposal of runoff from construction site to stormwater system and waterway during rainfall runoff. • Runoff from roads travelled by trucks outside of construction zones. • Disposal of runoff from construction work site to stormwater system and waterway during overland flood flows. • Disposal of groundwater to waterways during station box construction. • Disposal of groundwater to waterways during operation.	AE001 AE007 AE008 AE002 AE010
Entrances on the:		
• east side of Franklin Street • corner of Swanston and La Trobe Streets	• As above.	As above
CBD South station		
Located under Swanston Street, between Collins and Flinders Streets	• As above	As above

Concept Design	Issue	Risk #
Entrances:		
• Collins Street entrance at City Square (potential to include 65 and 67 Swanston Street)	• As above.	As above
• Flinders Street entrance including Port Phillip Arcade with underground connection to Flinders Street Station.	• As above.	As above

7.5.4 Benefits and Opportunities

No benefits or opportunities associated with the Concept Design have been identified for the precinct in relation to aquatic ecology or water quality.

7.6 Precinct 7: Domain Station

7.6.1 Project Components

The relevant components of the Concept Design for this report are:

- The location of the station within the stormwater drainage catchment of Albert Park Lake
- TBM southern launch site.

7.6.1.1 Construction

The main relevant construction activities relating to potential impacts on Albert Park Lake are:

- The siting of the TBM launch site, in particular soil-handling and material laydown areas being located at the surface
- Establishment of construction work sites
- Station structural works, including an excavation area of approximately 19,400 m^2.

7.6.1.2 Operations

The station box lining would be constructed to minimise groundwater infiltration. Even so, a small amount of groundwater could still infiltrate the station box, which would be collected and disposed of via an approved point of discharge as part of tunnel operations.

7.6.2 Existing Conditions

Existing conditions for the Yarra River are described in detail in Section 5.2. Existing Conditions for Albert Park Lake are described in detail in Section 5.5.

7.6.3 Key Issues

The key issues associated with the Concept Design are identified in Table 7-6. Impacts associated with these issues and recommended Environmental Performance Requirements are described in Section 8 of this report.

Table 7-6 Key issues associated with the Concept Design

Concept Design	Issue	Risk #
Located under St Kilda Road, adjacent to Albert Road	• Disposal of runoff from construction site to stormwater system and waterway during rainfall runoff. • Runoff from roads travelled by trucks outside of construction zones. • Disposal of runoff from construction work site to stormwater system and waterway during overland flood flows. • Disposal of groundwater to waterways during station box construction. • Disposal of groundwater to waterways during operation.	AE001 AE007 AE008 AE002 AE010
TBM Domain launch site	• Disposal of runoff from construction work site to stormwater system and waterway during rainfall runoff. • Runoff from roads travelled by trucks outside of construction zones. • Disposal of runoff from construction work site to stormwater system and waterway during overland flood flows.	AE001 AE007 AE008

7.6.4 Benefits and Opportunities

No benefits or opportunities associated with the Concept Design have been identified for the precinct in relation to aquatic ecology or water quality.

7.7 Precinct 8: Eastern Portal (South Yarra)

7.7.1 Project Components

The relevant components of the Concept Design for this report are:

- The location of the portal within the stormwater drainage catchment of the Yarra River.

7.7.1.1 Construction

The main relevant construction activities relating to potential impacts on the Yarra River are:

- Establishment of construction work sites
- Establishment of site offices, materials storage and laydown areas
- Surface works such as demolition works (building and bridge), construction of piled structures, the decline structure and the tunnel excavation and TBM retrieval
- Track works and installation of rail systems.

7.7.1.2 Operations

The relevant components during operation are the:

- Management of stormwater runoff
- Discharge rate into the existing drainage system.

7.7.2 Existing Conditions

Existing conditions for the Yarra River are described in detail in Section 5.2.

7.7.3 Key Issues

The key issues associated with the Concept Design are identified inTable 7-7. Impacts associated with these issues and recommended Environmental Performance Requirements are described in Section 8 of this report.

Table 7-7 Key issues associated with the Concept Design

Concept Design	Issue	Risk #
All eastern portal works including the TBM shaft and associated construction works in the rail reserve between Osborne Street and the existing Sandringham line	• Disposal of runoff from construction site to stormwater system and waterway during rainfall runoff. • Runoff from roads travelled by trucks outside of construction zones. • Disposal of runoff from construction work site to stormwater system and waterway during overland flood flows. • Discharge of groundwater to waterways during portal construction.	AE001 AE007 AE008 AE002
Eastern portal decline	• Disposal of runoff from portal decline during operation.	AE009

7.7.4 Benefits and Opportunities

No benefits or opportunities associated with the Concept Design have been identified for the precinct in relation to aquatic ecology or water quality.

7.8 Precinct 9: Western Turnback

7.8.1 Project Components

The relevant components of the Concept Design are:

- The location of the turnback at West Footscray being within the stormwater drainage catchment of Stony Creek.

7.8.1.1 Construction

The main relevant construction activities relating to potential impacts on Stony Creek are:

- Establishment of construction work sites
- Surface construction and track laying.

7.8.2 Existing Conditions

Existing conditions for Stony Creek are described in detail in Section 5.6.

7.8.3 Key Issues

The key issue associated with the Concept Design are identified in Table 7-8. Impacts associated with these issues and recommended Environmental Performance Requirements are described in Section 8 of this report.

Table 7-8 Key issues associated with the Concept Design

Concept Design	Issue	Risk #
West Footscray – a third platform and track at Footscray station, with modifications to existing concourse	• Disposal of runoff from construction work site to stormwater system and waterway during rainfall runoff. • Runoff from roads travelled by trucks outside of construction zones. • Disposal of runoff from construction site to stormwater system and waterway during overland flood flows.	AE001 AE007 AE008

7.8.4 Benefits and Opportunities

No benefits or opportunities associated with the Concept Design have been identified for the precinct in relation to aquatic ecology or water quality.

7.9 Early Works

7.9.1 Project Components

The early works component of the Concept Design has the potential to impact the Maribyrnong River, Moonee Ponds Creek and the Yarra River.

A number of early works are required prior to the commencement of the main construction works. The early works all comprise modifications, temporary works, relocations or new works associated with existing utilities and services as follows:

- Electrical
- Sewer
- Gas
- Water
- Stormwater
- Communications
- Tram works.

The works of relevance to aquatic flora and fauna and water quality impacts are any that involve disturbance to ground surfaces that could result in contaminated runoff entering waterways.

7.9.1.1 Construction

Surface runoff from construction work sites has the potential to enter stormwater drainage systems and impact on water quality in receiving waterways.

7.9.2 Existing Conditions

See relevant waterway sections for a description of existing conditions.

7.9.3 Key Issues

The key issue is the disposal of runoff from various construction work sites to the stormwater system and receiving waterway (Table 7-9). Impacts associated with these issues are described in Section 8 of this report.

Table 7-9 Key issues associated with the Concept Design

Concept Design	Issue	Risk #
Various locations	• Disposal of runoff from construction work site to stormwater system and waterway during rainfall runoff. • Runoff from roads travelled by trucks outside of construction zones. • Disposal of runoff from construction site to stormwater system and waterway during overland flood flows.	AE001 AE007 AE008

8 Impact Assessment

8.1 Assessment Criteria

The impact assessment considers the potential impact on aquatic ecology and river health values using the following draft EES evaluation objectives and assessment criteria (and indicators where relevant) (Table 8-1).

Table 8-1 Draft EES evaluation objectives and assessment criteria

Draft EES evaluation objectives	Assessment criteria
Hydrology and waste management: To protect waterways and waterway function and surface water and groundwater quality in accordance with statutory objectives, to identify and prevent potential adverse environmental effects resulting from the disturbance of contaminated or acid-forming material and to manage excavation spoil and other waste in accordance with relevant best practice principles.	Any discharge to waterways is to comply with background concentrations and/or relevant SEPP criteria.
Biodiversity: To avoid or minimise adverse effects on native terrestrial and aquatic flora and fauna, in the context of the project's components and urban setting.	Any discharge to waterways and direct construction impacts are to avoid or minimise impacts on aquatic fauna and flora (eg impacts on habitat and critical life history requirements such as fish passage).

Potential impacts can be categorised into those associated with general impacts that could potentially occur across all precincts (eg runoff from construction work sites) and those that are precinct-specific (eg Yarra River bed stabilisation.) These are described in more detail below. Recommended Environmental Performance Requirements are described in Section 9 of this report.

8.2 All Precincts

8.2.1 Construction work site runoff

All precincts have the potential to include construction activities at the surface that could result in exposed soil. These include TBM launch sites and emergency access shafts (tunnels precinct), portal construction (western portal and eastern portal precincts), station box construction (Arden, Parkville CBD North, CBD South and Domain Station precincts, turnback construction (Western Turnback precinct) and construction associated with early works.

1. **Rainfall runoff from construction work sites** (**Risk #AE001**). During rainfall events, there is the potential for runoff from exposed areas (including spoil and laydown areas) containing sediment and other contaminants (eg litter, oils and grease) to enter the stormwater drainage system and hence impact on water quality in receiving waterways (Yarra River, Moonee Ponds Creek, Maribyrnong River, Albert Park Lake and Stony Creek). The magnitude of potential impacts is site specific and depends on the location of the construction work site in relation to overland flow paths and exposure to surface runoff, and on the area of exposed material.

   Construction activities would be required to comply with the surface water requirements of the *Environment Protection Act 1970* and SEPP (WoV). To meet minimum SEPP (WoV) requirements, this would include compliance with the CSIRO's *Best Practice Environmental Management Guidelines for Urban Stormwater,* which requires treatment of 90 per cent of daily runoff events.

   Standard construction site management techniques – including vehicle wheel wash and rumble bars at worksite egress points, appropriate placement of material stockpiles and chemical storages, covered loads, street sweeping and water quality monitoring, where required – would be used to minimise the risk of contaminated runoff entering the stormwater drainage system.

Generally, these runoff impacts would be common to all Melbourne Metro precincts (although affecting different waterways) and similar mitigation measures would be adopted in each precinct. The adoption of these mitigations within an approved construction work site environmental management plan would achieve the project assessment requirements with respect to the management of surface runoff from construction sites and result in a low level of risk to aquatic ecosystem values**.**

2. **Rainfall runoff from roads** (**Risk #AE007**). In addition to rainfall runoff from constructions, there are also risks associated with runoff from roads travelled by trucks away from the construction zones. Trucks would travel along the existing road network throughout the construction period, bringing materials into construction sites and removing spoil/soil. There is potential for deposition of sediment and other pollutants on road surfaces from trucks that during rainfall events could enter the stormwater system and impact on water quality (increased turbidity, pollution event, oils and grease, etc.) in receiving waterways.

   Standard construction site management techniques, including vehicle wheel wash and rumble bars at worksite egress points, covered loads, street sweeping and water quality monitoring, where required, would minimise the chance of sediment and other contaminates entering the stormwater system from road surfaces

3. **Overland flood runoff from construction work sites** (**Risk #AE008**). Technical Appendix N *Surface Water*) has concluded that most precincts have the potential for some construction work sites to be exposed to flooding, either directly from overbank flooding flows (eg Arden station precinct) or via overland flow from local drainage systems (eg CBD South station precinct).

   Technical Appendix N *Surface Water* has identified risks and mitigation measures that would protect construction areas from the flooding associated with the one per cent AEP flood (100 year Average Recurrence Interval). Hence there is a low level of risk to aquatic ecology values on the basis that construction would be protected from flooding.

   In the event of larger floods, it may be more difficult to contain sediment on site and some impacts on local waterways may occur. However, these impacts are likely to be incrementally small compared with broader catchment scale water quality impacts associated with a large flood event and on this basis additional risk to aquatic values are also considered low.

8.2.2 Groundwater dewatering

During tunnels, station box and potentially portal construction there is potential for groundwater to enter work zones. There are several potential risks to aquatic ecosystems associated with this activity.

1. **Tunnel and station box drainage during construction** (**Risk# AE002**). This water is likely to contain high loads and sediment and other potential contaminants that, if released to waterways, could impact on aquatic ecosystem health. The Technical Appendix O *Groundwater* specifies that groundwater that infiltrates the tunnels and station boxes during construction should be treated and disposed to sewer. On this basis, the risks to aquatic ecosystems would be negligible.

   However, there is a risk associated with accidental discharge of this water to waterways; for example, if the treatment and disposal process breaks down. Construction site environmental management plans would need to identify procedures to mitigate the risk of accidental discharge and also implement monitoring in the event that an accidental discharge to a waterway does occur. The monitoring would be required to report on the extent of any impact.

2. **Ground subsidence** (**Risk# AE006**). Dewatering of the groundwater would result in lowering of groundwater levels that could result in ground movement that theoretically could cause changes in groundwater/surface water interactions and altered flow regime that impacts on river fauna. However, analysis shows subsidence to be of a very small magnitude provided standard mitigation methods are employed as described in Technical Appendix O *Groundwater* and Technical Appendix P *Ground Movement and Land Stability*. Also, the Yarra River flow regime is dominated by tidal process and not sensitive to changes in groundwater/surface water interactions, hence there is unlikely to be impacts

on flow regime through the estuary reach. On this basis the risk to aquatic ecology values would be low.

3. **Tunnel water and station box drainage during operation** (**Risk# AE010**)**.** After construction of Melbourne Metro, a very small volume of groundwater may infiltrate the tunnels and station boxes and may require collection and disposal. It is probable that most of this water would evaporate within the tunnels but if disposal to waterways is required, then collected water would be treated via an interceptor and hydrocarbon separator to remove contaminants prior to discharge to the stormwater system in accordance with an EPA and Melbourne Water approved management and disposal plan. Given such small volumes of water are expected to be collected and the high rates of dilution that would occur within the stormwater system, the risks to aquatic ecology values would be considered low.

8.3 Precinct 1 – Tunnels

The tunnels under the Yarra River and Moonee Ponds Creek would be constructed wholly underground. There would be no direct construction-related impacts on waterways, such as construction of coffer dams, creation of permanent or temporary barriers to fish passage, direct damage or impact on the waterway bed or banks. However, there are a number of potential impacts during the construction and operation that could impact on values associated with waterways:

1. **Bed Stabilisation** (**Risks #AE003 and #AE004**). During the tunnels construction, it may be necessary to stabilise sediments under the Yarra River. This would involve injecting grout into the sediments either from a barge located in the river or via cutter-head injection. If the former technique is used, the presence of a barge in the river may represent a behavioural barrier to fish passage and disturbance of the riverbed could release contaminated sediments to the river. However, standard environmental management practices would ensure that disturbance of riverbed sediments is minimised and no grout material is released to the river. If possible, timing of stabilisation activities should avoid the critical fish migration period of September to November. Even so, the presence of a barge in the river during the migratory period is unlikely to represent a significant barrier to fish passage in the context of other craft that use the river on a daily basis and overall impacts are likely to be. If the latter technique (cutter-head injection) is used there is no impact on the waterway or aquatic fauna, although under both options tunnel spoil would require appropriate handling. Residual risks associated with bed stabilisation are considered very low.

2. **Ground borne noise and vibration** (**Risk #AE005 and #AE011**). The TBM may generate ground noise and vibration that could have impacts on fish behaviour, including disruption to fish passage during critical migration periods. However, noise specialists indicate vibration and noise to be no more than background during construction and operation, so overall impact is very low (see Technical Appendix I *Noise and Vibration*, Section 1.3.1 and Section 1.3.2) and no further mitigation is required.

8.4 Precincts 2 and 8 – Western and Eastern Portals

After construction of Melbourne Metro, runoff from the portal rail bed would collect at the base of the portal decline. This runoff could contain sediments and other contaminants typical of existing road and rail runoff and could potentially impact on the values in receiving waterways. To meet minimum SEPP (WoV) requirements (ie compliance with the CSIRO's *Best Practice Environmental Management Guidelines for Urban Stormwater)*, runoff would be directed to standard best practice stormwater treatment systems sized appropriately for design runoff volume and treated prior to discharge to the Maribyrnong River (western portal) or Yarra River (eastern portal). On this basis, there is likely to be a low level of risk to receiving waterways (**Risk #AE009**).

8.5 Precinct 3 – Arden Station

An electrical substation is for construction in the Arden station precinct. There is potential for impacts on the aquatic health of Moonee Ponds Creek if flooding or equipment failure resulted in a leak of toxic substances from the substation. From a flooding perspective, Technical Appendix N *Surface Water* identifies mitigation

measures to protect the substation from flooding and on this basis, there is a low level of risk to aquatic ecosystem values. However, appropriate protection against floodwaters should be provided around the substation to prevent any toxic substances entering Moonee Ponds Creek (**Risk #AE012**).

9 Environmental Performance Requirements

This section provides a comprehensive list of the recommended Environmental Performance Requirements and mitigation measures identified as a result of this impact assessment. Table 9-1 provides the recommended Environmental Performance Requirements for each risk which apply across the project and on a precinct basis, linked to the draft EES evaluation objective.

Table 9-1 Recommended Environmental Performance Requirements

<table>
<tr><th>Draft EES evaluation objective</th><th>Impact</th><th>Environmental Performance Requirements</th><th>Mitigation measures</th><th>Precinct</th><th>Timing</th><th>Risk no.</th></tr>
<tr><td rowspan="2">Hydrology, water quality and waste management: To protect waterways and waterway function and surface water and groundwater quality in accordance with statutory objectives, to identify and prevent potential adverse environmental effects resulting from the disturbance of contaminated or acid-forming material and to manage excavation spoil and other waste in accordance with relevant best practice principles.

Biodiversity: To avoid or minimise adverse effects on native terrestrial and aquatic flora and fauna, in the context of the project's components and urban setting.</td><td>Potential impact to water quality in receiving waterway due to inputs of pollutants from construction zones (including early works) into waterways.</td><td>Fully integrate the stormwater treatment system into the design of Melbourne Metro for construction [all precincts] to ensure that stormwater entering a receiving water body complies with SEPP (Waters of Victoria).
The best practice performance objectives for achieving compliance with SEPP (Waters of Victoria) during the construction phase are described below:
<table>
<tr><th>Pollutant type</th><th>Receiving water objective</th><th>Current best practice performance objective[1]</th></tr>
<tr><td>Suspended solids</td><td>Comply with SEPP</td><td>Effective treatment of 90% of daily run-off events (e.g. <4 months ARI). Effective treatment equates to a 50 percentile suspended solids concentration of 50 mg/L.
This can be achieved by installing a sediment pond(s) to remove 95% of sediment down to 125 µm for a 1 year ARI.</td></tr>
<tr><td>Litter</td><td>Comply with SEPP</td><td>Prevent litter from entering the stormwater system.</td></tr>
<tr><td>Other pollutants</td><td>Comply with SEPP</td><td>Limit the application, generation and migration of toxic substances to the maximum extent practicable.</td></tr>
</table>
Notes:
1. Best practice performance objectives are based on the Best Practice Environmental Management Guidelines for Urban Stormwater – CSIRO
Best practice sedimentation and pollution control measures must be applied to protect waterways in accordance with Best Practice Environmental Management: Environmental Guidelines for Major Construction Sites – EPA publication 480 (1996) and in accordance with an approved construction environmental management plan.
Measures should include: vehicle wheel wash and rumble bars at worksite egress points, appropriate placement of material stockpiles and chemical storages, covered loads, street sweeping and water quality monitoring, where required</td><td>Develop construction site environmental management plans to contain and treat surface water runoff to meet agreed water quality standards.</td><td>All</td><td>Construction</td><td>AE001
AE007
AE008</td></tr>
<tr><td>Potential impact to water quality in</td><td>During construction, discharge tunnel, station box and portal construction water to sewer.</td><td>Develop construction site</td><td>1 - Tunnels</td><td>Construction</td><td>AE002</td></tr>
</table>

Draft EES evaluation objective	Impact	Environmental Performance Requirements	Mitigation measures	Precinct	Timing	Risk no.
	receiving waterway due to accidental disposal of groundwater during construction.	Where groundwater interception during construction is predicted to occur, dewatering is to be managed so that groundwater is not released to stormwater or sensitive surface water bodies (refer to related Technical Appendix O *Groundwater*).	environmental management plans to where possible contain any accidental discharge to waterways and include a monitoring program that would enable reporting of potential impacts.			
	Potential impact to water quality in receiving waterway due to inputs of sediments and pollutants from roads travelled by trucks (spoil haulage and other construction, including early works).	During construction, discharge tunnel, station box and portal construction water to sewer. Where groundwater interception during construction is predicted to occur, dewatering is to be managed so that groundwater is not released to stormwater or sensitive surface water bodies (refer to related Technical Appendix O *Groundwater*).	Develop construction site environmental management plans to describe environmental performance requirements.	All	Construction	AE007
	Potential impact to water quality in receiving waterway due to disposal of tunnel drainage water to waterways during operations.	During construction, discharge tunnel, station box and portal construction water to sewer. Where groundwater interception during construction is predicted to occur, dewatering is to be managed so that groundwater is not released to stormwater or sensitive surface water bodies (refer to related Technical Appendix O *Groundwater*).	Incorporate requirements for appropriate collection treatment and disposal into tunnel drainage design.	1 - Tunnels	Operation	AE010

<table>
<tr><th>Draft EES evaluation objective</th><th>Impact</th><th>Environmental Performance Requirements</th><th>Mitigation measures</th><th>Precinct</th><th>Timing</th><th>Risk no.</th></tr>
<tr>
<td></td>
<td>Potential impact to water quality in receiving waterway due to disposal of western and eastern portal decline runoff during operation.</td>
<td>
Fully integrate the stormwater treatment system into the design of the western portal and eastern portal to ensure that stormwater entering a receiving water body complies with SEPP (Waters of Victoria). The best practice performance objectives for achieving compliance with SEPP (Waters of Victoria) during the operations phase are described below:
<table>
<tr><th>Pollutant type</th><th>Receiving water objective</th><th>Current best practice performance objective[1]</th></tr>
<tr><td>Suspended solids (SS)</td><td>Comply with SEPP (not to exceed the 90th percentile of 80 mg/L) (1)</td><td>80% retention of the typical urban annual load</td></tr>
<tr><td>Total phosphorus (TP)</td><td>Comply with SEPP (base flow concentration not to exceed 0.08 mg/L) (2)</td><td>45% retention of the typical urban annual load</td></tr>
<tr><td>Total nitrogen (TN)</td><td>Comply with SEPP (base flow concentration not to exceed 0.9 mg/L) (2)</td><td>45% retention of the typical urban annual load</td></tr>
<tr><td>Litter</td><td>Comply with SEPP (No litter in waterways) (1)</td><td>70% reduction of typical urban annual load (3)</td></tr>
<tr><td>Flows</td><td>Maintain flows at pre-urbanisation levels</td><td>Maintain discharges for the 1.5 year ARI at pre-development levels</td></tr>
</table>
Notes:

Best practice performance objectives are based on the Best Practice Environmental Management Guidelines for Urban Stormwater – CSIRO
An example using SEPP (Waters of Victoria), general surface waters segment
SEPP Schedule F7 – Yarra Catchment – urban waterways for the Yarra River main stream
Litter is defined as anthropogenic material larger than five millimetres.

Sedimentation and pollution control measures must be applied to protect waterways in accordance with industry best practice. This shall include water quality monitoring, where required.
</td>
<td>Develop operational environmental management and maintenance plans to contain and treat surface water runoff to meet agreed water quality standards.</td>
<td>2 - Western portal
8 - Eastern portal</td>
<td>Operation</td>
<td>AE009</td>
</tr>
</table>

Draft EES evaluation objective	Impact	Environmental Performance Requirements	Mitigation measures	Precinct	Timing	Risk no.
Biodiversity: To avoid or minimise adverse effects on native terrestrial and aquatic flora and fauna, in the context of the project's components and urban setting.	Interruption to fish passage due to presence of barge in the Yarra River.		If practicable, use TBM cutter head injection rather than barge techniques, or Avoid activities on the Yarra River during primary migratory periods (September to November).	1 - Tunnels	Construction	AE004
	TBM-generated noise and vibration on Yarra River.	Environmental Performance Requirements for vibration associated with tunnelling and operation are detailed in Technical Appendix I *Noise and Vibration*.	See Technical Appendix I *Noise and Vibration*	1 - Tunnels	Construction	AE005 AE011
Hydrology, water quality and waste management: To protect waterways and waterway function and surface water and groundwater quality in accordance with statutory objectives, to identify and prevent potential adverse environmental effects resulting from the disturbance of contaminated or acid-forming material and to manage excavation spoil and other waste in accordance with relevant best practice principles.	Disturbance of Yarra River bed sediments if grouting is required to stabilise bed sediments.	Where ground treatment works are required in waterways, design and implement methods that prevent discharge of sediments into the water column.	If practicable use TBM cutter head injection rather than barge techniques. If barge techniques are necessary, develop standard environmental management practices to minimise sediment release.	1 - Tunnels	Construction	AE003
	Subsidence of Yarra River bed alters flow regimes.	Environmental Performance Requirements for ground movement are detailed in Technical Appendix O *Groundwater* and Technical Appendix P *Ground Movement and Land Stability*	See Technical Appendix O - *Groundwater* and Technical Appendix P *Ground Movement and Land Stability*	1 - Tunnels	Construction	AE006
	Flooding of electrical substation	Design the Arden electrical substation (as per Environmental Performance Requirement SW1 in Technical Appendix N *Surface Water*) to provide	Ensure substation is protected against	3 - Arden	Operation	AE012

Draft EES evaluation objective	Impact	Environmental Performance Requirements	Mitigation measures	Precinct	Timing	Risk no.
	from Moonee Ponds Creek during operation, resulting in release of contaminants to Moonee Ponds Creek.	appropriate protection against floodwaters during operation, to prevent the release of contaminants to Moonee Ponds Creek.	flooding, by either bunding, or setting it at a sufficiently high level to provide an acceptable level of flood immunity. (See Technical Appendix N *Surface Water*)	station		

10 Conclusion

This report documents the outcomes of an assessment of the risks to water quality, stream health and aquatic biodiversity in waterways from activities associated with construction and operation of the Melbourne Metro.

The focus for the assessment is the natural and man-made waterways that lie within the tunnel alignment or could be impacted by stormwater runoff from associated construction and operational activities.

10.1 Relevant EES objectives

The following draft EES evaluation objectives and assessment criteria (and indicators where relevant) are relevant to this assessment.

Draft EES evaluation objectives	Assessment criteria
Hydrology and waste management: To protect waterways and waterway function and surface water and groundwater quality in accordance with statutory objectives, to identify and prevent potential adverse environmental effects resulting from the disturbance of contaminated or acid-forming material and to manage excavation spoil and other waste in accordance with relevant best practice principles.	Any discharge to waterways is to comply with background concentrations and/or relevant State Environment Protection Policy (SEPP) criteria.
Biodiversity: To avoid or minimise adverse effects on native terrestrial and aquatic flora and fauna, in the context of the project's components and urban setting.	Any discharge to waterways and direct construction impacts are to avoid or minimise impacts on aquatic fauna and flora (eg impacts on habitat and critical life history requirements such as fish passage).

The project meets the assessment criteria in relation to hydrology and waste management because any discharge to waterways would be treated to comply with background/SEPP criteria.

The project meets the assessment criteria in relation to biodiversity because:

1. Discharge to waterways would comply with background/SEPP
2. The project does not propose direct construction in waterways
3. Other indirect construction impacts such as noise/vibration, contaminated runoff, etc., are dealt with as set out in other reports and compliance with the relevant Environmental Performance Requirements would achieve the assessment objective.

10.2 Impact Assessment Summary

The assessment addresses the specified EES Scoping Requirements and specifically evaluates potential impacts to surface water quality and aquatic flora and fauna based on the assessment criteria. A risk assessment process was adopted that identified potential construction and operational hazards, impact pathways, consequences to values (water quality and aquatic biodiversity) and likelihood of impacts. Risk to values was determined as the combination of consequence and likelihood. Where possible, mitigation measures were identified to reduce risks.

To inform the risk assessment, the current condition of receiving waterways was described. This was based on available water quality, fish survey data, searches of the Victorian Flora and Fauna Database and the Protected Matters Search Tool, and visual assessment of waterways in the vicinity of project components and construction activities.

Potential project hazards include direct impacts on waterways through construction activities within the waterway and indirect impacts due to runoff from construction sites adjacent to waterways.

The Concept Design involves tunnelling under the Yarra River and Moonee Ponds Creek, so there are no direct impacts on waterways and no direct impacts on aquatic flora and fauna. Moreover, a referral under the *EPBC Act 1999* noted there would be no significant effects on the threatened Australian grayling.

However, a range of indirect impacts have been identified:

- Inputs of surface sediments, chemicals and rubbish from construction zones into waterways
- Disposal of groundwater to waterways during construction
- Inputs of portal drainage runoff to waterways during operations
- Input of tunnel seepage to waterways during operations
- Disturbance of Yarra bed sediments if grouting is required for stabilisation noise and vibration on Yarra River and Moonee Ponds Creek during construction and operation
- Potential subsidence of riverbed and consequent alteration flow regimes
- Inputs to surface water drainage system and waterways from sediments and pollutants from roads travelled by trucks
- Input of potentially toxic substances from the substation.

Performance measures were identified that in all instances minimise impacts to waterway water quality and aquatic flora and fauna, and on this basis all project risks to water quality and aquatic flora and fauna are considered low or very low.

A suitable water quality monitoring program is required to demonstrate that low levels of risk are achieved.

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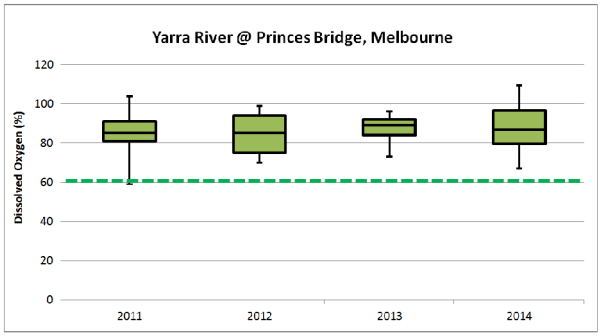
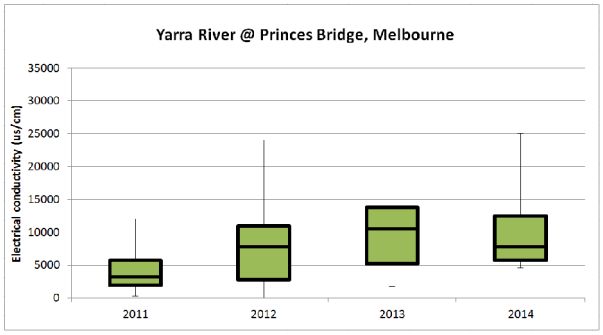
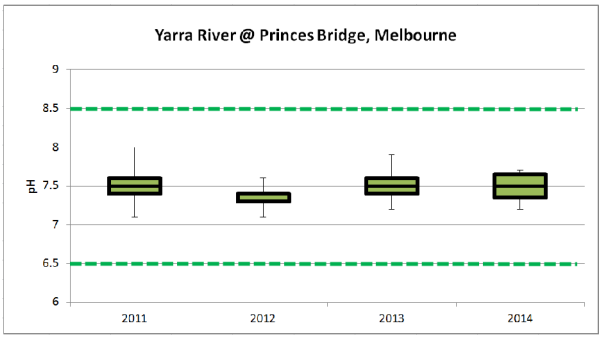
Appendices

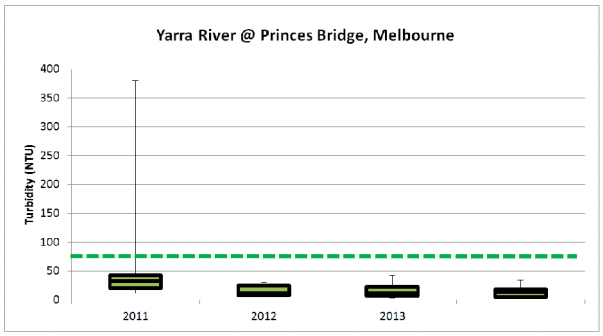
Appendix A – Water quality data and *EPBC Act* Protected Matters Search Tool results

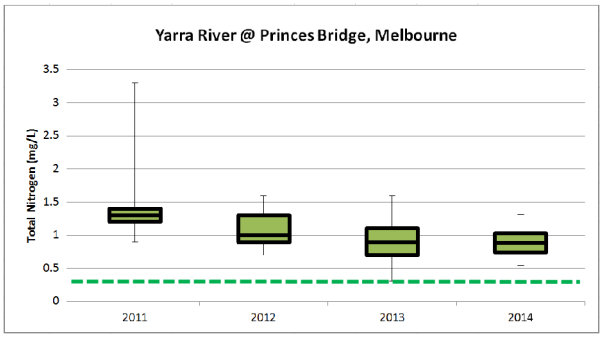
Yarra River

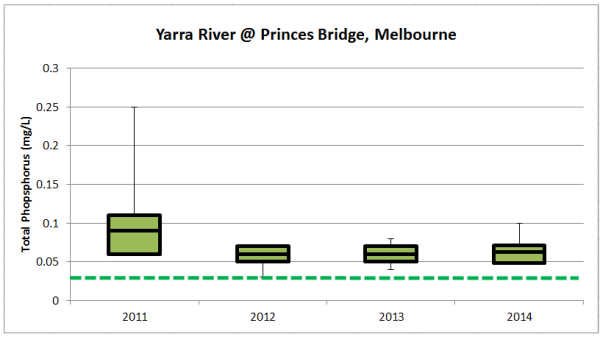

Yarra River @ Princes Bridge, Melbourne
Dissolved Oxygen (%)
120
100
80
60
40
20
0
2011
2012
2013
2014

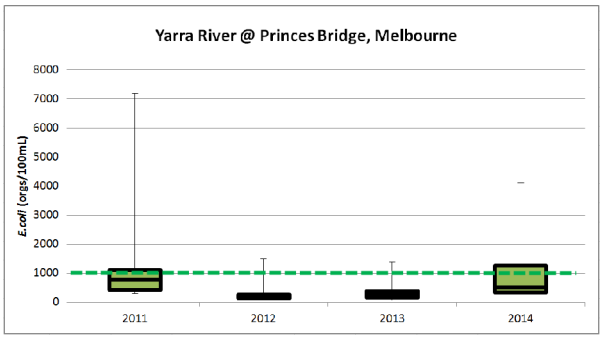

Yarra River @ Princes Bridge, Melbourne
Electrical conductivity (us/cm)
35000
30000
25000
20000
15000
10000
5000
0
2011
2012
2013
2014

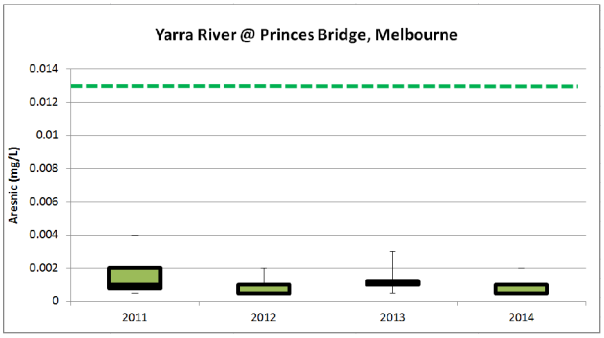

Yarra River @ Princes Bridge, Melbourne
pH
9
8.5
8
7.5
7
6.5
6
2011
2012
2013
2014

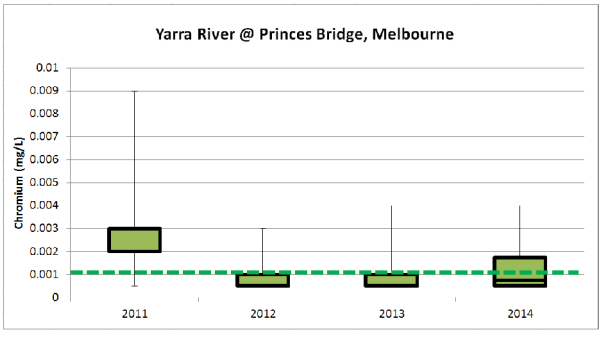

Yarra River @ Princes Bridge, Melbourne
Turbidity (NTU)
400
350
300
250
200
150
100
50
0
2011
2012
2013

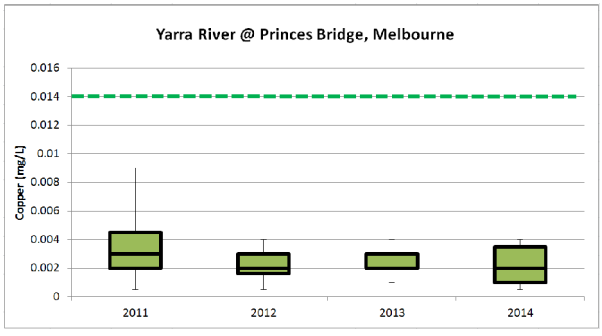

Yarra River @ Princes Bridge, Melbourne
Total Nitrogen (mg/L)
3.5
3
2.5
2
1.5
1
0.5
0
2011
2012
2013
2014

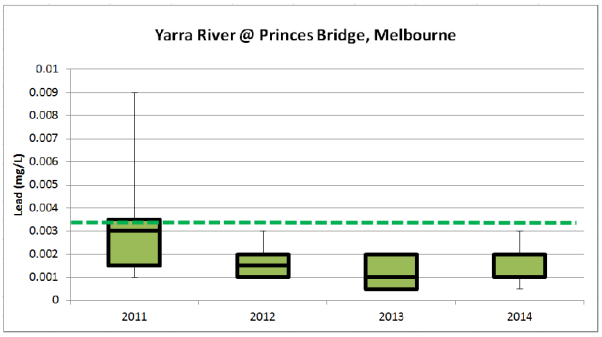

Yarra River @ Princes Bridge, Melbourne
Total Phopsphorus (mg/L)
0.3
0.25
0.2
0.15
0.1
0.05
0
2011
2012
2013
2014

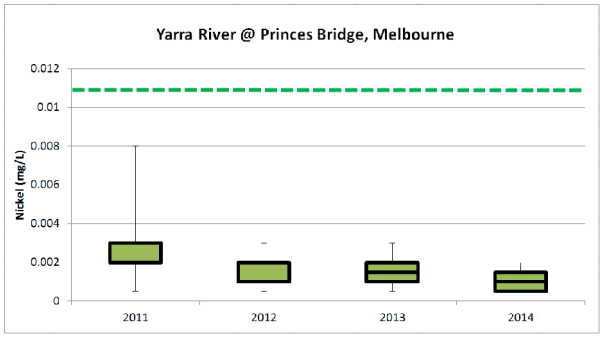

Yarra River @ Princes Bridge, Melbourne
E.coli (orgs/100mL)
8000
7000
6000
5000
4000
3000
2000
1000
0
2011
2012
2013
2014

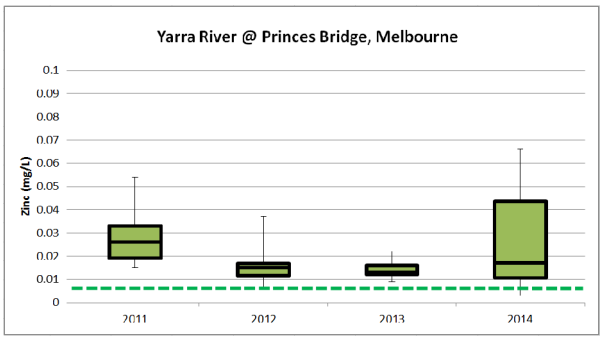

Yarra River @ Princes Bridge, Melbourne
Aresnic (mg/L)
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
2011
2012
2013
2014


Yarra River @ Princes Bridge, Melbourne
Chromium (mg/L)
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
2011
2012
2013
2014


Yarra River @ Princes Bridge, Melbourne
Copper (mg/L)
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
2011
2012
2013
2014







Water quality measured in the Yarra River at Princes Bridge Melbourne in 2011-2014.
Boxplot: Box ends equal 25th and 75th percentile, mid line equals the 50th percentile. Whiskers equal maximum and minimum values recorded. Green dashed line equals the relevant guideline concentrations (from SEPP or ANZECC)

***EPBC Act 1999* PMST assessment for listed threatened species, migratory species and marine species for the Yarra River estuary[#]**

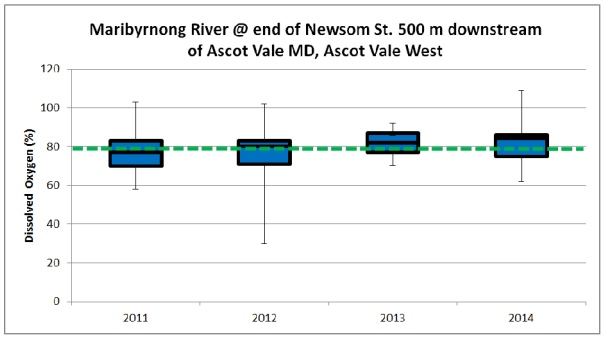
Asset / value	*EPBC* listing and search tool assessment	Assessment of probability of occurrence in potential impacted area
LISTED THREATENED SPECIES		
Eastern dwarf galaxias (*Galaxiella pusilla*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur. Most commonly found in well-vegetated, still or slow-flowing backwaters or drains in freshwater reaches, not deep, swiftly-flowing un-vegetated channels (Allen et al. 2002). Suitable habitat has not been recorded at the investigation site in the Yarra River.
Murray cod (*Maccullochella peelii*)	Vulnerable. Species or species habitat **may** occur within area.	**Very unlikely** to occur. They are generally found in locations with undercut banks, dense vegetation and large snags. The Murray Cod completes their entire life cycle in freshwater and therefore does not need to migrate to the ocean. They are located in the freshwater reaches of the Yarra River, occasionally including a short stretch downstream of Dights Falls, but have not been recorded from the lower estuary in the vicinity of the tunnels alignment. Suitable habitat has not been recorded at the investigation site in the Yarra River.
Macquarie perch (*Macquaria australasica*)	Endangered. Species or species habitat **likely** to occur with the area.	**Very unlikely** to occur**.** Most of the important populations and breeding sites are known from the middle and upper Yarra River (King and Mahoney 2010; Tonkin et al. 2014). Are located in the freshwater reaches of the Yarra River, occasionally including a short stretch downstream of Dights Falls, but have not been recorded from the lower estuary in the vicinity of the tunnels alignment. Suitable habitat has not recorded at the impacted area in the Yarra River.

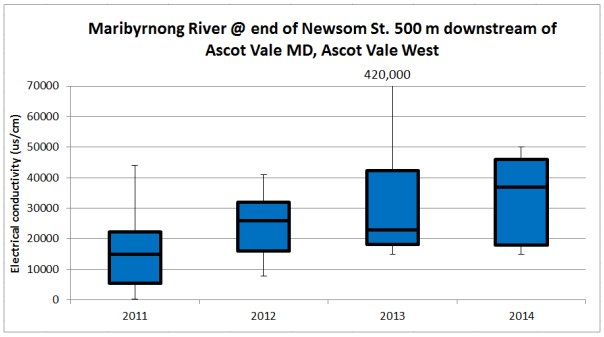
Asset / value	*EPBC* listing and search tool assessment	Assessment of probability of occurrence in potential impacted area
Yarra pygmy perch (*Nannoperca obscura*)	Vulnerable. Species or species habitat **likely** to occur with the area.	**Very unlikely** to occur. Last record on the VBA downstream of Dights Falls was in 1872. They are usually associated with dense emergent aquatic vegetation and woody debris in freshwater reaches. They complete their life cycle in freshwater (Sadlier and Hammer 2010) and therefore fish caught in the estuary likely to be vagrants. Only known population in the Melbourne region is from the upper reaches of Deep Creek in the Maribyrnong catchment.
Australian grayling (*Prototroctes maraena*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Likely** to occur. Known from the Yarra River estuary (Koster and Dawson 2013, 2014). It is not a resident species, but uses the estuary as a migratory pathway.
Loggerhead turtle (*Caretta carretta*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the Yarra River estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Green turtle (*Chelonia mydas*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the Yarra River estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Leatherback turtle (*Dermochelys coriacea*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Mostly recorded in temperate areas (Cogger 2000), but are known from the Victorian coast.
Great white shark (*Carcharodon carcharias*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Suitable habitat not present.
LISTED MIGRATORY SPECIES		
Bryde's whale (*Balaenoptera edeni*)	Species or species habitat **may** occur within area.	**Very unlikely** to occur. Suitable habitat not present.
Pygmy right whale (*Caperea marginata*)	Species or species habitat **may** occur within area.	**Very unlikely** to occur. Suitable habitat not present.
Great white shark (*Carcharodon carcharias*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Suitable habitat not present.
Loggerhead turtle (*Caretta carretta*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the Yarra River estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Green turtle (*Chelonia mydas*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the Yarra River estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Leatherback turtle (*Dermochelys coriacea*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur**.** Mostly recorded in temperate areas (Cogger 2000), but are known from the Victorian coast.
Southern right whale (*Eubalaena australis*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Suitable habitat not present.
Dusky dolphin (*Lagenorhynchus obscurus*)	Species or species habitat **may** occur within area.	**Very unlikely** to occur**.** Vagrants may occasionally venture up into the affected area, but not commonly.
Mackerel shark (*Lamna nasus*)	Species or species habitat **may** occur within area.	**Very unlikely** to occur. Suitable habitat not present.
Humpback whale (*Megaptera	Vulnerable. Species or species habitat **likely** to	**Very unlikely** to occur. Suitable habitat not present.

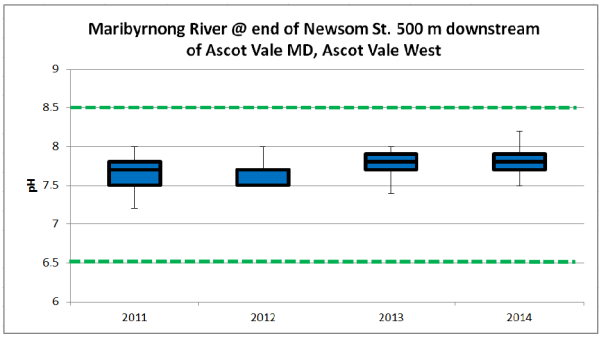
Asset / value	*EPBC* listing and search tool assessment	Assessment of probability of occurrence in potential impacted area
***novaeangliae*)**	occur within area.	
LISTED MARINE SPECIES		
New Zealand fur seal (*Arctocephalus forsteri*)	Species or species habitat **may** occur within area.	**Very unlikely** to occur**.** Vagrants may occasionally venture up into the affected area, but not commonly.
Australian fur seal (*Arctocephalus pusillus*)	Species or species habitat **may** occur within area.	**Possible.** Not a resident species, vagrants may occasionally venture up into the estuary. Last record in the Yarra River in the study area is July 2014 (http://www.theage.com.au/victoria/now-seal-here-playful-marine-mammal-journeys-14km-from-port-phillip-bay-to-yarra-river-20140728-zxmjj.html)
Loggerhead turtle (*Caretta carretta*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the Yarra River estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Green turtle (*Chelonia mydas*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the Yarra River estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Leatherback turtle (*Dermochelys coriacea*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur**.** Mostly recorded in temperate areas (Cogger 2000), but are known from the Victorian coast.
Bryde's whale (*Balaenoptera edeni*)	Species or species habitat **may** occur within area.	**Very unlikely** to occur. Suitable habitat not present.
Pygmy right whale (*Caperea marginata*)	Species or species habitat **may** occur within area.	**Very unlikely** to occur. Suitable habitat not present.
Common dolphin (*Delphinus delphis*)	Species or species habitat **may** occur within area.	**Possible.** Not a resident species, vagrants may occasionally venture up into the estuary. Last recorded in the Yarra River estuary in 2009. (http://www.heraldsun.com.au/news/dolphins-spotted-in-yarra-between-punt-rd-and-church-st-bridges/story-e6frf7jo-1225743362954)
Southern right whale (*Eubalaena australis*)	Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Suitable habitat not present.
Dusky dolphin (*Lagenorhynchus obscurus*)	Species or species habitat **may** occur within area.	**Very unlikely** to occur**.** Vagrants may occasionally venture up into the affected area, but not commonly.
Humpback whale (*Megaptera novaeangliae*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur. Suitable habitat not present.
Indian Ocean bottlenose dolphin (*Tursiops aduncus*)	Species or species habitat **likely** to occur with the area.	**Very unlikely** to occur. Vagrants may occasionally venture up into the affected area, but not commonly.
Bottlenose dolphin (*Tursiops truncates s. str.*)	Species or species habitat **may** occur within area.	**Very unlikely** to occur. Vagrants may occasionally venture up into the affected area, but not commonly.

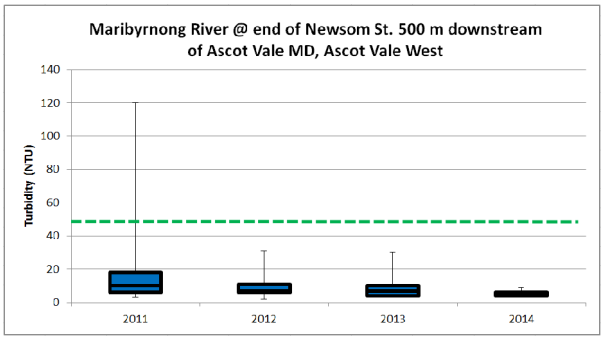
[#] Species shaded are likely, or could possibly occur within the potential impact area.
(Ref: *EPBC Act 1999* PMST; date accessed 19 May 2015)

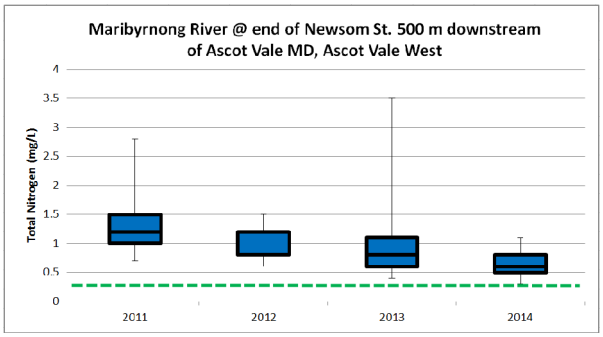
Maribyrnong River

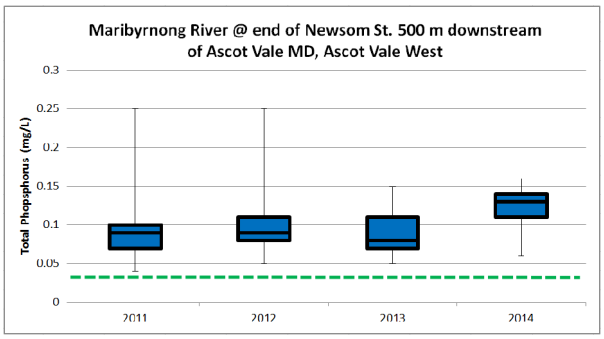


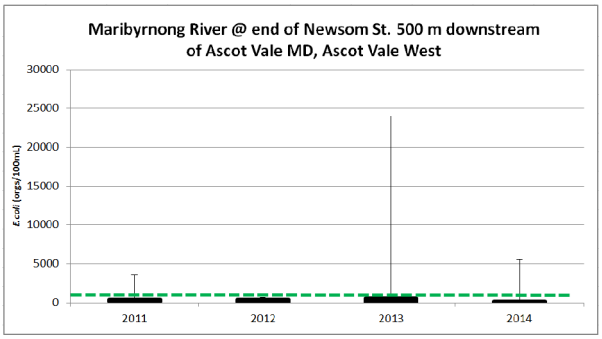


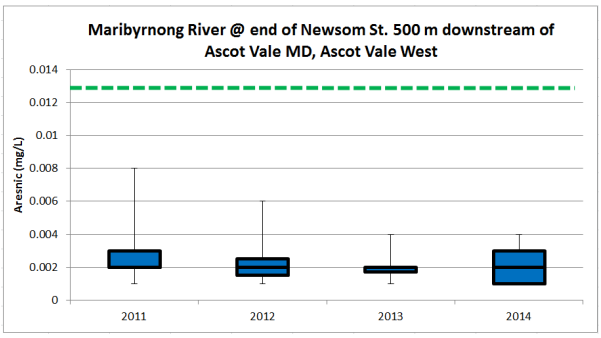


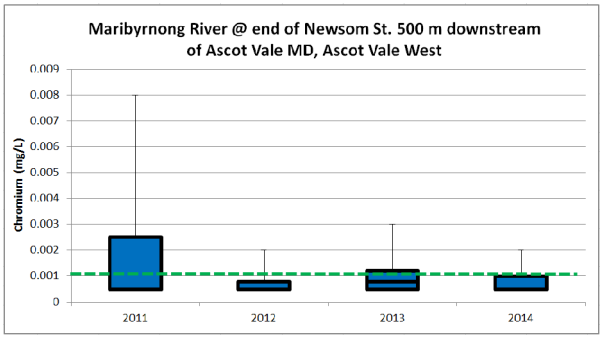


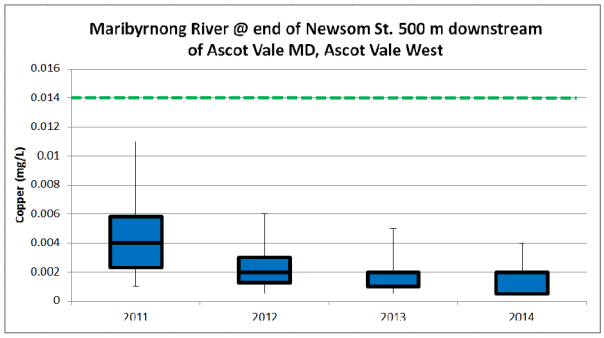


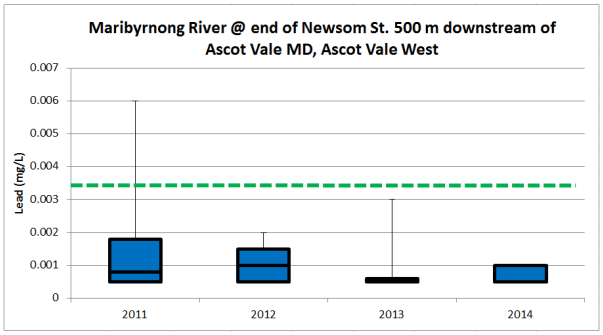


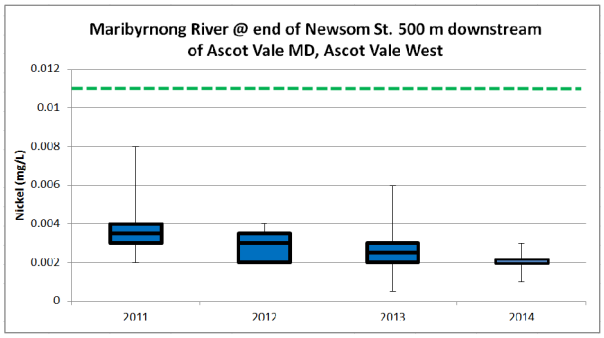


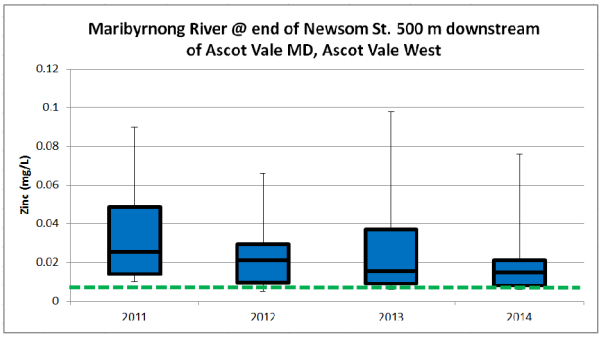












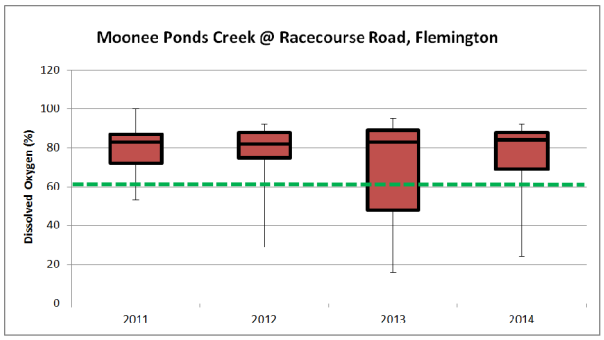
Water quality measured in the Maribyrnong River at the end of Newsom Road, Ascot Vale in 2011, 2012, 2013 and 2014. Boxplot: Box ends equal 25th and 75th percentile, mid line equals the 50th percentile. Whiskers equal maximum and minimum values recorded. Green dashed line equals the relevant guideline concentrations (from SEPP or ANZECC (2000)).

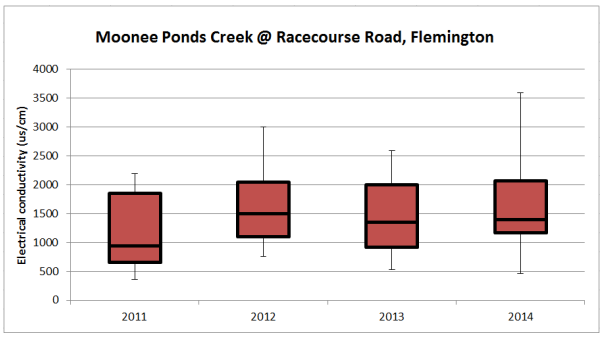
***EPBC Act* Protected Matters Search assessment for listed threatened species, migratory species and marine species for the Maribyrnong River. Species shaded are likely to, or could possibly, occur within the potential impact area (accessed 19 May 2015)**

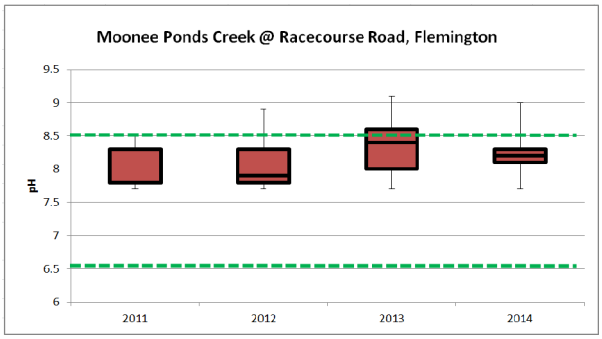
Asset / value	Details	Assessment of probability of occurrence in potential impacted area
LISTED THREATENED SPECIES		
Eastern dwarf galaxias (*Galaxiella pusilla*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur. Most commonly found in well-vegetated, still or slow-flowing backwaters or drains, not deep, swiftly-flowing un-vegetated channels (Allen et al. 2002). Suitable habitat not observed in the Maribyrnong River at the location of potential impact.
Murray cod (*Maccullochella peelii*)	Vulnerable. Species or species habitat **may** occur within area.	**Very unlikely** to occur. Generally found in locations with undercut banks, dense vegetation and large snags. Suitable habitat not recorded at the impacted area in the Maribyrnong River.
Australian grayling (*Prototroctes maraena*)	Vulnerable. Species or species habitat **may** occur with the area.	**Likely** to occur. Australian Grayling recorded from Deep Creek in upper Maribyrnong River catchment (Melbourne Water 2013). Not a resident species in the study area, but would use this area as a migration pathway.

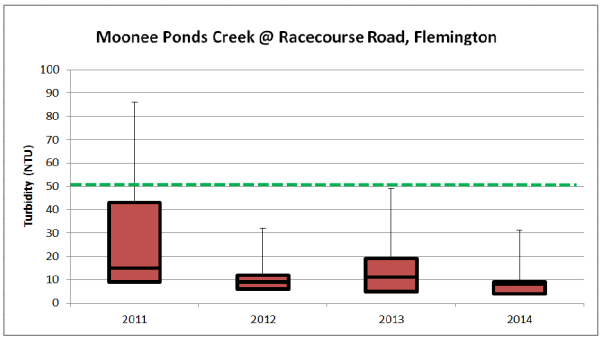
Asset / value	Details	Assessment of probability of occurrence in potential impacted area
Southern right whale (*Eubalaena australis*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Suitable habitat not present.
Humpback whale (*Megaptera novaeangliae*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur. Suitable habitat not present.
Loggerhead turtle (*Caretta carretta*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Green turtle (*Chelonia mydas*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Leatherback turtle (*Dermochelys coriacea*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur**.** Mostly recorded in temperate areas (Cogger 2000), but are known from the Victorian coast.
LISTED MIGRATORY SPECIES		
Loggerhead turtle (*Caretta carretta*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Green turtle (*Chelonia mydas*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Leatherback turtle (*Dermochelys coriacea*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur**.** Mostly recorded in temperate areas (Cogger 2000), but are known from the Victorian coast.
Southern right Whale (*Eubalaena australis*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Suitable habitat not present.
Humpback whale (*Megaptera novaeangliae*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur. Suitable habitat not present.
LISTED MARINE SPECIES		
Loggerhead turtle (*Caretta carretta*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Green turtle (*Chelonia mydas*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Leatherback turtle (*Dermochelys coriacea*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur**.** Mostly recorded in temperate areas (Cogger 2000), but are known from the Victorian coast.
Southern right whale (*Eubalaena australis*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Suitable habitat not present.
Humpback whale (*Megaptera novaeangliae*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur. Suitable habitat not present.

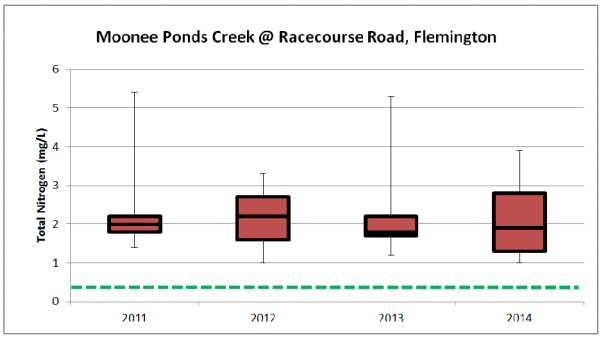
Moonee Ponds Creek

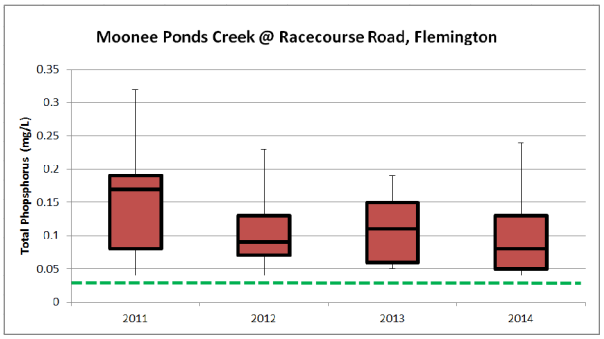


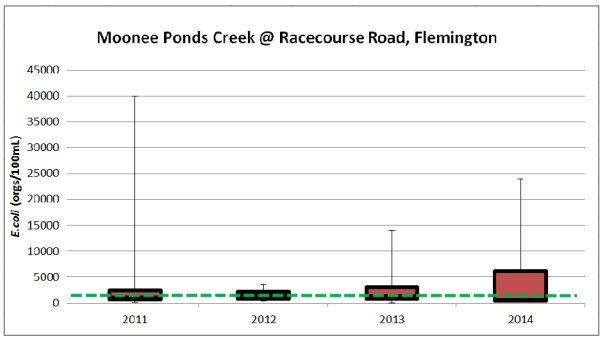


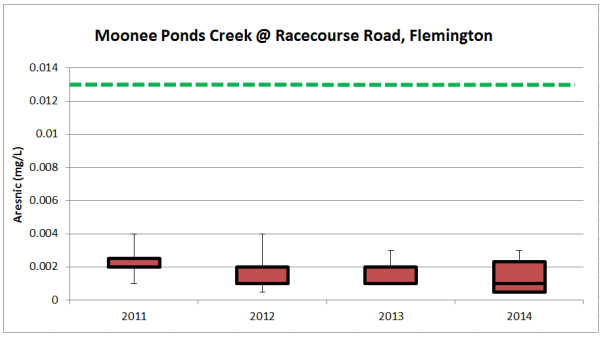


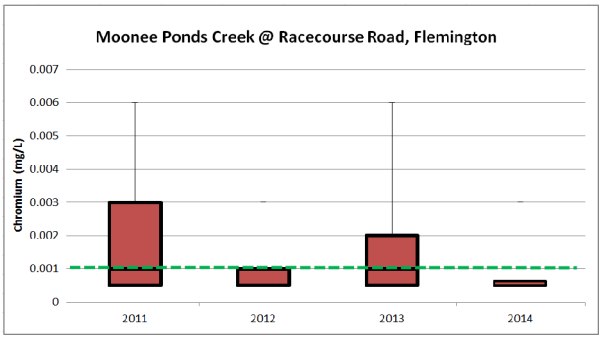


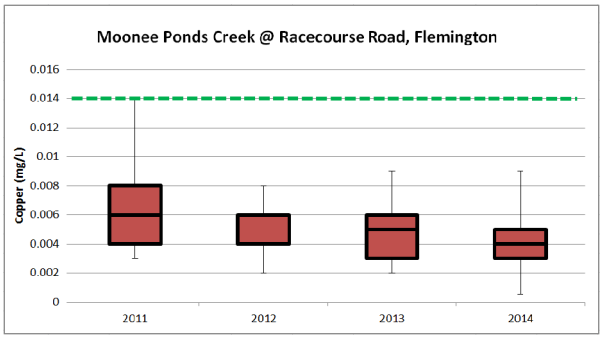


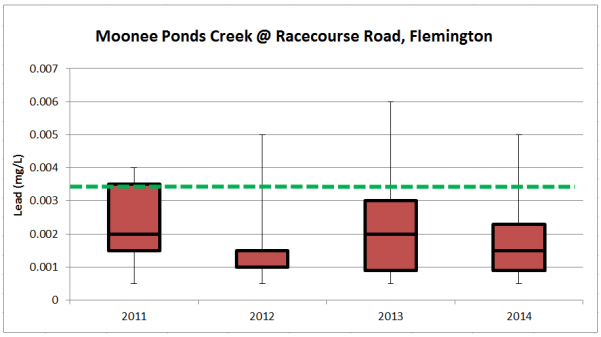


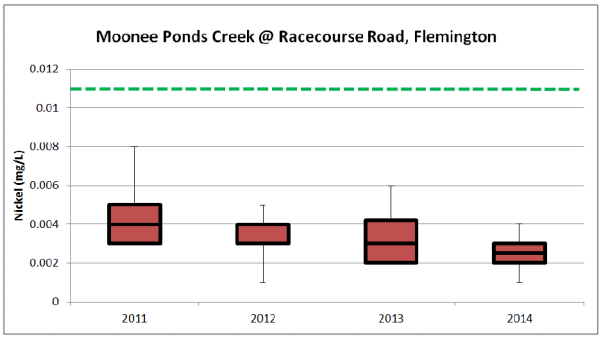


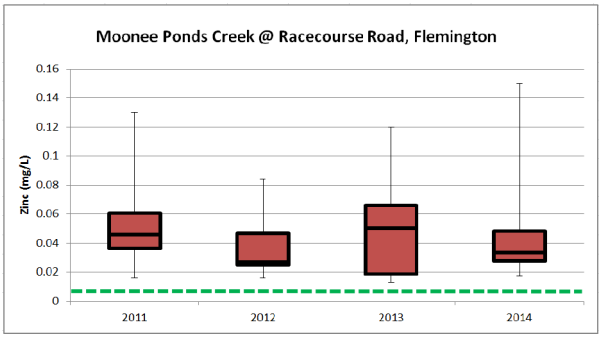












Water quality measured in Moonee Ponds Creek at Racecourse Road, Flemington in 2011, 2012, 2013 and 2014. Boxplot: Box ends equal 25th and 75th percentile, mid line equals the 50th percentile. Whiskers equal maximum and minimum values recorded. Green dashed line equals the relevant guideline concentrations (from SEPP or ANZECC (2000)).

***EPBC Act* Protected Matters Search Tool assessment for listed threatened species, migratory species and marine species for the Moonee Ponds Creek (accessed 19 May 2015)**

Asset / value	Details	Assessment of probability of occurrence in potential impacted area
LISTED THREATENED SPECIES		
Eastern dwarf galaxias (*Galaxiella pusilla*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur. Most commonly found in well-vegetated, still or slow-flowing backwaters or drains, not deep, swiftly-flowing un-vegetated channels (Allen et al. 2002). Suitable habitat not observed in the Moonee Ponds Creek at the location of potential impact.
Murray cod (*Maccullochella peelii*)	Vulnerable. Species or species habitat **may** occur within area.	**Very unlikely** to occur. Generally found in locations with undercut banks, dense vegetation and large snags. Suitable habitat not recorded at the impacted area in the Moonee Ponds Creek.
Australian grayling (*Prototroctes maraena*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Unlikely** to occur**.** Known from the Yarra River and Maribyrnong River but not recorded from the Moonee Ponds Creek. Moonee Ponds Creek does not provide suitable habitat.
Growling grass frog (*Litoria raniformis*)	Vulnerable. Species or species habitat **may** occur within area.	**Very unlikely** to occur in study area. Growling Grass Frogs prefer slow flowing, well vegetated habitats. Suitable habitat not observed in the Moonee Ponds Creek at the location of potential impact.
Loggerhead turtle (*Caretta carretta*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the Yarra River estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Green turtle (*Chelonia mydas*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the Yarra River estuary but only very rarely are individuals found in southern Australia (Cogger 2000).

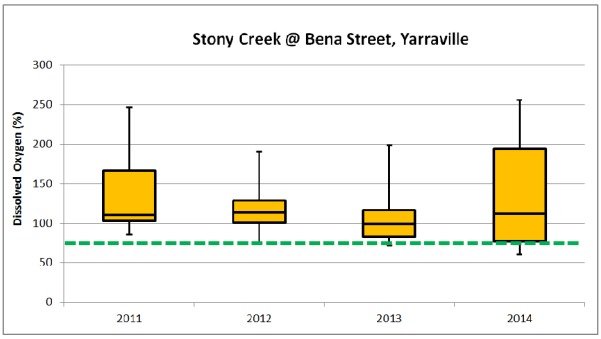
Asset / value	Details	Assessment of probability of occurrence in potential impacted area
Leatherback turtle (*Dermochelys coriacea*)	Endangered. Species or species habitat **known** to occur with the area.	**Very Unlikely** to occur**.** Mostly recorded in temperate areas (Cogger 2000), but are known from the Victorian coast.
Southern right whale (*Eubalaena australis*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Suitable habitat not present.
Humpback whale (*Megaptera novaeangliae*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur. Suitable habitat not present.
LISTED MIGRATORY SPECIES		
Loggerhead turtle (*Caretta carretta*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the Yarra River estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Green turtle (*Chelonia mydas*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the Yarra River estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Leatherback turtle (*Dermochelys coriacea*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur**.** Mostly recorded in temperate areas (Cogger 2000), but are known from the Victorian coast.
Southern right whale (*Eubalaena australis*)	Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Suitable habitat not present.
Humpback whale (*Megaptera novaeangliae*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur. Suitable habitat not present.
LISTED MARINE SPECIES		
Loggerhead turtle (*Caretta carretta*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the Yarra River estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Green turtle (*Chelonia mydas*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the Yarra River estuary but only very rarely are individuals found in southern Australia (Cogger 2000).
Leatherback turtle (*Dermochelys coriacea*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur**.** Mostly recorded in temperate areas (Cogger 2000), but are known from the Victorian coast.
Southern right whale (*Eubalaena australis*)	Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Suitable habitat not present.
Humpback whale (*Megaptera novaeangliae*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur. Suitable habitat not present.

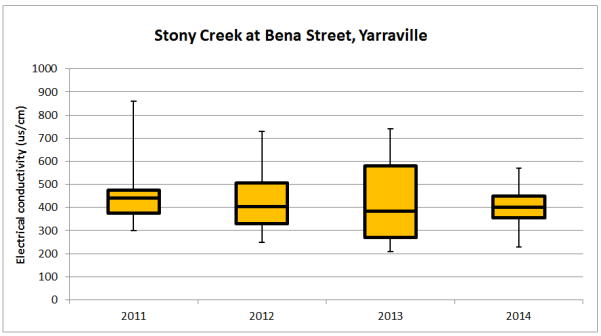
Albert Park Lake

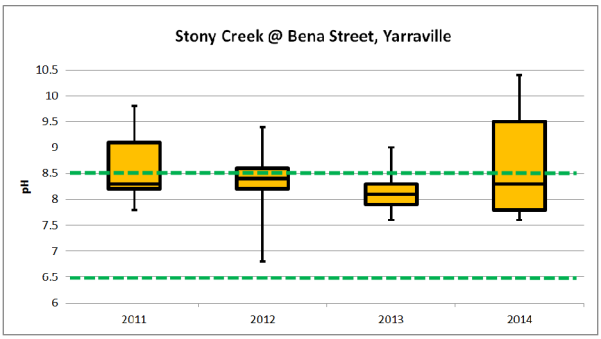
***EPBC Act* Protected Matters Search Tool assessment for listed threatened species for the Albert Park Lake (accessed 19 May 2015)**

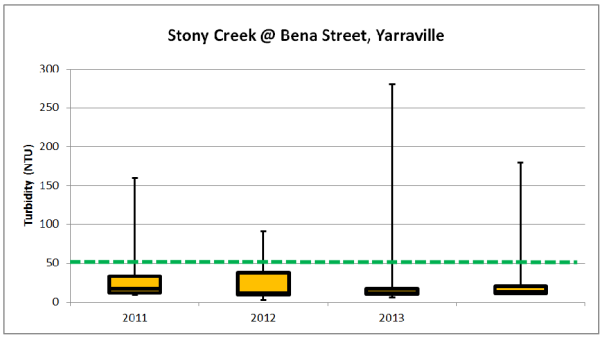
Asset / value	*EPBC* listing and search tool assessment	Assessment of probability of occurrence in potential impacted area
LISTED THREATENED SPECIES		
Australian grayling (*Prototroctes maraena*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur**.** Need to migrate to the ocean to complete their life cycle.
Eastern dwarf galaxias (*Galaxiella pusilla*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur in study area. Most commonly found in well vegetated, still or slow flowing backwaters or drains, rarely lakes (Allen *et al.* 2002). Suitable habitat has not been recorded at the investigation site in Albert Park Lake.
Murray cod (*Maccullochella peelii*)	Vulnerable. Species or species habitat **may** occur within area.	**Very unlikely** to occur in study area. They are generally found in locations with undercut banks, dense vegetation and large snags and unlikely to be present naturally in lakes.
Macquarie perch (*Macquaria australasica*)	Endangered. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur in study area.
Growling grass frog (*Litoria raniformis*)	Vulnerable. Species or species habitat **may** occur within area.	**Very unlikely** to occur in study area. Growling grass frogs prefer slow or still flowing, well vegetated habitats. Suitable habitat not observed in Albert Park Lake.

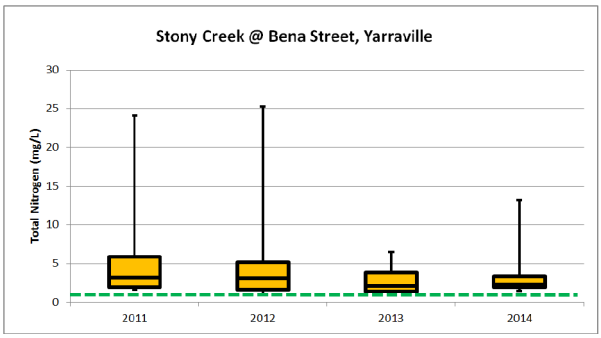
Stony Creek

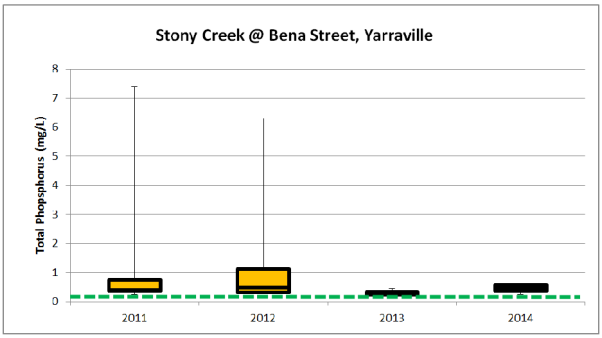

Stony Creek @ Bena Street, Yarraville
Dissolved Oxygen (%)
300
250
200
150
100
50
0
2011
2012
2013
2014

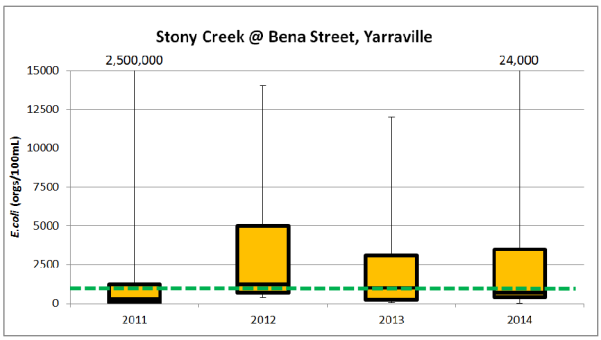

Stony Creek at Bena Street, Yarraville
Electrical conductivity (us/cm)
1000
900
800
700
600
500
400
300
200
100
0
2011
2012
2013
2014

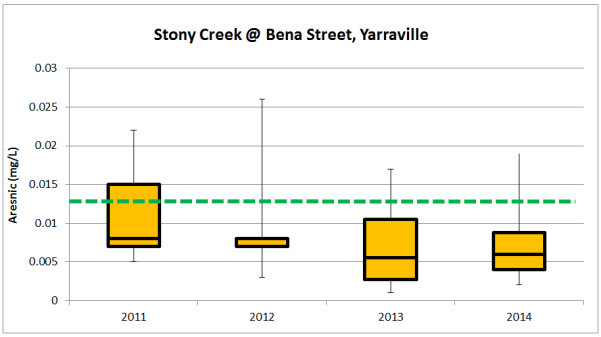

Stony Creek @ Bena Street, Yarraville
pH
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
2011
2012
2013
2014

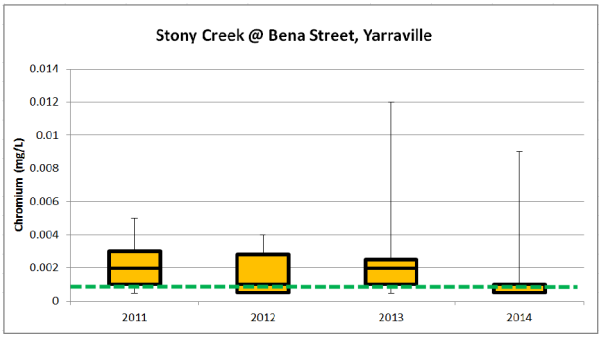

Stony Creek @ Bena Street, Yarraville
Turbidity (NTU)
300
250
200
150
100
50
0
2011
2012
2013

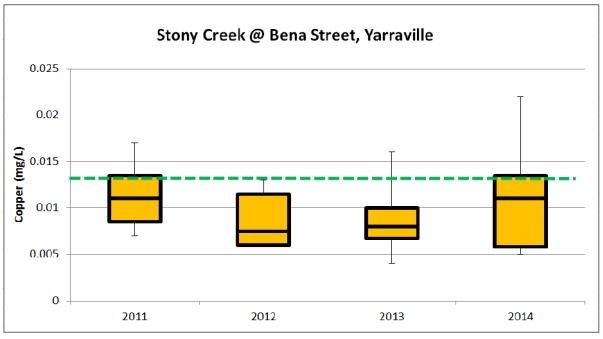

Stony Creek @ Bena Street, Yarraville
Total Nitrogen (mg/L)
30
25
20
15
10
5
0
2011
2012
2013
2014

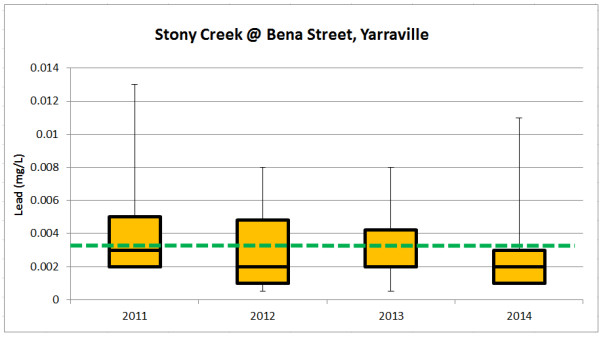

Stony Creek @ Bena Street, Yarraville
Total Phopsphorus (mg/L)
8
7
6
5
4
3
2
1
0
2011
2012
2013
2014

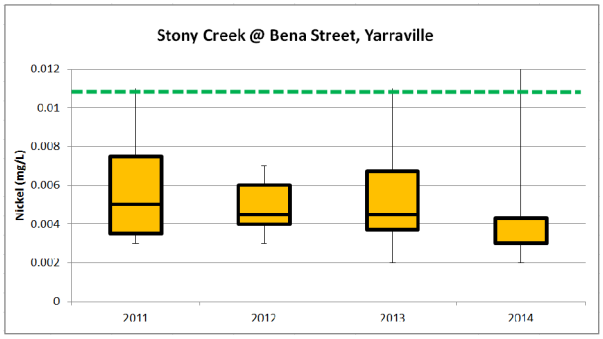

Stony Creek @ Bena Street, Yarraville
2,500,000
24,000
E.coli (orgs/100mL)
15000
12500
10000
7500
5000
2500
0
2011
2012
2013
2014

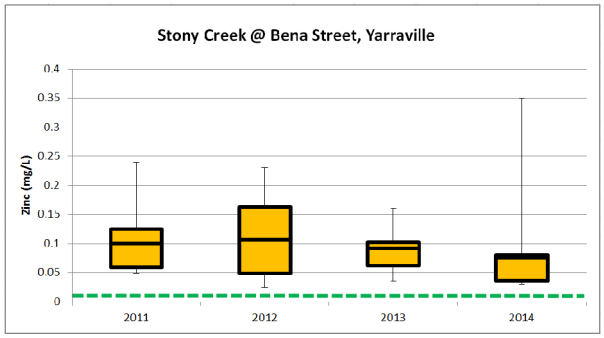

Stony Creek @ Bena Street, Yarraville
Aresnic (mg/L)
0.03
0.025
0.02
0.015
0.01
0.005
0
2011
2012
2013
2014


Stony Creek @ Bena Street, Yarraville
Chromium (mg/L)
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
2011
2012
2013
2014


Stony Creek @ Bena Street, Yarraville
Copper (mg/L)
0.025
0.02
0.015
0.01
0.005
0
2011
2012
2013
2014







Water quality measured in Stony Creek at Bena Street, Yarraville in 2011, 2012, 2013 and 2014.
Boxplot: Box ends equal 25th and 75th percentile, mid line equals the 50th percentile. Whiskers equal maximum and minimum values recorded. Green dashed line equals the relevant guideline concentrations (from SEPP or ANZECC (2000)).

***EPBC Act* Protected Matters Search Tool assessment for listed threatened species for Stony Creek (accessed 14 October 2015).**

Asset / value	*EPBC* listing and search tool assessment	Assessment of probability of occurrence in potential impacted area
LISTED THREATENED SPECIES		
Australian grayling (*Prototroctes maraena*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very Unlikely to occur.** Known from the Yarra River and Maribyrnong River but not recorded from Stony Creek. Stony Creek does not provide suitable adult habitat, concrete-lined channel would act as a barrier to upstream migration of juveniles.
Eastern dwarf Galaxias (*Galaxiella pusilla*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely to occur.** Stony Creek does not provide suitable habitat.
Murray cod (*Maccullochella peelii*)	Vulnerable. Species or species habitat **may** occur within area.	**Very unlikely to occur** in study area. They are generally found in locations with deep pools, undercut banks, dense vegetation and large snags. Suitable habitat is very unlikely to occur in Stony Creek.
Growling grass frog (*Litoria raniformis*)	Vulnerable. Species or species habitat **may** occur within area.	**Very unlikely to occur** in study area. Growling Grass Frogs prefer slow or still-flowing, well-vegetated habitats. Suitable habitat not observed downstream of Somerville Road.
Southern right whale (*Eubalaena australis*)	Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Suitable habitat not present.
Humpback whale (*Megaptera novaeangliae*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur. Suitable habitat not present.
Loggerhead turtle (*Caretta carretta*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the lower part of the creek but only very rarely are individuals found in southern Australia (Cogger 2000).

Asset / value	*EPBC* listing and search tool assessment	Assessment of probability of occurrence in potential impacted area
Green turtle (*Chelonia mydas*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the lower part of the creek but only very rarely are individuals found in southern Australia (Cogger 2000).
Leatherback turtle (*Dermochelys coriacea*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Mostly recorded in temperate areas (Cogger 2000), but are known from the Victorian coast.
LISTED MIGRATORY SPECIES		
Loggerhead turtle (*Caretta carretta*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the lower part of the creek but only very rarely are individuals found in southern Australia (Cogger 2000).
Green turtle (*Chelonia mydas*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the lower part of the creek but only very rarely are individuals found in southern Australia (Cogger 2000).
Leatherback turtle (*Dermochelys coriacea*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Mostly recorded in temperate areas (Cogger 2000), but are known from the Victorian coast.
Southern right whale (*Eubalaena australis*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Suitable habitat not present.
Humpback whale (*Megaptera novaeangliae*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur. Suitable habitat not present.
Mackerel shark (*Lamna nasus*)	Species or species habitat **may** occur within area.	**Very unlikely** to occur. Suitable habitat not present.
LISTED MARINE SPECIES		
Loggerhead turtle (*Caretta carretta*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the lower part of the creek but only very rarely are individuals found in southern Australia (Cogger 2000).
Green turtle (*Chelonia mydas*)	Vulnerable. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Occasional vagrants may be found in the lower part of the creek but only very rarely are individuals found in southern Australia (Cogger 2000).
Leatherback turtle (*Dermochelys coriacea*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Mostly recorded in temperate areas (Cogger 2000), but are known from the Victorian coast.
Southern right whale (*Eubalaena australis*)	Endangered. Species or species habitat **known** to occur with the area.	**Very unlikely** to occur. Suitable habitat not present.
Humpback whale (*Megaptera novaeangliae*)	Vulnerable. Species or species habitat **likely** to occur within area.	**Very unlikely** to occur. Suitable habitat not present.

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