17 Surface Water

17.1 Overview

This chapter provides an assessment of the surface water impacts associated with the construction and operation of Melbourne Metro. The chapter is based on the impact assessment presented in Technical Appendix N *Surface Water* and Technical Appendix U *Aquatic Ecology and River Health.* All relevant references are provided in Technical Appendix N and Technical Appendix U.

The Melbourne Metro alignment and temporary and permanent infrastructure potentially interface with three major waterways: the Yarra River, Moonee Ponds Creek and Maribyrnong River. Each of these major waterways is subject to flood events of varying frequency and severity and there is potential for the project's temporary or permanent construction works to obstruct overland flow paths or result in a loss of floodplain storage. There is also the potential for flooding of the tunnels and stations during severe flood and storm events, and for stormwater runoff from Melbourne Metro's infrastructure and construction works to discharge via local drainage systems to waterways – including drainage to Albert Park Lake from the Domain station construction work site and to Stony Creek from the western turnback site.

Potential surface water impacts from Melbourne Metro (in the absence of specific mitigation measures) would be:

- Flooding of the tunnels and stations during construction or operation, compromising the safety of construction workers, rail staff or commuters, and disrupting rail services. This could occur from riverine flooding or overland flows in excess of the capacity of the underground drainage system
- Temporary or permanent structures obstructing riverine flood or overland drainage flows or resulting in a loss of flood storage. This could potentially increase flood levels or velocities, resulting in an increased flood risk to infrastructure and property. The performance criterion proposed for the project works is that they *'maintain or improve existing flooding functions and characteristics'.* This risk was assessed, where possible, on the basis of the *'magnitude of predicted changes to one per cent Annual Exceedance Probability flood*[*] *and overland flow extents, flows, levels and velocities caused by temporary and permanent project works'*

[*] A one per cent Annual Exceedance Probability (AEP) flood event is one that has a one per cent chance of being equalled or exceeded in any year.

- Reductions in water quality caused by runoff to waterways (either directly or via stormwater drainage)
- Potential for leakage of toxic substances from the Melbourne Metro substation during flood events.

However, the impact assessments conducted for the EES have recommended Environmental Performance Requirements and proposed mitigation measures that, if implemented, would result in there being no significant residual surface water or water quality impacts associated with the construction and operation of Melbourne Metro. All residual risks associated with surface water and water quality have been assessed as 'low' or 'very low'.

Tunnelling for Melbourne Metro would result in no direct impacts on water quality or flows in the three major waterways traversed by the Melbourne Metro alignment. As the crossings of the Yarra River and Moonee Ponds Creek would be via bored tunnels, there would be no direct impacts on these waterways. As the alignment would not cross the Maribyrnong River and there would be no construction activity in the immediate vicinity of the river bank, there would also be no direct impacts on this waterway.

Above ground construction activity and cut and cover excavations would result in exposed surface areas. During high volume rainfall events, there would be the potential for runoff from these surfaces to impact water quality in waterways, either directly or via stormwater drainage systems. Standard construction site management techniques – including minimising the area of exposed ground, isolating site runoff from the existing drainage system and bunding (using retaining walls and similar structures) – would minimise the risk of contaminated runoff entering the stormwater drainage system during construction.

Runoff during the operation of Melbourne Metro (such as runoff from the uncovered portal rail decline structures) would be managed by adopting water sensitive design principles in the development of the stormwater treatment system and collecting and treating runoff before discharge to receiving waterways. It is important to note that impacts from this runoff would be insignificant as the quality of runoff would be equivalent to typical road or rail runoff and the surface areas of these structures would be very small compared with other paved surfaces in the locality.

There may also be opportunities post-construction to capture and reuse runoff from the Melbourne Metro decline structures for the irrigation of parks, sports fields or gardens, with appropriate treatment.

Temporary or permanent works would have the potential to obstruct riverine flood or overland drainage flows, reduce flood storage capacity or overload local drainage systems. This could lead to an increased flood risk to property and infrastructure in some locations. These potential impacts would be mitigated by providing compensatory flood storage to maintain existing storage capacity and by ensuring that works do not materially increase flow velocities, result in erosion or create additional flood risk. Any mitigating measures would be carried out to the requirements and satisfaction of the responsible authority. Implementing these measures would reduce the potential for infrastructure and construction works to impact on existing flooding risks to low or very low levels.

During the construction and operational phases of Melbourne Metro, there would be the potential for flooding of the tunnels via the Melbourne Metro portals and the existing City Loop tunnel portals, station entrances and other surface openings during severe storm and flooding events. This risk would be reduced substantially through the design of permanent and temporary works associated with the tunnels, tunnel portals, access shafts, station entrances and other surface openings to provide appropriate protection against floodwaters and overland stormwater flows, and by the implementation of flood warning systems and other emergency management measures. Flood warning systems would link to existing flood warnings that are in place, particularly in the Maribyrnong and Yarra River catchments.

The appropriate level of flood immunity would be informed by a flood immunity risk assessment that considers a range of events and that would be undertaken to the requirements and satisfaction of the responsible authority.

The Melbourne Metro Construction EMP and Operations EMP would include best practice measures to monitor, manage and avoid these and other surface water impacts, in line with relevant Victorian laws and policies.

17.2 EES Objectives

The EES Scoping Requirements set the following draft evaluation objective for the EES:

- *Hydrology, water quality and waste management – To protect waterways and waterway function and surface water…quality in accordance with statutory objectives … to manage excavation spoil and other waste in accordance with relevant best practice principles.*

In accordance with this objective, the potential effects on flood and stormwater flows and water quality have been determined through a surface water impact assessment that focused on the drainage and flood related aspects of hydrology (Technical Appendix N *Surface Water*) and an aquatic ecology and river health impact assessment that assessed water quality and stream health (Technical Appendix U *Aquatic Ecology and River Health*).

This assessment enabled identification of the potential impacts and risks associated with the construction and operation of Melbourne Metro. Using this information, Environmental Performance Requirements have been recommended to avoid or minimise adverse impacts from Melbourne Metro on waterway quality and function, and flood and stormwater flows.

17.3 Legislation and Policy

As discussed in Chapter 4 *EES Assessment Framework and Approach*, the protection of waterways during the construction and operation of Melbourne Metro would be managed and monitored in accordance with Victorian legislation, policies and guidelines. The main relevant laws and policies are set out below.

Table 17–1 Legislation and policy relevant to Melbourne Metro

Legislation	Policy/guideline	Comment
State		
Water Act 1989		This Act is the main legislation covering the management of Victoria's water resources. The reaches of the Yarra River, Moonee Ponds Creek and Maribyrnong River in the vicinity of the Melbourne Metro alignment are designated waterways managed by Melbourne Water. A Works on Waterways Permit would be required to undertake any works within or in proximity of a designated waterway. A permit would be required to build over, or near, any of Melbourne Water's underground assets such as pipes, drains, water mains and easements.
Planning and Environment Act 1987	Victoria Planning Provisions and the relevant planning scheme	Planning schemes manage the presence and movement of surface water through the application of overlays. Two of these overlays (Land Subject to Inundation Overlay and Special Building Overlay) exist within the proposed project boundary, meaning that planning approval may be required to commence and undertake works.
Environment Protection Act 1970	SEPP (Waters of Victoria) (WoV)	SEPP (WoV) provides the legal framework for the protection and rehabilitation of Victoria's surface waters. Melbourne Metro would need to comply with the objectives and standards set out in SEPP (WoV).
Coastal Management Act 1995	The Victorian Coastal Strategy	This strategy covers coastal, estuarine and marine environments in Victoria. It requires any planning in Victoria to consider a sea level rise benchmark of not less than 0.8 m by 2100. This benchmark has been incorporated into Clause 12.02 (Coastal Areas) of the State Planning Policy Framework of all Victorian planning schemes.

Legislation	Policy/guideline	Comment
Other relevant documents		
	Australian Rainfall and Runoff (ARR)	Australian Rainfall and Runoff is a national guideline published by Engineers Australia, which provides the basis for estimating flood flows. Planning for Melbourne Metro would be undertaken in accordance with this guideline.
	Austroads Guide to Road Tunnels (2010)	This publication provides guidance on the planning, design, operation and maintenance of new road tunnels in Australia. It includes tunnel flood immunity standards in line with a risk management approach. This approach would be adopted in planning the Melbourne Metro tunnels as no guidelines exist for rail tunnels.

17.4 Methodology

17.4.1 Assessment Approach

Study Area

While the impact assessment focused on flood prone areas of the Yarra River, Maribyrnong River and Moonee Ponds Creek in the vicinity of the Melbourne Metro tunnels alignment, the study area for the assessment extended along the whole of the alignment. This is because of the possibility of flooding of tunnels and stations from local stormwater runoff, and the possibility that stormwater runoff from the portal and station precincts could enter the stormwater drainage system and ultimately discharge to waterways in the vicinity.

Assessment Methodology

The potential effects of Melbourne Metro on flood and stormwater flows and water quality have been determined through a surface water impact assessment that focused on the drainage and flood related aspects of hydrology (Technical Appendix N) and an aquatic ecology and river health impact assessment that assessed water quality and stream health (Technical Appendix U). The approach adopted in these assessments included:

- A desktop assessment using available baseline and background data (see Section 17.4.2) to obtain information on the surface water within the proposed project boundary

- Hydrologic and hydraulic modelling* to determine flood flows and levels for a range of flood events, including allowances for the impacts of climate change
- Field assessments conducted by qualified and experienced specialists, including inspections at points where the tunnels would pass beneath floodplains and waterways
- Consultation with stakeholders, including Melbourne Water and the relevant Councils
- Conducting a risk assessment to identify the type and scale of risk
- Completing an impact assessment for each precinct
- Identifying measures to avoid or minimise impacts.

Technical Appendix O *Groundwater* and Technical Appendix Q *Contaminated Land and Spoil Management* have also been prepared. While these assessments contribute to identifying adverse effects on hydrology and water quality, they are discussed separately in Chapter 19 *Groundwater* and Chapter 20 *Contaminated Land and Spoil Management*.

Further details of the assessment methodology are provided in Section 4 of Technical Appendix N *Surface Water* and Section 4 of Technical Appendix U *Aquatic Ecology and River Health*.

Flood Immunity Standards

Hydrologic and hydraulic modelling undertaken for the assessment or obtained from existing available information has enabled the estimation of a range of peak flood flows and levels across the Melbourne Metro alignment. This information would be used to determine the appropriate levels of protection from flooding required for construction sites and above ground structures during construction and operation, and the potential need for implementation of flood warning systems and other emergency management measures, through further flood immunity risk assessment.

The modelling focused on assessing the impacts of temporary and permanent works associated with the project on one per cent AEP flood levels. The one per cent AEP flood event has a one per cent chance of being equalled or exceeded in any year. This is also sometimes referred to as the 100 year Average Recurrence Interval flood event.

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* Hydrologic modelling establishes estimates of flood and stormwater flows. Hydraulic modelling uses these flows to estimate flood levels and extents.

Melbourne Water uses the one per cent AEP flood event as the reference event for delineating land potentially affected by flooding and setting requirements for developing this land. Melbourne Water also uses the one per cent AEP event as the reference event against which to assess impacts associated with major infrastructure projects such as Melbourne Metro.

In considering the impacts of Melbourne Metro works, consideration was given to the impact on one per cent AEP flood levels under existing conditions and Year 2100 conditions (taking account of expected increases in rainfall intensities and sea levels associated with climate change). These impacts can be subdivided into two broad categories:

- Works that increase flood levels by restricting the passage of flood and overland flows. The relative increase in flood levels of these types of works will generally be greater for existing one per cent AEP flood conditions than for Year 2100 one per cent AEP flood conditions
- Works that increase flood levels by reducing flood storage. The impacts of these types of works will generally be greater for Year 2100 one per cent AEP flood conditions than for existing one per cent AEP flood conditions.

Input to the design process focused on Year 2100 flood levels for a range of AEPs. A range of potential design requirements need to be accounted for:

- Melbourne Water generally requires that major infrastructure be protected against a one per cent AEP flood, with a 600 mm freeboard allowance (additional distance above a design flood level as a factor of safety for such things as wave action and uncertainty associated with climate change) for riverine flooding and a 300 mm freeboard allowance for local stormwater flooding. Melbourne Water requires this assessment to take account of the design life of the infrastructure. Therefore, for Melbourne Metro, this assessment was based on Year 2100 conditions. MMRA is committed to providing this level of flood immunity as a minimum standard
- MMRA may decide to adopt higher flood immunity standards than are required by Melbourne Water. This would be informed by an additional flood immunity risk assessment. This assessment would need to consider the operability and integrity of the rail network as determined by the network owner and take account of the impacts of a range of flood events, including damage and clean-up costs and the costs associated with any potential long-term disruption of the rail network. This flood immunity assessment is separate to the environmental risk assessment discussed in Section 17.6 and is not a requirement of the EES Scoping Requirements. It does not form part of the environmental approvals process.

The surface water impact assessment (Technical Appendix N) was independently peer reviewed. The aquatic ecology and river health impact assessment (Technical Appendix U) was reviewed internally by the nominated practice reviewer.

17.4.2 Baseline and Background Data

Data sources used in the surface water impact assessments included:

- Routine water quality data collected by Melbourne Water from each of the relevant waterways within the proposed project boundary, including monthly data collected from the last three years (2012-2015) and data from Parks Victoria in respect of Albert Park Lake
- Information from previous studies and relevant planning scheme overlays
- Information obtained from field investigations
- Previously developed models from different sources, which were used to assist in determining flood flows and levels for a range of flood events, including allowances for the impacts of climate change.

17.5 Existing Conditions

Existing surface water conditions within the project boundary are described in general terms in this section. Conditions that are specific to individual precincts are described in Sections 17.8 to 17.15.

The Melbourne Metro alignment and infrastructure potentially interface with three major waterways:

- Yarra River – approximately 120 m from CBD South station and could also potentially impact on the eastern portal at South Yarra
- Moonee Ponds Creek – approximately 100 m from Arden station
- Maribyrnong River – approximately 500 m to the west of the closest western portal decline structure*.

The locations of these waterways are shown in Figure 17-1.

The tunnels alignment would run beneath the estuarine section of the Yarra River (the part of the river where the current meets the sea's tides), just upstream of Princes Bridge. It would run beneath Moonee Ponds Creek downstream of Arden Street. The alignment would not cross the Maribyrnong River, but the Project Area would extend near to the eastern bank of the Maribyrnong River (upstream of Dynon Road) at the western portal.

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* Melbourne Water has the primary responsibility for waterway, drainage and floodplain management for these waterways. Details of Melbourne Water's vision, values and planned actions for managing these waterways and urban runoff can be found in the *Healthy Waterways Strategy and Stormwater Strategy*, available at www.melbournewater.com.au.

Each of these waterways is subject to flood events of varying frequency and severity. Unobstructed overland flood paths are important to draining floodwaters and avoiding damage to property and infrastructure. The availability of flood storage (where water is temporarily stored within the riverine floodplain) also plays a critical role in ameliorating the effects of a flood event. There would be the potential for the project's construction works or permanent structures to obstruct overland flow paths if these impacts are not mitigated, or to result in a loss of floodplain storage if replacement storage is not provided.

There would also be the potential for stormwater runoff from the Melbourne Metro construction works and infrastructure to discharge via local drainage systems to these major waterways and to two other waterways located outside the study area: Albert Park Lake and Stony Creek.

17.5.1 Yarra River

The Yarra River is the largest waterway within the project boundary, with a catchment area of 4,080 km^2. The Yarra estuary extends 22 km from below Dights Falls in Abbotsford to the mouth of the river at Williamstown, where it flows into Hobsons Bay. Downstream of the Spencer Street bridge, the estuary has been significantly modified to form a series of docks and wharves. Large amounts of stormwater enter the lower reaches of the river, reducing water quality.

Water Quality

While water quality in the Yarra River has improved substantially in recent decades, the lower reaches of the river continue to record poor or very poor water quality ratings, due largely to high nutrients (such as nitrogen and phosphorus) and metal concentrations contained in runoff. In 2013, the EPA examined toxicants in the lower Yarra River over three decades and concluded '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 River contains higher concentrations of arsenic and nickel, and higher concentrations of dichloro-diphenyl-trichloroethane in the sediments (see EPA Publication number 1529, May 2013).

Flooding

Flood events on the Yarra River have the potential to impact Melbourne Metro around CBD South station, the eastern portal site and at CBD North station. The tunnels are prone to flooding from the Yarra River entering the City Loop tunnel portals east of Flinders Street Station and flowing into the Melbourne Metro tunnels through the cross-connection between the two tunnels at CBD North station. Two to three days warning would typically be available in advance of a flood peak on the Yarra River at these locations.

17.5.2 Maribyrnong River

The Maribyrnong River has a catchment area upstream of the three parallel railway bridges to the west of the western portal site of approximately 1,400 km^2. The Maribyrnong estuary extends from Avondale Heights to join the Yarra River at Yarraville, a length of approximately 20 km. The section of the river running through Kensington and Footscray (adjacent to the study area) flows through a highly urbanised and industrial landscape.

Water Quality

Water quality in the river's estuarine section is generally poor, with nitrogen, phosphorus and zinc levels consistently above SEPP (WoV) guideline concentrations. Melbourne Water reports that 'improving waterway condition [in the lower reaches of the river] is a challenge. Water quality has been significantly reduced due to the impacts of urbanisation and development and extensive land clearing, which has left little natural streamside vegetation' (River Health Data, Maribyrnong Catchment, Melbourne Water website).

Flooding

Flood events on the Maribyrnong River have the potential to impact the western portal site. Any loss of floodplain storage for the Maribyrnong River from construction works or permanent structures would also be likely to result in increases in flood flows and levels in the vicinity of this precinct. At least twelve hours warning would typically be available in advance of a flood peak on the Maribyrnong River at the western portal.

17.5.3 Moonee Ponds Creek

The Moonee Ponds Creek rises within the vicinity of Yuroke, runs through the northern suburbs of Melbourne and joins the Yarra River downstream of Docklands. For most of its length, the Moonee Ponds Creek is a heavily modified man-made channel and it is concrete-lined for much of its lower reaches.

The Moonee Ponds Creek estuary extends from Macaulay Road in 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 that has been modified significantly over many years of activities in the area, with levees along one or both banks for much of this reach.

Water quality

Due to stormwater runoff entering the creek, downstream water quality is rated poor. In particular, nitrogen, phosphorus and zinc levels are consistently above SEPP (WoV) and ANZECC guideline levels.

Flooding

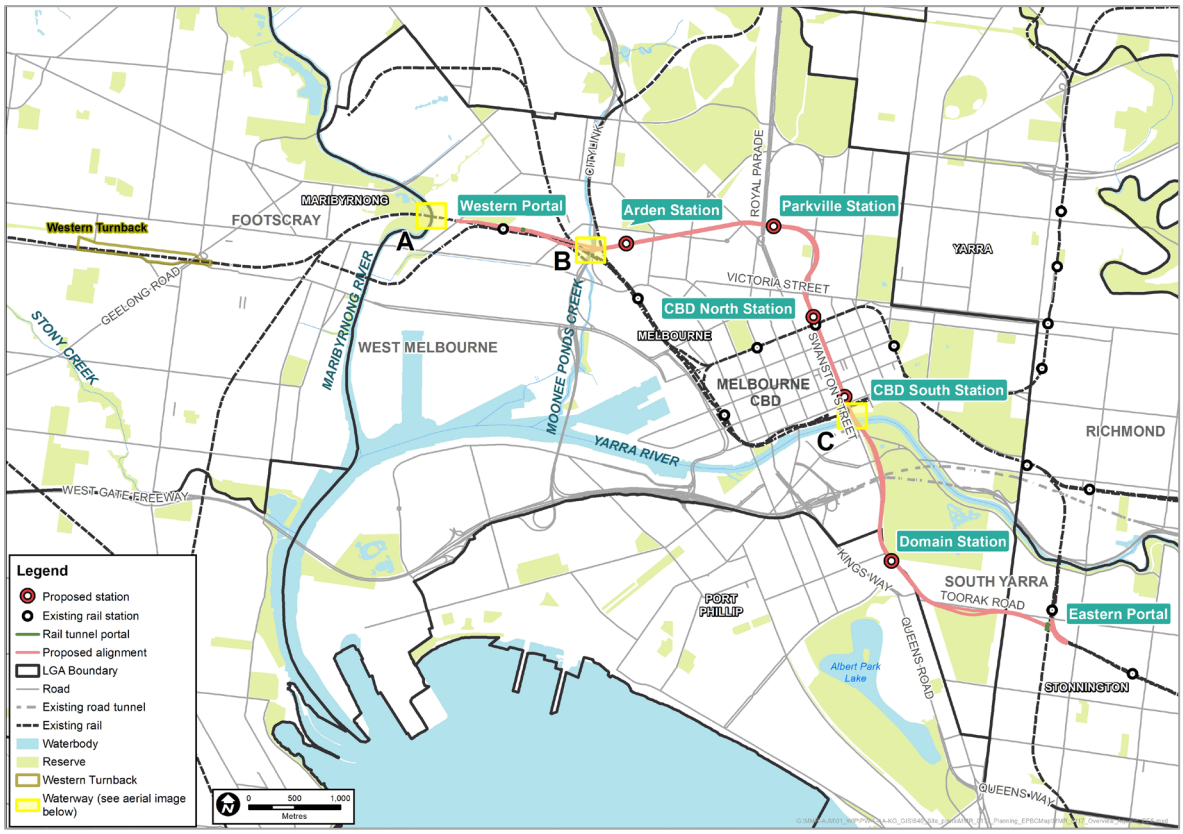
Flood events on Moonee Ponds Creek have the potential to impact Melbourne Metro at the Arden station site. Any loss of flood storage for Moonee Ponds Creek from construction works or permanent structures would also be likely to result in increases in flood flows and levels in the vicinity of the Arden station precinct. Flood events on Moonee Ponds Creek typically occur relatively quickly, and only one to two hours warning would typically be available in advance of a flood peak at the proposed Arden station site.

17.5.4 Other Waterways

Two other waterways are located in stormwater catchments where Melbourne Metro works could take place:

- Albert Park Lake (located to the south-east of the study area) – Albert Park Lake is within the stormwater catchment of Domain station. Water quality in the lake is indicative of an urban system that receives stormwater runoff. While dissolved oxygen, salinity and pH generally meet guidelines, total nitrogen and phosphorus levels and turbidity are elevated compared to SEPP (WoV) guidelines
- Stony Creek (located to the south-west of the study area) – Stony Creek would receive stormwater drainage from the western turnback (West Footscray). Water quality in the creek is generally poor and rarely meets guideline concentrations. Total nitrogen and phosphorus are elevated compared to guidelines and E. coli is also extremely high at times. Some heavy metal concentrations (such as chromium, lead and zinc) are also frequently elevated.

Figure 17-1 Waterways in relation to the alignment



A – Maribyrnong River

B – Moonee Ponds Creek

C – Yarra River

17.5.5 Drainage Systems

Major overland stormwater flows associated with drainage systems are also present within the project boundary:

- Melbourne Water's Arden Street Main Drain services local sub-catchments on the eastern side of Moonee Ponds Creek, adjacent to the proposed Arden station site
- The CBD South station area is immediately adjacent to two existing City of Melbourne drains in Swanston Street. Flows in excess of the combined capacity of these drains flow west into the Elizabeth Street Main Drain, which is the responsibility of Melbourne Water

- The Hannah Street Main Drain system, which services the catchment around Domain station, runs approximately north-south along Kings Way before discharging to the Yarra River near Crown Casino. The system also includes outfalls to Albert Park Lake
- The Prahran Main Drain and Yarra Street Outfall Drain systems service the area in the immediate vicinity of the eastern portal site and discharge to the Yarra River in the vicinity of the rail crossing to the north of South Yarra station
- The western turnback at West Footscray crosses Melbourne Water's Graingers Road Main Drain, which flows from north to south across the rail alignment and discharges into Stony Creek approximately one kilometre south of the station.

17.6 Risk Assessment

An Environmental Risk Assessment has been completed for impacts of Melbourne Metro in relation to surface water. Further information about the risk assessment approach adopted for Melbourne Metro is included in Chapter 4 *EES Assessment Framework and Approach*.

Impact assessment must be informed by risk assessment so that the level of mitigation action relates to the likelihood of an adverse impact occurring.

While many of the potential surface water risks associated with Melbourne Metro would have a rare or unlikely likelihood rating (such as 0.1 per cent AEP or 0.01 per cent AEP flood events), the potential consequences of these hazardous events could be major or severe in the absence of mitigation measures. As a result, a number of initial risk ratings of medium or high were assigned.

The impact assessment focused on those risks that were assessed as having an initial risk level of medium or above. As a result of the impact assessment, project-specific Environmental Performance Requirements – combined with the implementation of proposed mitigation measures (such as portal flood gates and emergency procedures) – have been recommended to reduce surface water impacts. Achieving the recommended Environmental Performance Requirements and the proposed mitigation measures, combined with the relative rarity of these events, would be expected to reduce the residual risk consequence ratings to negligible or minor. Accordingly, all residual surface water risks have been assessed as low or very low.

A full list of surface water risks, showing the initial and residual consequence rating of each risk, is provided in Technical Appendix B *Environmental Risk Assessment Report*, Technical Appendix N *Surface Water* and Technical Appendix U *Aquatic Ecology and River Health*.

The recommended Environmental Performance Requirements are listed in Section 17.17.

17.7 Impact Assessment

Potential surface water impacts from Melbourne Metro (in the absence of specific mitigation measures) would be:

- Flooding of the tunnels and stations from tunnel portals, station entrances or other surface openings during construction or operation, potentially compromising the safety of construction workers, rail staff or commuters, and disrupting rail services. This could occur from riverine flooding, or overland flows in excess of the capacity of the underground drainage system
- Temporary or permanent works obstructing riverine flood or overland drainage flows, or resulting in loss of flood storage. This could potentially increase flood levels or velocities, in turn resulting in an increased flood risk to infrastructure and property. The performance criterion proposed for the project works is that they '*maintain or improve existing flooding functions and characteristics'*. This was assessed, where possible, on the basis of the '*magnitude of predicted changes to one per cent Annual Exceedance Probability flood and overland flow extents, flows, levels and velocities caused by temporary and permanent project works'*
- Reductions in water quality caused by runoff or accidental discharge to waterways (either directly or via stormwater drainage)
- Potential for leakage of toxic substances from the Melbourne Metro substation in the Arden precinct during flood events or equipment failure.

It is important to note that the surface water impacts cover two different risk profiles: sources of impacts from the environment to the project (such as riverine flooding inundating tunnels and stations) and sources of impacts from the project to the environment (such as temporary structures obstructing overland drainage flows).

The Melbourne Metro Construction EMP and Operations EMP would include controls to monitor, manage and avoid these impacts, in line with relevant Victorian laws and policies. The impact assessment found that, with appropriate mitigation measures in place, waterway quality and function would be protected from any adverse consequences caused by the construction or operation of Melbourne Metro.

The main impacts are described in greater detail in the following sections. Sections 17.8 to 17.15 describe these impacts as they apply specifically to each of the Melbourne Metro precincts.

17.7.1 Construction

Interface with Major Waterways

As the crossings beneath the Yarra River and Moonee Ponds Creek would be via bored tunnels, there would be no direct impacts on these waterways. As noted in Section 17.1, the Melbourne Metro alignment would not cross the Maribyrnong River, but would extend near to the eastern bank of the river at the proposed western portal site. However, at this point the existing rail infrastructure would be used and there would be no construction activity in the immediate vicinity of the Maribyrnong River bank.

Accordingly, no direct impacts on water quality or flows in these three major waterways are anticipated as a result of tunnelling activities for Melbourne Metro.

Flooding

There is a possibility that flooding of the tunnels and stations could occur during construction if a significant flood or rainfall event occurs. Such flooding would have potentially serious implications for the health and safety of construction workers.

This risk would be reduced substantially by the adoption of the approach to flood immunity outlined in Section 17.4.1 in the design of tunnel portals, station entrances and other critical infrastructure to provide appropriate protection for construction works and workers from the impacts of floodwaters and overland stormwater flows. This would be informed by a flood immunity risk assessment that considers a range of flood events, and to the requirements and satisfaction of the responsible authority and owner of the rail network.

Areas identified as being potentially susceptible to major flood events are:

- Precinct 1 - Tunnels – where the tunnels are prone to flooding from the Yarra River entering the City Loop tunnel portal east of Flinders Street Station and then flowing into the Melbourne Metro tunnels through the cross-connection between the two at CBD North station
- Precinct 2 - Western portal – where areas around the existing rail embankment are in the Maribyrnong River floodplain
- Precinct 3 - Arden station – where land around the station box would be located in the Moonee Ponds Creek floodplain
- Precinct 6 - CBD South station – where areas along Swanston and Flinders Streets are prone to flooding from local stormwater runoff
- Precinct 7 - Domain station – where the station box is proposed to extend across an overland flow path
- Precinct 8 - Eastern portal – where the areas around the proposed portal are subject to flooding from the Yarra River.

These potential impacts are discussed in greater detail under each precinct.

Where required, design mitigation measures (such as flood gates) and emergency measures (such as flood warning systems and emergency evacuation procedures) would be developed and implemented to manage the impacts of large flood events.

Disruption of Riverine and Drainage Flows

Temporary or permanent works undertaken for Melbourne Metro could obstruct riverine flood or overland drainage flows or result in a loss of flood storage. This could potentially increase flood levels or velocities, heightening the flood risk to infrastructure and property. However, these impacts can generally be avoided or mitigated.

The impact assessment determined that by achieving the recommended Environmental Performance Requirements and mitigation measures, Melbourne Metro would maintain or improve existing flooding functions and characteristics, and comply with Melbourne Water's floodplain management requirements. In those precincts where the loss of flood storage could result in flooding impacts – the western portal and Arden station precincts – compensatory flood storage would be provided to offset losses of floodplain storage. The required volumes of compensatory flood storages have been estimated. Further consultation with Melbourne Water during the detailed design phase would be required to finalise the location and design of compensatory flood storages.

Stormwater Runoff

Melbourne Metro would result in exposed surface areas at above-ground construction sites and cut-and cover excavations, as well as increased deposition of sediment and other pollutants on road surfaces from the additional truck movements required for construction. During high volume rainfall events, there would be potential for flooding and runoff from these surfaces to have an adverse impact on water quality in waterways, either directly or via stormwater drainage systems. This runoff would be likely to contain surface sediments, chemicals, oils and rubbish.

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 would include compliance with the CSIRO's Best Practice Environmental Management Guidelines for Urban Stormwater.

Standard management techniques – including minimising the area of exposed ground, isolating site runoff from the existing drainage system, sediment containment, bunding and regular street sweeping – 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.

17.7.2 Operation

The main impacts during the operation phase of Melbourne Metro are expected to be the potential impacts of flooding of the tunnels via the Melbourne Metro or City Loop portals or station entrances.

Flooding

There is a possibility that flooding of the tunnels and stations could occur during operation if a significant flood or rainfall event occurs. Such flooding could pose a potentially serious risk to commuters and rail staff, and a significant disruption to rail services.

This risk would be mitigated by the adoption of:

- Minimum flood immunity standards in accordance with Melbourne Water requirements
- Higher flood immunity standards than are required by Melbourne Water, where appropriate. As discussed in Section 17.4.1, the adoption of these higher standards would be informed by an additional flood immunity risk assessment. The flood immunity risk assessment would need to consider the operability and integrity of the rail network as determined by the network owner and take account of the impacts of a range of flood events, including damage and clean-up costs, and the costs associated with any potential long-term disruption of the rail network.

Stormwater Runoff

Runoff from above-ground structures (tunnel portals and station entrances) would be likely to contain sediment, oils and greases, leading to a reduction in water quality if discharged to the stormwater drainage system and ultimately to waterways. However, it is important to note that impacts from this runoff would be insignificant as the quality of runoff would be equivalent to typical road or rail runoff and the surface areas of these structures would be very small compared with other paved surfaces.

The potential impacts of runoff would be mitigated by:

- Collecting runoff and treating it appropriately before discharge to receiving waterways in accordance with applicable standards
- Adopting water sensitive design principles in the development of the stormwater treatment system, in consultation with the EPA
- Designing the capacity of the stormwater system to capture any spills of hazardous liquids in accordance with EPA requirements, including incident response procedures.

These runoff impacts would be common to all Melbourne Metro precincts with above-ground structures and similar mitigation measures would be adopted in each precinct, although treatment options may vary between precincts.

17.8 Precinct 1: Tunnels

As noted earlier in this chapter, as the tunnels are located underground, there would be no direct impacts on waterways from their construction or operation.

Precinct 1 also includes a potential TBM southern launch site in Fawkner Park, the emergency access shafts and two above-ground construction work sites, which would have the potential to generate surface water impacts. There are no flooding overlays or major overland flow paths in the vicinity of the potential TBM southern launch site in Fawkner Park or the emergency access shaft sites in Fawkner Park and Queen Victoria Gardens.

Note that the TBM southern launch sites are in Domain only or in Domain and Fawkner Park.

17.8.1 Construction

Flooding

The Melbourne Metro tunnels are potentially subject to flooding via the existing City Loop tunnels and the underground interconnection at CBD North station. Of the six City Loop tunnel portals between Flinders Street and Richmond Stations, the portal on the line between Flinders Street and Parliament Stations (near Federation Square) would be at the greatest risk of riverine flooding and would be subject to flooding from the Yarra River in an event more frequent than a Year 2100 (that is, including allowance for climate change) one per cent AEP Yarra River flood. The Melbourne Metro tunnels would fill relatively quickly (within hours) once inundation thresholds were exceeded at this location. This could be mitigated by the installation of flood gates on the City Loop tunnel portal.

The other five City Loop portals in this area would all be immune from flooding in a Year 2100 0.1 per cent AEP Yarra River flood event. Further flood immunity risk assessment would be required to determine whether additional mitigation measures would be required on these portals.

There is a small catchment draining to the area around the proposed TBM launch site in Fawkner Park that would create a minor risk of some inundation of the site during construction. This could be mitigated relatively easily by the construction of small barriers to intercept minor overland flows reaching the north side of the excavation and diverting these around the excavation. Diversion of these flows would have a negligible impact on overland flow depths.

17.8.2 Operation

Once design mitigation measures are implemented to ensure permanent structures do not obstruct riverine flood or overland drainage flows, no significant surface water impacts would be anticipated from the operation of the tunnels.

During operation 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, 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.

17.8.3 Alternative Design Options

The alternative locations for the emergency access shafts are very similar to those for the Concept Design and would have no significant advantage or disadvantage in terms of surface water impacts.

17.9 Precinct 2: Western Portal (Kensington)

The main components that may influence surface water impacts in Precinct 2 are the piled structure, decline structure and cut and cover tunnelling works associated with the western portal and the TBM retrieval box, and the establishment of a major construction site at 1-39 Hobsons Road in Kensington.

Much of the precinct is subject to flooding from the Maribyrnong River, with a number of locations covered by a Land Subject to Inundation Overlay of the Melbourne Planning Scheme.

17.9.1 Construction

Flooding

There is potential for flooding of the western portal from the Maribyrnong River during construction. Without design mitigation, floodwaters would be likely to fill the portal and tunnels relatively quickly (within hours) during a flood event, potentially posing a significant risk to construction workers. The area on the north side of the rail embankment is currently subject to flooding in an event more frequent than a one per cent AEP flood (100 year Average Recurrence Interval). Accordingly, the portal and tunnels would be designed to provide protection against flooding to at least this level during construction. Retaining walls or similar barriers are proposed to protect the portal during construction.

Larger flood events would generally be expected to rise relatively slowly in this floodplain area; consequently, warnings of many hours would generally be available to enable evacuation and other necessary emergency measures (such as emergency evacuation procedures linked to existing flood warning systems in the Maribyrnong catchment) to be put in place in advance of a flood peak.

Disruption of Drainage Flows

Construction of the portal and permanent works would result in some loss of floodplain storage. This would be mitigated by providing permanent compensatory flood storage of approximately 9,000 m^3 (cubic metres). Further consultation with Melbourne Water during the detailed design phase would be required to finalise the location of this storage in accordance with the recommended Environmental Performance Requirements.

Runoff

During rainfall events, there would be the potential for runoff from exposed areas containing sediment and other contaminants to enter the stormwater drainage system. This runoff would be managed in accordance with the measures described in Section 17.7.1.

17.9.2 Operation

Flooding

There is potential for flooding of the tunnels via the portal during operation. Without design mitigation, floodwaters typically would be likely to fill the tunnels within hours, potentially posing a serious risk to commuters and rail staff and resulting in a significant disruption to rail services.

Accordingly, the portal and tunnels would be designed to provide protection against flooding from the Maribyrnong River – for example, through a retaining wall to provide protection against the one per cent AEP flood event and the installation of automatic flood gates that extend to the full height and width of the portal, providing protection against extreme flood events.

Disruption of Drainage Flows

None of the western portal infrastructure works would be located such that they would obstruct flows along any major flood flow paths.

Runoff

Drainage runoff from the decline structure would be pumped into the local drainage system. As the decline structure would increase the overall paved area, there would likely be a need to control the discharge rate into the existing drainage system. This would require the provision of local drainage storage onsite of around 180 m^3 for the operational phase of the project. A number of options for the location of this storage have been considered and would need to be approved in accordance with the recommended Environmental Performance Requirements. It may be feasible to combine this storage with the compensatory flood storage requirements described in Section 17.9.1.

Stormwater runoff from the proposed western portal would potentially impact water quality in the Maribyrnong River and/or Moonee Ponds Creek. This runoff would be managed through adoption of the proposed mitigation measures described in Section 17.7.1.

There may be opportunities to capture and reuse runoff from the decline structure for the irrigation of parks, sports fields or gardens, with appropriate treatment.

17.9.3 Alternative Design Options

As with the Concept Design, construction of the alternative design option at the western portal would result in some loss of floodplain storage. This would be mitigated by providing compensatory flood storage (approximately 7,000 m^3).

The alternative design option involving the location of the Melbourne Metro substation in the 50 Lloyd Street Business Estate would not be within any areas covered by flood overlays.

17.10 Precinct 3: Arden Station

The main components that may influence surface water impacts in the Arden station precinct would be the cut and cover construction of the station, tunnel excavation and TBM launch, the use of publicly owned (VicTrack) land as a major staging and construction work site, and the permanent station entrance structures. The Melbourne Metro intake substation (located north of Arden Street, between CityLink to the west and Langford Street to the east) would also potentially impact surface water in the area.

The area around Arden station is subject to flooding from Moonee Ponds Creek and local sub-catchments on either side of the creek, and the station site is located almost entirely within a Land Subject to Inundation Overlay. The proposed entrances to the station would be in the Moonee Ponds Creek floodplain and land around the station box and entrances would be subject to flooding in events as frequent as 10 per cent AEP.

17.10.1 Construction

Flooding

Flooding of the station box during construction has the potential to cause significant inundation of the box and adjacent sections of the tunnels in a relatively short time (within hours). Without design mitigation, this has the potential to pose a significant risk to construction workers. This risk would need to be managed during construction by the erection of retaining walls or similar barriers around the station box and the implementation of emergency management measures, including a flood warning system and evacuation procedures.

Disruption of Drainage Flows

Construction of the station box would result in some loss of floodplain storage. This would be mitigated by providing compensatory flood storage (approximately 6,000 m^3). Melbourne Water has provided in-principle agreement to this concept. It is currently proposed that the flood storage be provided by lowering surface levels in a car park at the southern end of the VicTrack land on which the construction work site would be located.

Runoff

During rainfall events and/or flooding of Moonee Ponds Creek, there would be the potential for runoff from exposed areas containing sediment and other contaminants to enter the stormwater drainage system. This runoff would be managed in accordance with the measures described in Section 17.7.1.

17.10.2 Operation

Flooding

During operation, potential flooding of the station and tunnels via the station entrances and other surface openings has the potential to cause significant inundation of these assets in a relatively short time frame, with associated risks to commuters and rail staff. These potential impacts would be minimised by raising the station entrance, emergency access points and any other surface openings (such as ventilation shafts) to levels above the Year 2100 0.1 per cent AEP flood level (1,000 year Average Recurrence Interval) with allowance for climate change effects. Further flood immunity risk assessment will be undertaken to determine if this level of protection is appropriate.

As flood warning times in Moonee Ponds Creek are relatively short (only one to two hours) and floodwaters rise quickly, appropriate emergency management measures would need to be put in place if deemed necessary to provide protection against events more severe than the Year 2100 0.1 per cent AEP event. In addition to suspending rail services, these measures could include emergency sandbagging or automated flood gates on the station entrances.

The permanent station entrance and other surface structures would result in some minor loss of floodplain storage and require compensatory flood storage of around 1,600 m^3. This volume is significantly less than the storage required during the construction stage and could be readily accommodated within the publicly owned land.

Disruption of Drainage Flows

Major Moonee Ponds Creek and overland flow paths in this area are generally located along the main creek channel and along Arden Street. None of the permanent infrastructure works would be located such that they would obstruct flows through any of these major flood flow paths.

Arden Electricity Intake Substation

The electrical substation would be within the Moonee Ponds Creek floodplain. However, the location would be largely on a small strip of slightly elevated ground surrounded by the Land Subject to Inundation Overlay and would not obstruct major Moonee Ponds Creek and overland flood flow paths.

Construction of the substation may result in some very minor loss of floodplain storage, which would be mitigated by the provision of a small volume of compensatory flood storage (less than 200 m^3). This storage volume could be readily incorporated within the much larger compensatory storages required to offset loss of floodplain storage associated with Arden station (see above).

There is potential for impacts on the aquatic health of Moonee Ponds Creek if flooding or equipment failure results in a leak of toxic substances from the substation. With flood prevention measures as described above, there is a low level of risk to aquatic ecosystem values. In the event of a non-flood related leak, a proposed mitigation measure would be for bunding to be placed around the substation to collect any toxic substances and prevent them from entering Moonee Ponds Creek.

17.10.3 Alternative Design Options

Both alternative design options for the substation site would be within the Moonee Ponds Creek floodplain. The first option (co-location at Metro Trains Melbourne (MTM) traction substation) would be wholly within an area covered by the Land Subject to Inundation Overlay. The western section of the second option (southern section of the Arden precinct, between the rail to the west and Laurens Street to the east) would be also covered by the Land Subject to Inundation Overlay.

As with the Concept Design, the location of the substation at either of the two alternative design option sites would not obstruct flows along any major flood flow paths. However, construction of the substation at either of these sites could result in some minor loss of floodplain storage. This would be mitigated by providing small volumes of compensatory flood storage as follows:

- Substation co-located at MTM Melbourne traction substation: approximately 400m^3
- Substation located in southern section of the Arden precinct: approximately 250m^3.

As for the Concept Design, these volumes are small and could be readily incorporated within the much larger compensatory storages required to offset loss of floodplain storage associated with Arden station (see above).

As with the Concept Design, there would be 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. With flood prevention measures as described above, there is a low level of risk to aquatic ecosystem values. In the event of a non-flood related leak, a proposed mitigation measure is for bunding to be placed around the substation to collect any toxic substances and prevent them from entering Moonee Ponds Creek.

There is another option located at the western portal, however this would not be affected by flooding issues.

17.11 Precincts 4 and 5: Parkville Station and CBD North Station

Similar surface water issues and impacts are associated with these two precincts, due to there being no planning scheme flooding overlays or major overland flow paths in the vicinity of either Parkville or CBD North stations.

Components with the potential to impact surface water in these precincts include the construction of station structures, the creation of temporary work sites and the permanent station entrances.

17.11.1 Construction

Flooding

There is potential for some inundation of both station boxes during construction from minor overland flows. This could be mitigated relatively easily by the construction of small barriers to intercept these flows and divert them away from the excavation (at the Parkville station site) and cavern entrances (at the CBD North station site). Diversion of these flows would have a negligible impact on overland flow depths.

Runoff

As the construction work sites are subject to only negligible overland flow risk, direct rainfall would be the most likely source of runoff. During rainfall events, there is the potential for runoff to enter the stormwater drainage system and impact on water quality in Moonee Ponds Creek and/or the Yarra River. As discussed in Section 17.7.1, the adoption of standard construction site management techniques would minimise this impact.

17.11.2 Operation

Flooding

There would be potential for some inundation of the stations via the entrances during operation. This could be mitigated by minor elevation of the station entrances and other surface openings above adjacent ground levels (to be determined through further flood immunity risk assessment).

17.11.3 Alternative Design Option

The choice of construction method for Parkville station would make no difference to surface water impacts in this precinct.

17.12 Precinct 6: CBD South Station

Surface water impacts in Precinct 6 would be associated with the construction of station entrances, the establishment of a major construction work site at City Square and other smaller work sites, and the permanent station entrances.

Areas covered by the Land Subject to Inundation Overlay associated with flooding from the Yarra River are to the south of the station site.

The station area would impact directly on two existing City of Melbourne drains in Swanston Street: a 1,220 mm diameter concrete pipe and a 1950 mm x 1350 mm brick ovoid drain. Both drains are over 100 years old. Surface water flooding is known to occur along parts of Swanston and Flinders Streets. Flows in excess of the combined capacities of the Swanston Street drains and overland flow paths along Swanston Street flow west into the Elizabeth Street Main Drain system.

The drains in Elizabeth Street are the responsibility of Melbourne Water. Elizabeth Street is prone to regular and significant flooding. The most recent significant event was in 2010. Overland flows from the Swanston Street catchment are known to contribute to the Elizabeth Street flooding. Areas to the west of the station site are covered by the Special Building Overlay in the Melbourne Planning Scheme associated with flooding from the Elizabeth Street Main Drain.

17.12.1 Construction

Flooding

Without mitigation, the station box could be subject to flooding during construction. Significant inundation could occur with relatively little warning (tens of minutes), potentially posing a significant risk to construction workers.

To mitigate this risk, cavern entrances would need to be protected against flooding from local stormwater flows during construction. This could be achieved by constructing small barriers around the cavern entrances. This would have negligible impact on adjacent flood levels.

Runoff

Direct rainfall would be the most likely source of runoff during construction, with the potential for runoff to enter the Yarra River. As discussed in Section 17.7.1, the adoption of standard construction site management techniques would minimise this impact.

17.12.2 Operation

Flooding

Potential flooding of CBD South station and adjoining sections of the tunnels from the Yarra River via the proposed station entrances would potentially cause significant inundation of the tunnels in a relatively short time frame. The entrances to CBD South station are all either very close to or above the Year 2100 0.01 per cent AEP Yarra River flood level. Therefore, the risk of flooding of the station entrances from the Yarra River during operation is very low.

Many hours warning time would generally be available to implement emergency management measures in advance of a more extreme flood to reduce the risks associated with station flooding and inundation of tunnels (such as the suspension of rail services and station evacuation).

The levels of station entrances and other surface openings would need to be raised to provide an appropriate level of flood immunity. This would be determined by further flood immunity risk assessment. The entrance at greatest risk is the laneway next to the Nicholas Building (Flinders Street Station entrance facing Swanston Street), which is subject to some slight ponding of stormwater flows. None of the other entrances are subject to ponding to the same extent and no other flood protection measures would be expected to be required, other than some very minor raising of the entrances above ground levels.

17.13 Precinct 7: Domain Station

Components with the potential to impact surface water in Precinct 7 are the station structural works and permanent station entrances, the establishment of construction work sites, the new tram superstop in St Kilda Road and the access hatch, fire egress shaft and overhead track exhaust/tunnel ventilation system in the centre of St Kilda Road.

The northern end of the Domain station box would extend across the western end of Domain Road at its intersection with St Kilda Road. Domain Road acts as an overland flow path for stormwater flows in excess of pipe capacity from a moderate sized catchment on the north side of the road. These flows then discharge across St Kilda Road and away to the south and west along Park Street, Albert Road and Bowen Lane, towards Albert Park Lake.

The area around the intersection of Albert Road and Kings Way is subject to overland flooding from Melbourne Water's Hannah Street Main Drain. The major overland flow path from this drain is north along Kings Way towards the Yarra River. The system also includes outfalls to Albert Park Lake.

This area is also subject to flooding from breakaway flows from the Yarra River downstream of Princes Bridge in extreme events. A Special Building Overlay in the Port Phillip Planning Scheme runs roughly parallel to the Melbourne Metro alignment to the south-west on the western side of St Kilda Road. This overlay is understood to represent the approximate extent of the one per cent AEP flood in this area.

Modelling of Yarra River flows indicates that the area surrounding the Domain station, including the station entrances, is not subject to flooding from this source for events up to and including the Year 2100 0.01 per cent AEP event, including allowance for climate change.

17.13.1 Construction

Flooding

The proposed mitigation measures for Domain station include the provision of retaining walls or similar barriers to prevent inundation of the station box from overland flows during construction. Any proposed flow diversion works could result in an increase in flows along Bowen Crescent. However, Bowen Crescent is relatively steep, and this would only result in negligible increases in flow depths.

Larger storm events in excess of the capacity of any underground drains and overland flow paths around the station box could overtop the barrier and flood the station box. This would happen in a relatively short timeframe (tens of minutes, and with only tens of minutes warning) and could pose a risk to construction workers. Depending on the height of barriers, these could also back overland flows up into Melbourne Grammar School. This could be mitigated during construction by an appropriate combination of barrier heights and flow diversion capacities.

Runoff

Construction areas may be exposed to overland flooding and direct rainfall, with the potential for runoff to enter the stormwater drainage system and impact water quality in Albert Park Lake. As discussed in Section 17.7.1, the adoption of standard construction site management techniques would minimise this impact.

17.13.2 Operation

Flooding

There is some potential for inundation of the station during operation from overland flows from the catchment around Domain Road to the east. However, overland flow depths at the proposed station entrances would be relatively shallow and the potential for flooding could be mitigated by the minor elevation of the entrances and other surface openings above surrounding ground levels. This would have negligible impact on overland flow depths.

17.14 Precinct 8: Eastern Portal (South Yarra)

The main components that may influence surface water impacts in the eastern portal precinct are the widening of the existing rail corridor and construction of retaining walls, construction of an emergency access shaft and the TBM retrieval shaft, and the use of work sites at the South Yarra Siding Reserve and Osborne Street Reserve.

The Prahran Main Drain and Yarra Street Outfall Drain systems service the areas in the immediate vicinity of the eastern portal. The portal site is close to areas associated with flooding from these systems that are covered by a Special Building Overlay and Land Subject to Inundation Overlay in the Stonnington Planning Scheme.

17.14.1 Construction

Flooding

There is potential for flooding of the eastern portal from the Yarra River in a Year 2100 0.1 per cent AEP event. Two to three days warning would typically be available in advance of a Yarra River flood peak at this location. At a minimum, a flood warning system would be implemented to link with existing flood warning systems in the Yarra catchment, such that rail services could be suspended and the tunnel and stations evacuated in advance of an extreme flood. Subject to further flood immunity risk assessment, additional measures such as sandbagging or flood gates could also be put in place to protect the tunnel from flooding in more extreme events during both construction and operation. Currently, it is proposed that the eastern portal incorporate works to allow flood gates in the form of stop logs to be installed across the portal in advance of a flood event. These stop logs would be stored adjacent to the portal.

The eastern portal would also be subject to smaller volumes of inundation from overland flows from the Prahran Main Drain and Yarra Street Outfall Drain systems. The volumes are unlikely to be sufficient to cause significant disruption of rail services.

Runoff

Direct rainfall is the most likely source of runoff generation, with the potential for runoff to enter the Yarra River. As discussed in Section 17.7.1, the adoption of standard construction site management techniques would minimise this impact.

17.14.2 Operation

Flooding

As noted in Section 17.14.1, there is potential for flooding of the tunnels via the portal during operation. Without design mitigation, floodwaters would be likely to fill the tunnels relatively quickly (typically within hours), potentially posing a serious risk to commuters and rail staff and resulting in a significant disruption to rail services.

Without any additional mitigation works, the portal would be immune to flooding from the Yarra River in events up to approximately the estimated Year 2100 0.1 per cent AEP (1,000 year Average Recurrence Interval) event. Further flood immunity risk assessment would be undertaken to determine if this level of protection is appropriate. Additional measures that could be put in place if deemed necessary are as discussed in Section 17.14.1.

Runoff

Drainage runoff from the decline structure would be pumped into the local drainage system. As the decline structure would increase the overall paved area, there would likely be a need to control the discharge rate into the existing drainage system. This would require a local drainage storage of around 60 m^3. It is currently envisaged that this would be located in the South Yarra Siding Reserve adjacent to the proposed portal.

There may be opportunities to capture and reuse runoff from the decline structure for the irrigation of parks, sports fields or gardens, with appropriate treatment.

17.15 Precinct 9: Western Turnback (West Footscray)

Much of the area in the vicinity of the existing West Footscray station is covered by a Special Building Overlay in the Maribyrnong Planning Scheme. This is associated with overland flows in excess of the capacity of underground drains in the Graingers Road Main Drain system. This system passes under the western end of West Footscray station and outfalls to Stony Creek downstream of Somerville Road.

However, this overlay does not extend continuously across the existing rail reserve, indicating that there is no overland flow across the rail reserve in a one per cent AEP flood event under existing conditions. Accordingly, any works within the rail reserve would not obstruct overland flows.

As the platform works are suspended decks and hollow underneath, any loss of flood storage would be negligible.

Construction of the western turnback may involve runoff to Stony Creek. This runoff would be managed through adoption of the mitigation measures described in Section 17.7.1.

17.16 Early Works

In general, early works would seek to modify existing services as they relate to water, sewerage, drainage, power, telecommunications and tramways. The works of relevance to surface water drainage and flooding issues are those relating to stormwater that would occur in the western portal, Arden station, Parkville station, CBD North station and CBD South station precincts. These works comprise realignment of stormwater drains and manholes to enable construction of other Melbourne Metro works, while maintaining or improving the current level of drainage service. However, it should be noted that all early works have the potential to impact on water quality if construction activities expose disturbed surfaces to rainfall runoff.

There are no key issues associated with the Concept Design involving miscellaneous stormwater relocation and realignment works. The works are all routine, small-scale drainage works to maintain or improve the current level of drainage service. Any potential surface water issues of increasing flood levels in areas adjacent to the works could be readily managed by standard construction measures. Likewise, any potential water quality issues could be readily managed by standard construction sediment control measures.

As such, these works are unlikely to result in any significant surface water impacts and there would be negligible impacts on existing flooding and drainage functions and characteristics, or on water quality in receiving waterways.

17.17 Environmental Performance Requirements

As discussed in Section 17.3, existing regulations, standards and guidelines are available – and are used regularly – to avoid or minimise the effects on waterways during the construction and operation of major infrastructure projects. Table 17–2 shows the recommended Environmental Performance Requirements for Melbourne Metro and proposed mitigation measures in relation to managing surface water impacts.

The risk numbers listed in the final column align with the list of surface water risks provided in Technical Appendix B *Environmental Risk Assessment Report.*

Table 17–2 Environmental Performance Requirements for Surface water

Draft EES evaluation objective	Environmental Performance Requirements	Proposed mitigation measures	Precinct	Timing	Risk No.
Hydrology and water quality – To protect waterways and waterway function and surface water…quality in accordance with statutory objectives	For all precincts (with the exception of the Western turnback) design permanent and temporary works and, if necessary, develop and implement emergency flood management measures for the tunnels, tunnel portals, access shafts, station entrances and Arden electrical substation to provide appropriate protection against floodwaters and overland stormwater flows. This would be informed by a flood immunity risk assessment that considers a range of events, and to the requirements and satisfaction of the responsible authority.	*Stations entrances (all)* Ensure station entrances and other surface openings (such as ventilation shafts) are at an appropriate level to provide an acceptable level of flood immunity. Acceptability to be determined by flood immunity risk assessment. Emergency management measures in the event of a larger flood (such as automatic flood gates, flood warning system, evacuation procedures, suspension of rail services. *Tunnels (where not otherwise covered under station entrances and portals)* Install flood gates on the City Loop tunnel portal near Federation Square Ensure other five City Loop portals between Flinders Street and Richmond stations are at an appropriate level to provide an acceptable level of flood immunity. Acceptability to be determined by flood immunity risk assessment Construction of small barriers to prevent overland flow inundating the Fawkner Park TBM launch site during construction *Western portal* Ensure retaining walls or similar barriers are in place to protect portal and TBM shaft during construction Emergency management measures in place during construction – flood warning system, evacuation of workers Install automatic gates to protect portal in events in excess of the 100 year ARI event during operation *Arden station* Ensure retaining walls or similar barriers are in	All (except Precinct 9 - Western turnback)	Construction/ Operation	SW001 SW002 SW003 SW005 SW007 SW009 SW010 SW011 SW014 SW015 SW016 SW018 SW019 SW022 SW024 SW025 SW027 SW029 SW030 SW031 SW032 AE012

Draft EES evaluation objective	Environmental Performance Requirements	Proposed mitigation measures	Precinct	Timing	Risk No.
		place to protect station box during construction			
		Emergency management measures in place during construction – flood warning system for evacuation of workers Ensure substation is protected against flooding, by either bunding or setting it at a sufficiently high level to provide an acceptable level of flood immunity. Acceptability to be determined by flood immunity risk assessment *Parkville, CBD North and CBD South stations* Ensure small retaining walls or similar barriers are in place to protect station box during construction *Domain station* Ensure barriers are in place to protect station box and TBM launch site from local catchment inflows during construction. *Eastern portal* Emergency management measures in place during construction – sandbagging or other barriers to floodwaters, flood warning system, evacuation of workers Ensure portal is at an appropriate level to provide an acceptable level of flood immunity during operation. Acceptability to be determined by flood immunity risk assessment Emergency management measures in place in the event of a larger flood during operation, including flood warning system, evacuation procedures for tunnel and station, suspension of rail services and, if deemed necessary, sandbagging or flood gates to protect the portal. Currently proposed that the portal incorporate works to allow flood gates in the form of stop logs to be installed across the portal in advance of a flood event, and that stop logs be			

<table>
<tr><th>Draft EES evaluation objective</th><th>Environmental Performance Requirements</th><th>Proposed mitigation measures</th><th>Precinct</th><th>Timing</th><th>Risk No.</th></tr>
<tr><td></td><td></td><td>stored adjacent to the portal</td><td></td><td></td><td></td></tr>
<tr><td></td><td>For all precincts:
Maintain existing flood plain storage capacity potentially impacted by the project, to the requirements and satisfaction of the responsible authority
Permanent and associated temporary construction works must not increase flood levels that result in an additional flood risk to the requirements and satisfaction of the responsible authority
Ensure permanent and associated temporary works do not increase flow velocities that would potentially affect the stability of property, structures or assets, and/or result in erosion during operation or construction, to the requirements and satisfaction of the responsible authority
Undertake modelling of the design of permanent and temporary works to demonstrate the resultant flood levels and risk profile to the satisfaction of the responsible authority.</td><td>Western portal
Provision of compensatory flood storage (approx. 9,000 m^3)
Provision of balancing storage (approx. 180 m^3)
Arden station
Provision of compensatory flood storage during construction (approx. 6,000 m^3)
Provision of compensatory flood storage during operation (approx. 1,600 m^3)
Domain station
If necessary, provide appropriate combination of barrier heights and flow diversion capacity to avoid backing up flooding into Melbourne Grammar during construction
Eastern portal
Provision of balancing storage (approx. 60 m^3)</td><td>All</td><td>Construction/ Operation</td><td>SW004
SW006
SW008
SW012
SW013
SW017
SW020
SW021
SW023
SW026
SW028
SW033
SW034</td></tr>
<tr><td></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 (eg <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</td></tr></table></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>Design/ Construction</td><td>AE001</td></tr>
</table>

Draft EES evaluation objective	Environmental Performance Requirements			Proposed mitigation measures	Precinct	Timing	Risk No.
			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				
	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.				All	Construction	
	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			Develop construction site environmental management plans to where possible contain any accidental discharge to waterways and include a monitoring program that will enable reporting of potential impacts Develop construction site environmental management plans to describe environmental performance requirements Incorporate requirements for appropriate collection treatment and disposal into tunnel drainage design	All (except Precinct 9 - Western turnback)	Construction	AE002 AE007
	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	1 - Tunnels	Construction	AE003

<table>
<tr><th>Draft EES evaluation objective</th><th>Environmental Performance Requirements</th><th>Proposed mitigation measures</th><th>Precinct</th><th>Timing</th><th>Risk No.</th></tr>
<tr><td></td><td></td><td>standard environmental management practices to minimise sediment release</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Design the Arden electrical substation to provide appropriate protection against floodwaters during operation, to prevent the release of contaminants to Moonee Ponds Creek</td><td>Ensure substation is protected against flooding, by either bunding or setting it at a sufficiently high level to provide an acceptable level of flood immunity</td><td>3 - Arden station</td><td>Design/ Operation</td><td>AE012</td></tr>
<tr><td></td><td>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</td><td></td><td>1 - Tunnels</td><td>Operation</td><td>AE010</td></tr>
<tr><td></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)(4)</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)(4)</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></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	Environmental Performance Requirements	Proposed mitigation measures	Precinct	Timing	Risk No.
	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.				
Refer also to the recommended Environmental Performance Requirements in relation to groundwater. These requirements and proposed mitigation measures are provided in Chapter 18.					

17.18 Conclusion

The specialist assessment of the surface water impacts of Melbourne Metro found that, with the adoption of the recommended Environmental Performance Requirements and proposed mitigation measures, all residual consequence risk ratings would be reduced to low or very low.

The impact assessment found that Melbourne Metro would be consistent with the draft EES evaluation objectives as it would result in negligible impact on existing flooding and drainage functions and characteristics. It would also comply with Melbourne Water's flood immunity requirements.

Achieving the recommended Environmental Performance Requirements would also assist in ensuring that the Concept Design meets the requirements of the SEPP (WoV) and the EPA in relation to water quality.