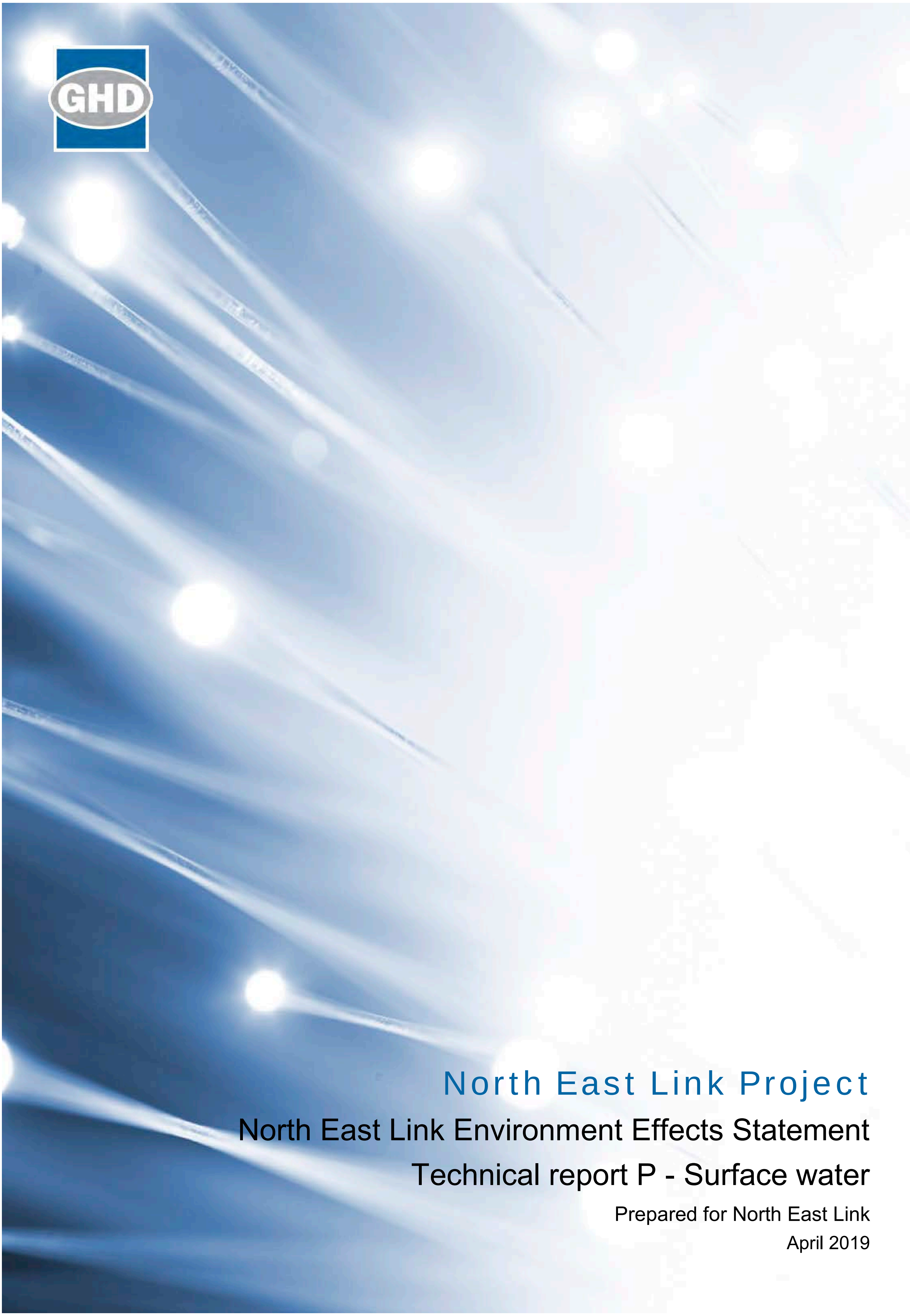
Environment
Effects Statement

Technical Report P
Surface water



North East Link Project

North East Link Environment Effects Statement

Technical report P - Surface water

Prepared for North East Link

April 2019

Executive summary

This technical report is an attachment to the North East Link Environment Effects Statement (EES). It has been used to inform the EES required for the project, and defines the Environmental Performance Requirements (EPRs) necessary to meet the EES objectives.

Overview

North East Link ('the project') is a proposed new freeway-standard road connection that would complete the missing link in Melbourne's ring road, giving the city a fully completed orbital connection for the first time. North East Link would connect the M80 Ring Road (otherwise known as the Metropolitan Ring Road) to the Eastern Freeway, and include works along the Eastern Freeway from near Hoddle Street to Springvale Road.

The Major Transport Infrastructure Authority (MTIA) is the proponent for North East Link. The MTIA is an administrative office within the Victorian Department of Transport with responsibility for overseeing major transport projects.

North East Link Project (NELP) is an organisation within MTIA that is responsible for developing and delivering North East Link. NELP is responsible for developing the reference project and coordinating development of the technical reports, engaging and informing stakeholders and the wider community, obtaining key planning and environmental approvals and coordinating procurement for construction and operation.

On 2 February 2018, the Minister for Planning declared North East Link to be 'public works' under Section 3(1) of the *Environment Effects Act 1978*, which was published in the *Victorian Government Gazette* on 6 February 2018 (No. S 38 Tuesday 6 February 2018). This declaration triggered the requirement for the preparation of an EES to inform the Minister's assessment of the project and the subsequent determinations of other decision-makers.

The EES was developed in consultation with the community and stakeholders and in parallel with the reference project development. The reference project has been assessed in this EES.

GHD was commissioned to undertake a surface water impact assessment to inform the EES.

Surface water context

The scoping requirements for the EES by the Minister for Planning set out the specific environmental matters to be investigated and documented in the project's EES, which informs that scope of the EES technical studies. The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the project.

The following evaluation objectives are relevant to the surface water assessment:

- **Land Stability** – To avoid or minimise adverse effects on land stability from project activities, including tunnel construction and river and creek crossings.
- **Catchment Values** – To avoid or minimise adverse effects on surface water and groundwater and floodplain environments.

To assess the potential impacts on surface water a risk-based approach was used. A summary of the assessments completed in this report is provided below.

A high level review of surface water features including waterways, drains and other surface water bodies in close proximity to North East Link was undertaken to identify which sites were potentially impacted by the project. This review identified that the project has the potential to impact Banyule Creek, Koonung Creek, the Yarra River, Yando Street Main Drain, Kempton Street Main Drain and the Watsonia Station drain as well as their associated floodplains and tributaries. Potential impacts to other water bodies have also been identified and these impacts have been further investigated in an impact assessment.

The impact assessment has considered the potential for the construction or operation of the project to influence water quality, waterway stability and of flooding within their associated floodplains. Other surface water bodies have also been considered, along with the potential for these to be impacted, affecting existing water supplies for land users.

A summary of the impact assessment is provided below.

Construction

This assessment has investigated the potential for construction activities to increase flood risk due to the temporary placement of construction structures or materials within the floodplain. Locating these items within the floodplain could have the potential to displace floodwaters in a flood event, increasing the flood frequency and levels at properties within or adjacent to the existing floodplain.

To manage the potential impacts, a Surface Water Management Plan would be implemented. This would specify the measures the construction process would be required to adhere to, so that flood risk was minimised. The measures within the Surface Water Management Plan would be informed by the modelling of temporary work stages to demonstrate that the project meets Melbourne Water's flood level, flow and velocity requirements. Consideration of appropriate combinations of construction activities is subject to adopted construction methodologies and sequencing. Construction staging would need to consider how flows in the waterways and tributaries would be maintained during works in the waterway. The construction activities would also be required to provide adequate clearances and access for ongoing maintenance of existing drainage assets

This assessment has considered the potential for the construction activities required for North East Link to affect waterway health and water quality.

The Surface Water Management Plan would include details of the water quality requirements for the project, including best practice sediment and erosion control and monitoring, and would be based on EPA Victoria guidelines. This management plan would also outline the requirements for the location and bunding of contaminated material. Water quality monitoring undertaken during construction would also be used to confirm that environmental controls documented in the Surface Water Management Plan are effective, and if necessary to inform the need for more stringent controls. Implementation of the Surface Water Management Plan would assist in meeting the SEPP (Waters) requirements and reduce the potential for water quality impacts during construction.

This assessment has considered the potential for any construction works undertaken within waterways or floodplains to alter the landform or geomorphic condition of the waterway. Changes to the slope, flow, velocity, flow frequency and timing have the potential to change the geomorphic condition of the waterway, and these have been investigated. The assessment also considered the potential for changes to result in erosion and sediment transfer downstream, which could impact water quality.

The project would maintain waterway stability by maintaining existing flow conditions. This would be achieved by minimising the works in or around the waterways, considering appropriate timing of works (aligned with low flow periods) and regular monitoring of the water quality downstream of the location of works to provide any indication of potential erosion and subsequently bank stability. All works on the waterways would be undertaken to minimise the potential for erosion and to the requirements of Melbourne Water in consultation with relevant local councils. Preparation and implementation of a Surface Water Management Plan specifying the required mitigation measures, as well as drainage asset condition assessments before and after construction works would avoid or minimise adverse effects on bank stability.

Construction of the tunnels at Bulleen Road would impact the private dam on the Trinity Grammar School Sporting Complex, affecting the Trinity Grammar School Sporting Complex as well as Marcellin College. The irrigation function of this dam could be maintained using an existing extraction licence from the Yarra River, or by providing an alternative water supply during construction of the project.

Operation

This impact assessment has investigated the potential for the operation of North East Link to increase flood levels, affecting private property and infrastructure or flooding of the tunnel portals. North East Link would include new roads as well as tunnel portal and ventilation structures that would be located within the existing floodplain extents and could displace floodwater.

Modelling of the reference project to assess the potential for flood impacts on surrounding public safety, property and assets indicates that with some further refinement, sufficient floodplain storage and flow control would be provided to offset the loss of floodplain storage, and this would be enough to control downstream flooding. Therefore, additional flood risk on private property or assets is not anticipated.

Residual issues would be resolved as part of the detailed design which would be required to demonstrate through modelling that the design of permanent infrastructure, which may vary from the reference project assessed, meets the flood level, flow and velocity requirements with consideration for climate change.

To manage the risk of the tunnels flooding, the project would include floodwalls and the road geometry has been carefully considered to provide passive protection for large flood events. Modelling has demonstrated that with the floodwalls and the implementation of operation management plans, the tunnel portals would be appropriately protected from flood waters.

The assessment investigated the two main ways that surface water has the potential to be contaminated:

- By contaminated runoff from additional impervious area flowing into waterways
- By spills or accidents occurring on North East Link and flowing into waterways.

To minimise the potential for pollutants to end up in the waterways, the reference project includes a number of water treatment features along the alignment that would filter and treat the stormwater captured by the new road surfaces and provide some attenuation. These water sensitive urban design (WSUD) features include wetlands, bioretention ponds and storage dams. Modelling has shown that pollutant reductions in accordance with best practice can be achieved using a subset of the potentially available sites.

To reduce the potential of spilled liquids ending up in waterways, the project would include spill containment features on drainage outlets to contain spills in accordance with Austroads guidelines.

The project increases the amount of paved surface area through the creation of many new roads and ramps, carparks and shared use paths. Connectivity of stormwater runoff from roads to the drains and waterways would be increased, as well as the risk of increasing peak inflows to drains and waterways, which has the potential to affect the ecological and geomorphic conditions of receiving waterways. New roads for North East Link would require new drainage networks to cater for stormwater runoff along the alignment.

Controls to mitigate the risk of impacts on stream geomorphic conditions include compliance with the flow objectives of local councils and Melbourne Water for the retardation of increased flows. Ecological considerations are dealt with in EES Technical report Q – Ecology. The stormwater treatment system would be integrated into the design in accordance with the EPA Victoria *Best Practice Environmental Management Guidelines for Urban Stormwater.* Permanent works must not have any adverse impacts on flow velocities, and any change to the flow regime must satisfy Melbourne Water and adhere to its requirements.

The private dam on the Trinity Grammar School Sporting Complex would be impacted by the construction of the cut and cover tunnels at Bulleen Road. If this storage was not reinstated it would potentially impact the availability of stormwater for the irrigation of Trinity Grammar School Sporting Complex as well as Marcellin College. The functionality of the existing storage volume and supply would need to be reinstated to meet the supplied irrigation demand of the Trinity Grammar School Sporting Complex and Marcellin College as well as maintain drainage and attenuation of runoff from the local catchment. The supplied irrigation demand could potentially be maintained using an existing extraction licence from the Yarra River, or by providing an alternative water supply during construction of the project.

Although the design and the subsequent modelling are still being refined, the surface water risks have been defined (refer Table 7-1) and a set of Environmental Performance Requirements (EPRs) (refer Table 12-1) have been drafted to effectively manage these potential issues. With the application of these EPRs, the residual surface water risks are substantially reduced. Further discussions with stakeholders, refinement of the design and modelling assessment of the design’s performance is expected to demonstrate that application of the EPRs would result in a project with acceptable surface water construction risks and long-term outcomes during operation.

Structure of the EES

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EES main report

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4. EES assessment framework
5. Communications and engagement
6. Project development
7. Urban design
8. Project description
9. Traffic and transport
10. Air quality
11. Surface noise and vibration
12. Tunnel vibration
13. Land use planning
14. Business
15. Arboriculture
16. Landscape and visual
17. Social
18. Human health
19. Historical heritage
20. Aboriginal cultural heritage
21. Ground movement
22. Groundwater
23. Contamination and soil
24. Surface water
25. Ecology
26. Greenhouse gas
27. Environmental management framework
28. Conclusion

Technical reports

A. Traffic and transport
B. Air quality
C. Surface noise and vibration
D. Tunnel vibration
E. Land use planning
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G. Arboriculture
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K. Historical heritage
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N. Groundwater
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Glossary

afflux	Referring to the change in typically flood level resulting from the flow of flood water over proposed relative to existing conditions.
Annual Exceedance Probability	Defines the likelihood of a flood occurring in any given year. The most commonly used definition in planning is the '1 in 100 year flood'. This refers to a flood level that has a one in a hundred, or 1%, chance of being equalled or exceeded in any year (1% AEP = 100 year average recurrence interval)
Department of Transport	The Victorian Department of Transport is responsible for delivering the government's transport infrastructure agenda. It was formed on 1 January 2019 when the former Victorian Department of Economic Development, Jobs, Transport and Resources transitioned into the Department of Transport and the Department of Jobs, Precincts and Regions.
Major Transport Infrastructure Authority	The Major Transport Infrastructure Authority (MTIA) is the proponent for North East Link. The MTIA is an administrative office within the Victorian Department of Transport with responsibility for overseeing major transport projects.
North East Link Project	North East Link Project (NELP) is an organisation within MTIA that is responsible for developing and delivering North East Link. NELP was formerly known as the North East Link Authority prior to 1 January 2019. NELP is responsible for developing the reference project and coordinating development of the technical reports, engaging and informing stakeholders and the wider community, obtaining key planning and environmental approvals and coordinating procurement for construction and operation.
Probable Maximum Flood (PMF)	The largest flood that could conceivable occur at a particular location, usually estimated from Probable Maximum Precipitation (PMP) and, where applicable, snow melt, coupled with the worst flood-producing catchment conditions.
RORB	A general non-linear runoff and streamflow routing program used to calculate flood hydrographs from rainfall and other catchment inputs
TUFLOW	1D/2D finite difference numerical model used to simulate hydraulic behaviours in rivers, floodplains and urban drainage environments

Abbreviations

AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
ARI	Average Recurrence Interval
ARMCANZ	Agriculture and Resources Management Council of Australia and New Zealand
CFSL	Compensatory Flood Storage Location
CEMP	Construction Environmental Management Plan
DELWP	Department of Environment, Land, Water and Planning
DEM	Digital Elevation Model
EES	Environment Effects Statement
EPA	Environment Protection Authority Victoria
EPBC Act	The Environment Protection and Biodiversity Conservation Act 1999
FO	Floodway Overlay
GDA	Geocentric Datum of Australia
IRC	Index of River Condition
ISC	Index of Stream Condition
LPPF	Local Planning Policy Framework
LSIO	Land Subject to Inundation Overlay
MGA	Map Grid of Australia
MTIA	Major Transport Infrastructure Authority
NELP	North East Link Project
NES	Matters of National Environmental Significance according to the EPBC Act
NHMRC	National Health and Medical Research Council
NWQMS	National Water Quality Management Strategy
OEMP	Operational Environmental Management Plan
PMF	Probable Maximum Flood
SBO	Special Building Overlay
SCEW	Standing Council on Environment and Water
SEPP	State Environment Protection Policies
SEPP (Waters)	State Environment Protection Policy (Waters)
SPPF	State Planning Policy Framework
SUP	Shared Use Path (pedestrian and bike path)
UFZ	Urban Floodway Zone
VPP	Victorian Planning Provisions
VWMS	Victorian Waterway Management Strategy
WSUD	Water Sensitive Urban Design (sometimes WSRD for Water Sensitive Road Design) a design approach to minimise the impact of development on the water cycle which is in part aimed at reducing the volume of stormwater and pollution entering waterways.

1. Introduction

1.1 Purpose of this report

North East Link ('the project') is a proposed new freeway-standard road connection that would complete the missing link in Melbourne's ring road, giving the city a fully completed orbital connection for the first time. North East Link would connect the M80 Ring Road (otherwise known as the Metropolitan Ring Road) to the Eastern Freeway, and include works along the Eastern Freeway from near Hoddle Street to Springvale Road.

The Major Transport Infrastructure Authority (MTIA) is the proponent for North East Link. The MTIA is an administrative office within the Victorian Department of Transport with responsibility for overseeing major transport projects.

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On 2 February 2018, the Minister declared the works proposed for North East Link as Public Works and issued a decision confirming that an Environment Effects Statement (EES) is required for the project due to the potential for significant environmental effects.

Similarly, the project was referred to the Australian Government's Department of the Environment and Energy on 17 January 2018. On 13 April 2018 the project was declared a 'controlled action', requiring assessment and approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* ('EPBC Act'). Separate to this EES, a Public Environment Report (PER) is required to be prepared to satisfy the EPBC Act requirements, and assess the impacts of the project on Commonwealth land and matters of national environmental significance (MNES).

The purpose of this report is to assess the potential surface water impacts associated with North East Link to inform the preparation of the EES and EPBC Act assessments required for the project.

1.2 Why understanding surface water is important

Water quality and hydrology are important to the health and sustainability of Melbourne's urban creeks, river systems and floodplains. It is important that North East Link is designed to minimise threats to the health of surface water ecosystems and maintain floodplain functionality.

The project would be located within the urban waterway reaches of the Yarra River catchment. This highly urbanised part of Melbourne includes long-established residential areas, industrial precincts, parks and reserves, and community and recreation facilities.

There are many locations where the project would intersect with an existing floodplain. At these locations, obstruction of existing flow paths has the potential to change the existing flood extent. If not managed appropriately, this could pose a flood risk to public safety, surrounding properties and infrastructure. In addition, if the tunnels were flooded once the project was operating it could cause a public safety risk.

Existing surface water quality in the region does not always meet the baseline objectives set by the State Environment Protection Policy (SEPP) (Waters). Nevertheless, the project has the potential to mobilise existing contaminated sediments during construction and increase contaminant loads during operation due to runoff from additional road surfaces.

Potential surface water impacts associated with North East Link's construction generally relate to:

- Increased risk of property flooding due to loss of floodplain storage or obstruction of drainage paths
- Reduced water quality due to release of pollutants to waterways
- Altered geomorphic conditions resulting in changes in erosion, deposition or waterway stability
- Loss of pre-existing sources or storages used for water supply.

Potential surface water impacts associated with the project during its operation primarily relate to:

- Increased risk of flooding of property due to installation of project elements within the floodplain
- Reduced water quality due to release of pollutants to waterways
- Altered geomorphic conditions resulting in changes to erosion, deposition or waterway stability
- Change in the availability of water supply
- Flood waters entering the tunnels during a flood event.

The potential for impacts relating to the above surface water risks have been investigated. To avoid and/or manage the potential for adverse impacts, Environmental Performance Requirements for the project have been developed.

2. EES scoping requirements

2.1 EES Evaluation objectives

The scoping requirements for the EES by the Minister for Planning set out the specific environmental matters to be investigated and documented in the project's EES, which informs the scope of the EES technical studies. The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the project in accordance with the *Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1987*.

The following evaluation objectives are relevant to the surface water assessment:

- **Land Stability** – To avoid or minimise adverse effects on land stability from project activities, including tunnel construction and river and creek crossings.
- **Catchment Values** – To avoid or minimise adverse effects on surface water, groundwater and floodplain environments.

2.2 EES scoping requirements

The aspects from the scoping requirements relevant to the surface water evaluation objectives are shown in Table 2-1, as well as the location where these items have been addressed in this report or elsewhere in the EES. It is noted there are some scoping requirements under the above evaluation objectives that are not relevant to the surface water assessment and therefore are not included in the table below. These are discussed in the relevant technical reports.

Table 2-1 Scoping requirements relevant to surface water

Aspect	Scoping requirement	Section addressed
Key issues	Potential for project works to cause or lead to land subsidence or erosion that could adversely affect properties, structures, infrastructure, drainage, river health or other values including under future climate change scenarios.	Impact assessment: Sections 8.3 and 9.3
	Potential for project works to affect waterways, groundwater and hydrology, including with respect to flooding and future climate change scenarios.	Impact assessment: Sections 8.1 and 9.1 Technical report N – Groundwater.
	Potential for contaminated runoff or other water, including groundwater, to be discharged into surface waters or groundwater environments.	Impact assessment: Sections 8.2 and 9.2 Technical report O – Contamination and soil Technical report N – Groundwater.
Priorities for characterising the existing environment	Identify and map ground conditions along the project corridor including geology, hydrogeology and drainage.	Existing conditions: Sections 6.1.1, 6.2.1, 6.3.1, 6.4.1.
	Identify hydrological or geomorphic conditions that may contribute to susceptibility to erosion (eg steep slopes, channels).	Existing conditions: Sections 6.4.3, 6.5.4, 6.6.3.
	Identify and map the natural and constructed surface water drainage system relevant to the geographic coverage of project works.	Existing conditions: Section 6.

Aspect	Scoping requirement	Section addressed
	Document the key assumptions to be adopted in the surface and groundwater hydrological analysis with respect to future climate change scenarios.	Methodology: Section 5.3.1. Technical report N – Groundwater.
	Identify existing key surface water quality and stream condition parameters and trends.	Existing conditions: Sections 6.4.2, 6.5.3, 6.6.2.
Design and mitigation measures	Identify design and construction management measures to maintain ground stability and prevent erosion where risks of potential instability due to the project have been identified.	Impact assessment: Section 8.3.
	Describe measures to avoid or mitigate project effects on waterways and flood behaviour and management.	Impact assessment: Section 8.1.
	Describe measures to protect surface water quality, especially during the construction phase, with reference to SEPP objectives and other relevant standards and guidelines.	Impact assessment: Section 8.2.
Assessment of likely effects	Predict subsidence and erosion due to project works and assess residual effects on assets and values.	Erosion assessed in impact assessment: Section 8.3. Subsidence is addressed by Technical report M – Ground movement.
	Assess residual effects on waterways and hydrology, including with respect to flood behaviour and management with respect to public safety and potential effects on private property and assets.	Impact assessment: Sections 8.1.
	Assess residual effects on quality and availability of groundwater and water quality in receiving waters, having regard to existing water quality conditions, proposed mitigation measures and relevant SEPP standards.	Impact assessment: Section 8.2.
	Assess residual effects of short-term or longer-term changes to groundwater conditions, with particular regard to ground subsidence, tunnel drainage, groundwater availability and quality, relevant SEPP standards and beneficial uses.	Technical report N – Groundwater and Technical report M – Ground movement.
	Assess residual effects on surface and groundwater users or environmental values from contaminated soil, acid forming materials or contaminated groundwater.	Technical report O – Contamination and soil
	Undertake sensitivity analysis, if required.	Some limited sensitivity analysis has been undertaken to assess the impact of changes in the ARR guidelines refer Sections 6.1.2, 6.2.2 and 6.5.2. Other sensitivity analysis may be required as design progresses.

Aspect	Scoping requirement	Section addressed
Approach to manage performance	Describe the Environmental Performance Requirements to set subsidence and erosion outcomes that the project must achieve.	Erosion assessed in Impact assessment: Section 8.3. Subsidence is addressed in Technical report M – Ground movement.
	Describe the Environmental Performance Requirements to set surface water and groundwater quality outcomes as well as groundwater level or flood behaviour outcomes that the project must achieve.	Surface water and flood behaviour addressed in Section 8.2. Groundwater is addressed in Technical report N – Groundwater.

2.3 Linkages to other reports

This report relies on or informs the technical assessments indicated in Table 2-2.

Table 2-2 Linkages to other technical reports

Specialist report	Relevance to this impact assessment
Technical report N – Groundwater	Provides an assessment of the project's effects on groundwater and details locations of groundwater and surface water interaction that are an input to the assessment of surface water. Specifically, the residual effects on short-term or longer-term changes to groundwater conditions, with particular regard to interchange between surface water and ground water, ground subsidence, tunnel drainage, groundwater quality, relevant SEPP (Waters) standards and beneficial uses.
Technical report O – Contamination and soil	Provides an assessment of the project's effects on contamination and soil that are an input to the assessment of surface water. Specifically it assesses the potential for contaminated runoff or other water, including groundwater, to be discharged into surface waters or groundwater environments during construction and operation. Assesses the potential for disturbance of contaminated soil or groundwater or naturally occurring acid sulfate soils. Characterises and assesses the management of a range of waste streams for the project. Describes and evaluates proposed design, management or site protection measures that could avoid or mitigate potential adverse effects of the excavated spoil or other waste streams generated by the project on land or water values, especially with regard to the project construction activities.
Technical report M – Ground movement	Provides an assessment of the projects effects on ground movement that are an input to the assessment of surface water. Specifically, the potential for project works to cause or lead to reduced ground stability and riverbed or bank erosion that could adversely affect properties, structures, infrastructure, river health or other values.
Technical report Q – Ecology	Provides an assessment of the projects effects on water sensitive ecological assets/communities that are an input to the assessment of surface water. Specifically providing an understanding of the beneficial uses of downstream surface water environments.

3. Project description

3.1 Overview

The North East Link alignment and its key elements assessed in the Environment Effects Statement (EES) include:

- **M80 Ring Road to the northern portal** – from the M80 Ring Road at Plenty Road, and the Greensborough Bypass at Plenty River Drive, North East Link would extend to the northern portal near Blamey Road utilising a mixture of above, below and at surface road sections. This would include new road interchanges at the M80 Ring Road and Grimshaw Street.
- **Northern portal to southern portal** – from the northern portal the road would transition into twin tunnels that would connect to Lower Plenty Road via a new interchange, before travelling under residential areas, Banyule Flats and the Yarra River to a new interchange at Manningham Road. The tunnels would then continue to the southern portal located south of the Veneto Club.
- **Eastern Freeway** – from around Hoddle Street in the west through to Springvale Road in the east, modifications to the Eastern Freeway would include widening to accommodate future traffic volumes and new dedicated bus lanes for the Doncaster Busway. There would also be a new interchange at Bulleen Road to connect North East Link to the Eastern Freeway.

These elements are illustrated in Figure 3.1.

The project would also improve existing bus services from Doncaster Road to Hoddle Street through the Doncaster Busway as well as pedestrian connections and the bicycle network with connected shared use paths from the M80 Ring Road to the Eastern Freeway.

For a detailed description of the project, refer to EES Chapter 8 – Project description.

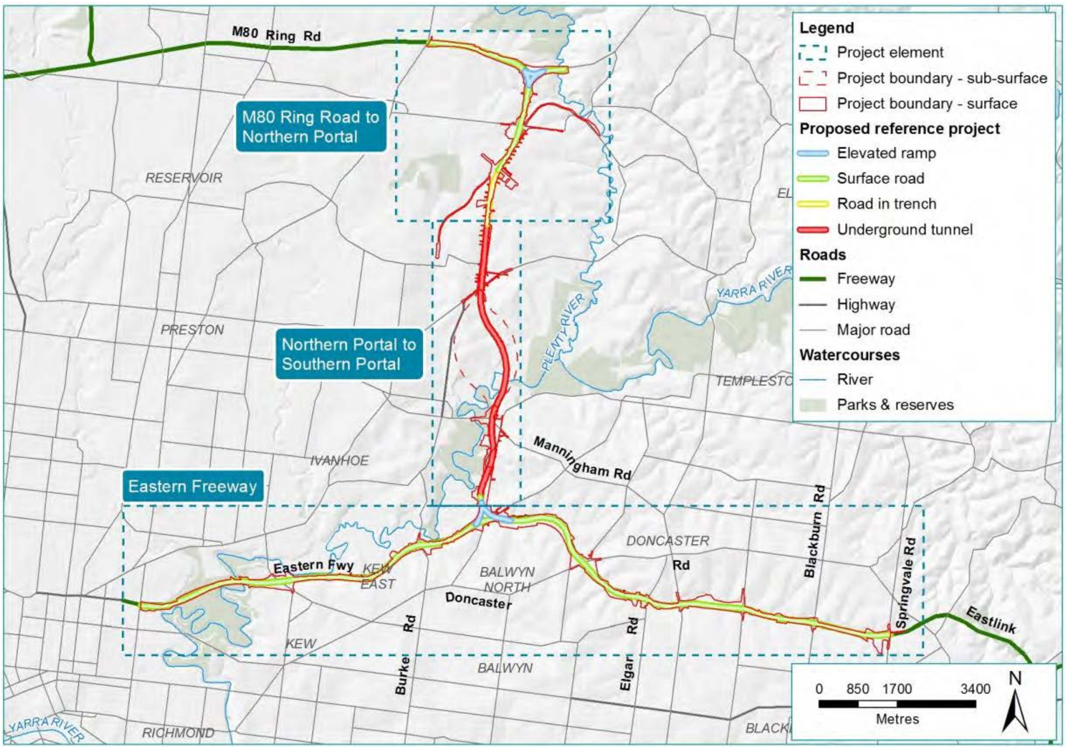


Figure 3-1 Overview of North East Link

3.2 Construction

Key construction activities for North East Link would include:

- General earthworks including topsoil removal, clearing and grubbing vegetation
- Relocation, adjustment or installation of new utility services
- Construction of retaining walls and diaphragm walls including piling
- Ground treatment to stabilise soils
- Tunnel portal and dive shaft construction
- Storage and removal of spoil
- Construction of cross passages, ventilation structures and access shafts
- Installation of drainage and water quality treatment facilities
- Road building
- Installation of a Freeway Management System
- Tunnel construction using tunnel boring machines (TBMs), mining and cut and cover techniques
- Installation of noise walls
- Restoration of surface areas.

3.3 Operation

Following construction of North East Link, key operation phase activities would include:

- Operation and maintenance of new road infrastructure
- Operation and maintenance of Freeway Management System
- Operation of North East Link motorway control centre
- Operation and maintenance of the tunnel ventilation system
- Operation and maintenance of water treatment facilities
- Operation and maintenance of the motorways power supply (substations)
- Maintenance of landscaping and Water Sensitive Urban Design (WSUD) features.

3.4 Activities and design considerations relevant to surface water

In addition to the construction and operation activities listed in Sections 3.2 and 3.3 the following design considerations are relevant to surface water:

- The potential for flooding of the tunnel portals
- The diversion or realignment of creeks to accommodate the project alignment
- The construction and maintenance of floodwalls for the protection of tunnel portals from inundation by flood water
- The maintenance and operation of flood gates for the protection of tunnel portals from inundation by flood water.

4. Legislation, policy, guidelines and criteria

4.1 Key legislation, policy and guidelines

Numerous legislative, policy and guidance documents were found to be relevant to this surface water impact assessment and are discussed further in this report. The key legislation, policy and guidelines that apply to surface water impact assessment for the project are summarised in Table 4-1.

Key legislation, policy and guidelines that are summarised in Table 4-1 are documented in further detail in Sections 4.2, 4.3, and 4.4 respectively.

Table 4-1 Key legislation, policy and guidelines

Regulation	Policy/Guideline	Description
Commonwealth		
National Water Quality Management Strategy 1994	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000)	ANZECC 2000 set the water quality objectives required to sustain current or future environmental values for natural and semi-natural water resources in Australia and New Zealand. Recommended limits to acceptable change in water quality that would continue to protect the associated environmental values are identified in the document. Meeting the guidelines for North East Link would provide a level of certainty there would be no significant impact on water resource values.
	Australian Rainfall and Runoff 1987	The third edition of *Australian Rainfall and Runoff – A guide to flood estimation* (ARR, 1987) as last updated in 1997 is the basis of the methodologies and approach used for all existing and current flood models covering areas within the project boundary. As such it remains a significant reference for this assessment.
	Australian Rainfall and Runoff 2016	The substantially revised version of *Australian Rainfall and Runoff* (ARR, 2016) was released in late 2016 and contains many significant changes in both approach and data. Some sensitivity testing has been undertaken using this new guideline to assess the potential significance of adopting different versions of this guideline. While still a draft with some updates pending, it is expected that usage of ARR 2016 will progressively replace the use of ARR 1987.
State		
Water Act 1989	By-Law No. 2: Waterways, Land and Works Protection and Management	The Water Act is the primary legislation for the resourcing and use of water in Victoria. The Act gives Melbourne Water the responsibility of granting a permit to undertake works on a waterway. North East Link would require works to be undertaken within waterways and Melbourne Water has specified a set of criteria that must be met for each individual waterway.
	Melbourne Water Standards for infrastructure projects in flood-prone areas	These standards document requirements for the project in flood-prone areas under the control of Melbourne Water.

Regulation	Policy/Guideline	Description
	Victorian Waterway Management Strategy (2013)	The Victorian Waterway Management Strategy provides the policy direction for managing Victoria's waterways over an 8-year period. It requires the development and implementation of regional waterway strategies for 10 catchment management regions across Victoria. Compliance with the Victorian Waterway Management Strategy requires that all North East Link works maintain or improve the condition of rivers, estuaries and wetlands so they can continue to provide environmental, social, cultural and economic values for all Victorians.
	Healthy Waterways Strategy (2013)	The Healthy Waterways Strategy describes Melbourne Water's role in managing rivers, estuaries and wetlands in the Port Phillip and Westernport region. It identifies priority areas and management actions to improve waterway health over five years from 2013 to 2018. The strategy sets implementation targets to measure progress and effectiveness in implementing its actions. North East Link works should not inhibit Melbourne Water from achieving the longer-term waterway implementation targets identified in the Healthy Waterways Strategy.
	Healthy Waterway Strategy 2018	The Healthy Waterways Strategy documents a 50-year vision for the Port Phillip and Westernport region. It identifies high waterway values and priority management activities over a 10-year period with objectives to guide activities and indicate progress towards improving the waterway condition.
	Melbourne Water's Shared Pathways Guidelines	The Shared Pathways Guidelines have been developed to document standards for paths along waterways and provide details on the most effective way to liaise with Melbourne Water to ensure successful construction of a shared path.
Environment Protection Act 1970	SEPP (Waters)	SEPP (Waters) replaced SEPP (Waters of Victoria) on 19 October 2018. It sets a statutory framework for the protection of the uses and values of Victoria's fresh and marine water environments. The Urban Stormwater Best Practice Environmental Management Guidelines (BPEMG) establish best practice performance objectives for urban stormwater (for urban development) to assist in determining the level of stormwater management necessary to meet the SEPP (Waters) requirements. North East Link would be required to comply with the BPEMG in operation (not construction) which would assist in meeting the SEPP (Waters) over the long term for pollutant concentrations in receiving waters.
	SEPP (Waters of Victoria)	Although superseded by SEPP (Waters), refer above, it is still referenced by a number of documents such as the VPP which are yet to be updated.

Regulation	Policy/Guideline	Description
Planning and Environment Act 1987	Planning schemes (Banyule, Boroondara, Manningham, Nillumbik Whitehorse, Yarra) • Land Subject to Inundation Overlay (LSIO) • Floodway Overlay (FO) • Special Building Overlay (SBO) • Urban Floodway Zone (UFZ)	Local council planning schemes identify the presence of surface water and control development through the application of overlays and related policies (such as Land Subject to Inundation Overlay (LSIO), Floodway Overlay (FO), Special Building Overlay (SBO), Urban Floodway Zone (UFZ)). A permit is required to construct or carry out works (including works for North East Link) within a defined planning scheme.
Climate Change Act 2017	Policy objective 22b	Policy objective (22b) is 'to build the resilience of the State's infrastructure, built environment and communities through effective adaptation and disaster preparedness action'. The guiding principles include 'integrated decision making' to ensure that any decisions made consider all relevant issues relating to climate change. The project would include an assessment of future climate change conditions and provide an allowance for these.
	Yarra River Action Plan (2016)	Outlines the Victorian Government's support of the 30 recommendations made by a ministerial advisory committee report which followed on from a discussion paper and extensive consultation. The action plan is guided by five objectives which cover a healthy river, the parklands, cultural diversity, security and modern governance.
Yarra River Protection (Willip-gin Birrarung Murron) Act 2017	Yarra Strategic Plan	Melbourne Water is leading the development of the Yarra Strategic Plan under the Yarra River Protection (Willip-gin Birrarung Murron) Act). The Yarra Strategic Plan has the following key objectives: the overall environmental health of the river (waterway and riparian land); community use; access and amenity of the river and parklands; the river's landscape setting and interface of the river corridor with adjacent land use; cultural and heritage values.
Other Standards and Guidelines		
	Austroads Guide to Road Tunnels	The Guide to Road Tunnels provides a comprehensive guide for the planning of road tunnels and describes important issues and considerations relating to implementation, general planning, regulation, structural and geometric design, drainage, geology, the environment as well as operation, construction and maintenance. The risk management approach identified in the Guide to Road Tunnels has been adopted in the assessment of tunnel flood immunity standards.
	Austroads Guide to Road Design Parts 5, 5A and 5B	The Guide to Road Design Parts 5, 5A and 5B provides guidance on road design in relation hydrology and drainage for aspects including roads surfaces, drainage networks, basins, subsurface drainage, open channels, culverts and floodways.
	Integrated Water Management Guidelines – VicRoads	The Integrated Water Management Guidelines set the direction for the management of water resources during road construction, operation and maintenance activities.

Regulation	Policy/Guideline	Description
	Water for Victoria (Water Plan)	Water for Victoria recognises the need to better manage Victoria's water resources into the future and the economic benefits of doing so as Victoria responds to both a changing climate and growing population. The following have been developed in response to Water for Victoria: • The Integrated Water Management Framework for Victoria • Melbourne Water System Strategy.

4.2 Legislation

4.2.1 Commonwealth

No Commonwealth legislation applies to the surface water assessment of North East Link.

4.2.2 State

Water Act 1989

The *Water Act 1989* ('Water Act') is the principal piece of water legislation in Victoria and provides the legal framework for managing Victoria's water resources.

There are many parts of the Water Act of relevance to the project. A brief summary of some of the key clauses is provided below:

Part 2 Rights and Liabilities – includes the following clauses

s12 Authorisation may be conditional as required to:

- ensure the conservation of waterways, wetlands and aquifers; and to
- avoid or lessen any possible adverse effects of activities or changes in land use which may have a physical or hydrologic effect on drainage in a catchment.

s16 Liability arising out of flow of water – a person who causes an unreasonable flow or as the land occupier fails to prevent an unreasonable flow is liable for damages with respect to the resultant injury, damage or economic loss

Part 10 Waterway Management – includes the following divisions:

Division 2 – Waterway Management – For all designated waterways (as defined under S188 of the Water Act), and Melbourne Water's broad functions and obligations for designated waterways (under s189 of the Water Act) that includes protection and enhancement of land and waterways

Division 3 – Regional Drainage – Drainage functions of Melbourne Water (under s199 of the water Act)) are to provide, manage, operate, protect and maintain drainage systems into all designated waterways and all designated land and works

Division 4 – Floodplain Management – Melbourne Water's Floodplain Management (under s202 of the water Act) includes taking any action necessary to minimise flooding and flood damage including controlling developments that may be proposed for land adjoining waterways

Sections 160 and 219 of the Water Act provide a means for an Authority to make by-laws for anything that is authorised, required, necessary or convenient for performing the functions of the Authority under this Act. Melbourne Water Corporation as an Authority under the Water Act has created by-law No 2 which is summarised in Section 4.2.2.

By-law No. 2: Waterways, Land and Works Protection and Management

By-law No. 2: Waterways, Land and Works Protection and Management was made by Melbourne Water pursuant to its powers under the Water Act in April 2009. The by-laws include specific rules that apply within a specific area of Melbourne Water's responsibility. The objectives of By-law No. 2 include (Melbourne Water, 2018a):

- Preventing or minimising interference with the flow of water
- Preventing or minimising pollution of our waterways
- Prohibiting or regulating the removal of materials from our waterways
- Regulating certain activities.

By-law No. 2 has objectives that prohibit certain activities without written authorisation from Melbourne Water. These activities are listed below (Melbourne Water, 2018a):

- General access
- Interference with Melbourne Water property
- The carrying out of activities that interfere with the flow of water, cause erosion or pollution, damage vegetation or removal of soil (without a permit issued under this by-law)
- Lighting a fire
- Fishing or swimming
- Using or leaving vehicles or vessels
- Entering drains
- Dumping rubbish
- Camping
- Causing noxious weeds to become established.

Melbourne Water standards for infrastructure projects in flood-prone areas

As per Section 4.2.2, one of the objectives of By-law No. 2 is preventing or minimising interference with the flow of water. More specifically, By-law No. 2 has objectives that prohibit certain activities without written authorisation from Melbourne Water including:

- The carrying out of activities that interfere with the flow of water, cause erosion or pollution, damage vegetation or removal of soil.

For North East Link, Melbourne Water has issued project specific guidance as well as a new standard that together document the requirements for the project. The Melbourne Water standards for infrastructure projects in flood-prone areas are provided in Appendix B. Project-specific guidance initially included advice that the project analysis should proceed in accordance with ARR 1987.

Environment Protection Act 1970

The *Environment Protection Act 1970* ('Environment Protection Act') is the primary legislation that regulates and controls actions relating to the protection of Victoria's environment. The Environment Protection Act is administered by EPA Victoria. The Environment Protection Act covers several aspects of the natural and built environment with a particular focus on air, land, noise, waste and water. In relation to water, the Act provides the basis for protecting Victoria's water environments from pollution.

The Environment Protection Act empowers EPA Victoria to administer legislation including, but not limited to Acts, regulations and State Environment Protection Policies. The State Environment Protection Policy (SEPP), Waters is summarised in the section below.

State Environment Protection Policy (Waters) 2018

The State Environment Protection Policy Waters 2018 (SEPP Waters) recently replaced SEPP (Waters of Victoria). SEPP (Waters) combines the two former policies (surface water and groundwater) into a single streamlined policy to better reflect community values, better clarify industry obligations, provide for greater accountability, and apply updated science (Engage Victoria, 2018).

SEPP (Waters) sets a statutory framework for the protection of the uses and values of Victoria's fresh and marine water environments, including:

- The uses and values of the water environment that the community and government want to protect (beneficial uses)
- The objectives and indicators which describe the environmental quality required to protect beneficial uses
- Guidance to local councils, catchment management authorities, water authorities and state government agencies to protect and rehabilitate water environments to a level where environmental objectives are met and beneficial uses are protected.

SEPP (Waters) requires measures to be implemented to control the environmental impact of discharges and protect the beneficial uses of water. A beneficial use is defined in the Environment Protection Act and includes a current or future environmental value or use of surface waters that communities want to protect. A beneficial use does not prohibit or permit the use of surface waters for any particular purpose, but requires surface waters to be of a suitable quality and quantity to support that use or value.

The following beneficial uses are to be protected:

- Protection of water-dependent ecosystems and species
- Water for human consumption
- Water for agriculture, aquaculture and industry
- Water for recreation
- Cultural and spiritual values
- Other beneficial uses.

To protect both the beneficial uses and the aquatic ecosystems, the following indicators are used for rivers and streams:

- Nutrients (phosphorus and nitrogen)
- Turbidity
- Electrical conductivity
- pH
- Dissolved oxygen
- Toxicants in water and sediments.

EPA Victoria has developed a series of Information Bulletins to support and guide SEPP (Waters). Two of the Information Bulletins relevant to this study include:

- Water Quality Objectives for Rivers and Streams – Ecosystem Protection (June 2003)
- Nutrient Objectives for Rivers and Streams – Ecosystem Protection (June 2003).

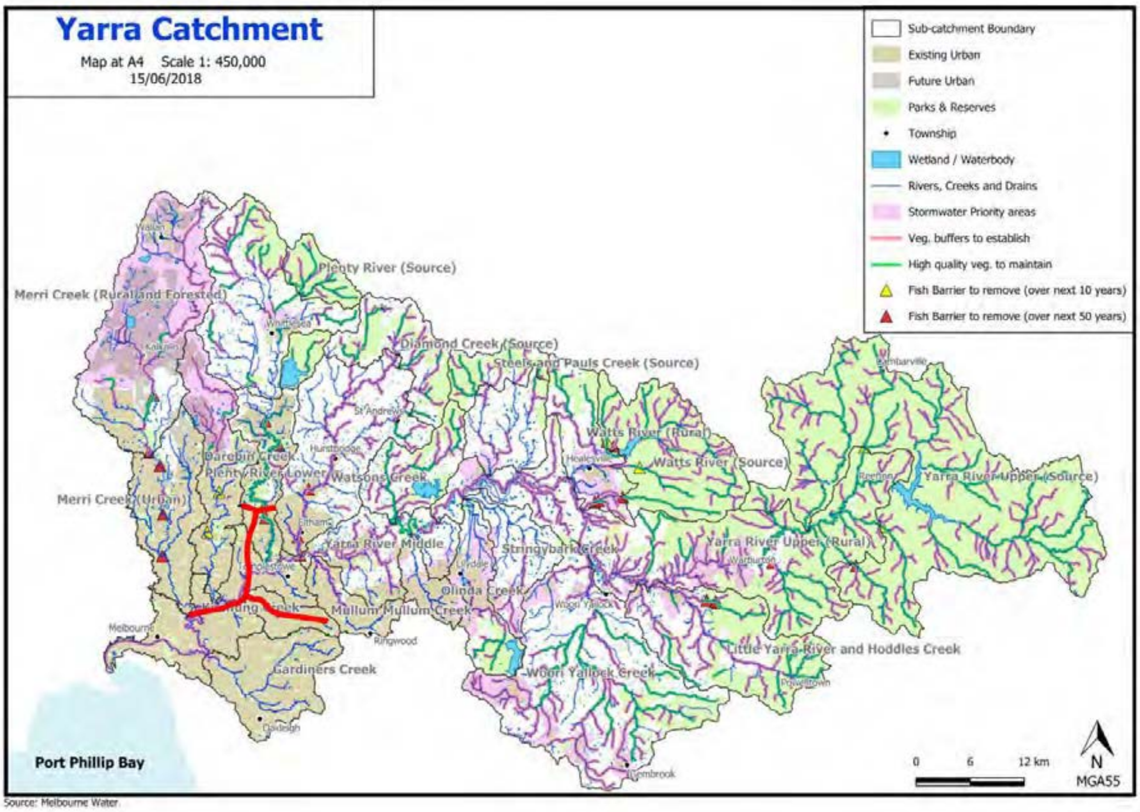


Figure 4-1 North East Link (red) within the Yarra catchment

The objectives set out in these publications are outlined in Table 4-2.

Table 4-2 SEPP Water Quality objectives applicable to North East Link

Policy	SEPP(Waters) (Table 1)			
Segment	Mainstream		Tributaries	
Indicator	Central Foothills and Coastal Plains (slightly to mderately modified) Lowlands of Yarra		Urban (highly modified) Lowlands of Yarra	
Total phosphorus	<55	75th percentile (µg/L)	<110	75th percentile (µg/L)
Total nitrogen	≤1100	75th percentile (µg/L)	≤1300	75th percentile (µg/L)
Dissolved oxygen (percent saturation U.N.O.)	≥75 110	25th percentile Maximum	≥70 110	25th percentile Maximum
Turbidity (NTU)	≤25	75th percentile	≤35	75th percentile
Electrical conductivity	≤250	µS/cm@ 25°C	≤500	µS/cm@ 25°C
pH (pH units)	≥6.7 ≤7.7	25th percentile 75th percentile	≥6.4 ≤7.9	25th percentile 75th percentile

SEPP (Waters) references the *Best Practice Environmental Management Guidelines* (1999) (BPEMG) which were developed to establish best practice performance objectives for urban stormwater (for urban development). These objectives are set out in Table 4-3. These objectives assist in determining the level of stormwater management necessary to meet the SEPP (Waters) requirements as detailed above. The BPEMG sets specific pollutant reduction targets for future development.

Table 4-3 Objectives for environmental management of stormwater (BPEMG, 1999)

Pollutant	Receiving water objective	Current best practice performance objective
Construction		
Suspended solids	Comply with SEPP (Waters)	Effective treatment of 90% of daily runoff events. Effective treatment equates to a 50 percentile SS concentration of 50 mg/L.
Litter	Comply with SEPP (Waters)	Prevent litter from entering the stormwater system.
Other pollutants	Comply with SEPP (Waters)	Limit the application, generation and migration of toxic substances to the maximum extent practicable.
Operation		
Suspended solids (SS)	Comply with SEPP (Waters)	80% retention of the typical urban annual load.
Total phosphorus (TP)	Comply with SEPP (Waters)	45% retention of the typical urban annual load.
Total nitrogen (TN)	Comply with SEPP (Waters)	45% retention of the typical urban annual load.
Litter	Comply with SEPP (Waters)	70% retention of typical urban annual load.
Flows	Maintain flows at pre-urbanisation levels	Maintain discharges for the 1.5 year ARI at pre-development levels.

Planning and Environment Act 1987

The *Planning and Environment Act 1987* ('Planning and Environment Act') establishes a framework for planning the use, development and protection of land in Victoria in the present and long-term interests of all Victorians.

The Planning and Environment Act aims to:

- Provide for the fair, orderly, economic and sustainable use, and development of land
- Provide for the protection of natural and man-made resources and the maintenance of ecological processes and genetic diversity
- Secure a pleasant, efficient and safe working, living and recreational environment for all Victorians and visitors to Victoria
- Protect public utilities and other assets and enable the orderly provision and coordination of public utilities and other facilities for the benefit of the community.

Planning schemes

The *State Planning Policy Framework* (SPPF) is common to all Victorian planning schemes, and contains policies in relation to various themes including Clause 12 in relation to Environmental and Landscape Value. The SPPF has a series of specific provisions including but not limited to:

- Rivers to protect and enhance the significant river corridors of metropolitan Melbourne' with specific policies for the Yarra River.

The planning schemes for the municipalities of Banyule, Boroondara, Manningham, Nillumbik, Whitehorse and Yarra each contain a *Local Planning Policy Framework* (LPPF) setting out the municipal strategic statement and local planning policies that apply to the planning schemes, in addition to the SPPF.

While Melbourne Water is responsible for regional drainage, flood plain and waterway management and for contributing to the protection and improvement of waterway health across greater Melbourne, local councils are the responsible authorities for planning decisions made with reference to planning schemes that control land use and development.

The administration and enforcement of a planning scheme is the duty of a responsible authority which in most cases will be the local council. However in some cases it can be the Minister administering the Planning and Environment Act or any other Minister or public authority specified in Clause 61.01 of the scheme (DELWP, 2018).

Planning schemes identify the presence of surface water and control development through the application of overlays applied to protect areas from adverse impacts or allow easy identification of constraints in developments on that area) through the *Victorian Planning Provisions* (VPP). The VPPs shows a number of planning overlays that relate to surface water and are applicable to North East Link. These overlays are discussed below.

Changes were announced on 19 October 2018 to all Victorian planning schemes to extend the stormwater planning requirements to commercial, industrial, public developments. These changes provide greater scope for the Best Practice Environmental Management Guidelines (BPEMG) for Urban Stormwater.

Land Subject to Inundation Overlay

The purpose of the Land Subject to Inundation Overlay (LSIO) as stated within the planning provisions is to:

- Implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies
- Identify land in a flood storage or flood fringe area affected by the 1 in 100 year flood or any other area determined by the floodplain management authority
- Ensure that development maintains the free passage and temporary storage of floodwaters, minimises flood damage, is compatible with the flood hazard and local drainage conditions and would not cause any significant rise in flood level or flow velocity
- Reflect any declaration under Division 4 of Part 10 of the Water Act 1989 where a declaration has been made
- Protect water quality in accordance with the provisions of relevant State Environment Protection Policies, particularly in accordance with Clauses 33 and 35 of the State Environment Protection Policy (Waters of Victoria).

A permit is required to construct or carry out works (including works for North East Link) within a LSIO.

Floodway Overlay

The purpose of the Floodway Overlay (FO/RFO) as stated within the planning provisions is to:

- Implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies
- Identify waterways, major flood paths, drainage depressions and high hazard areas which have the greatest risk and frequency of being affected by flooding
- Ensure that any development maintains the free passage and temporary storage of floodwater, minimises flood damage and is compatible with flood hazard, local drainage conditions and the minimisation of soil erosion, sedimentation and silting
- Reflect any declarations under Division 4 of Part 10 of the *Water Act 1989 (Vic)* if a declaration has been made
- Protect water quality and waterways as natural resources in accordance with the provisions of relevant State Environment Protection Policies, and particularly in accordance with Clauses 33 and 35 of the State Environment Protection Policy (Waters of Victoria).

A permit is required to construct or carry out works (including works for North East Link) within a FO.

Special Building Overlay

The purpose of the Special Building Overlay (SBO) as stated within the planning provisions is to:

- Implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies
- Identify land in urban areas liable to inundation by overland flows from the urban drainage system as determined by, or in consultation with, the floodplain management authority
- Ensure that development maintains the free passage and temporary storage of floodwaters, minimises flood damage, is compatible with the flood hazard and local drainage conditions and would not cause any significant rise in flood level or flow velocity
- Protect water quality in accordance with the provisions of relevant State Environment Protection Policies, particularly in accordance with Clauses 33 and 35 of the State Environment Protection Policy (Waters of Victoria).

A permit is required to construct or carry out works (including works for North East Link) within a SBO.

Urban Floodway Zone

The purpose of the Urban Floodway Zone (UFZ) as stated within the planning provisions is to:

- Implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies
- Identify waterways, major flood paths, drainage depressions and high hazard areas within urban areas which have the greatest risk and frequency of being affected by flooding
- Ensure that any development maintains the free passage and temporary storage of floodwater, minimises flood damage and is compatible with flood hazard, local drainage conditions and the minimisation of soil erosion, sedimentation and silting
- Reflect any declarations under Division 4 of Part 10 of the Water Act
- Protect water quality and waterways as natural resources in accordance with the provisions of relevant State Environment Protection Policies, and particularly in accordance with Clauses 33 and 35 of the State Environment Protection Policy (Waters of Victoria).

A permit is required to construct or carry out works (including works for North East Link) within a UFZ.

Climate Change Act 2017

The *Climate Change Act 2017* ('Climate Change Act') provides Victoria with legislative foundation to manage climate change risks. An overview of the Climate Change Act states the following (DELWP, 2017a):

> *'The Parliament of Victoria recognises that some changes in the earth's climate are inevitable, despite all mitigation efforts. Victoria is particularly vulnerable to the adverse effects of climate change. Natural disasters are increase in frequency and severity as a result of the change in climate. Impacts are felt differently and to different extents across individual regions and communities'.*
>
> *'Victoria must also take strong action to build resilience to, and reduce the risks posed by, climate change and protect those most vulnerable'.*
>
> *One of the policy objectives of the Climate Change Act (22b) is 'to build the resilience of the State's infrastructure, built environment and communities through effective adaptation and disaster preparedness action'.*

The guiding principles include 'integrated decision making' to ensure that any decisions made consider all relevant issues relating to climate change. North East Link should consider the impacts of climate change on the project and how these can be mitigated or adapted to.

Yarra River Protection (Willip-gin Birrarung Murron) Act 2017

Legislation was introduced into the Victorian Parliament in 2017 to protect the Yarra River with the *Yarra River Protection (Willip-gin Birrarung Murron) Act 2017* ('Yarra River Protection (Willip-gin Birrarung Murron) Act') (Melbourne Water, 2018b).

Melbourne Water is leading the development of the Yarra Strategic Plan which will underpin the Yarra River Protection (Willip-gin Birrarung Murron) Act. The Yarra Strategic Plan has four key elements (Melbourne Water, 2018b):

- The overall environmental health of the river (waterway and riparian land)
- Community use, access and amenity of the river and parklands
- The river's landscape setting and interface of the river corridor with adjacent land use
- Cultural and heritage values.

4.3 Policy

4.3.1 Commonwealth

National Water Quality Management Strategy

The *National Water Quality Management Strategy* (1994) (NWQMS) is a joint national approach to improving water quality in Australian and New Zealand waterways. It was originally endorsed by two Ministerial Councils – the former Agriculture and Resources Management Council of Australia and New Zealand (ARMCANZ) and the former Australian and New Zealand Environment and Conservation Council (ANZECC).

Since 1992 the NWQMS has been developed by the Australian and New Zealand governments in cooperation with state and territory governments. Ongoing development is currently overseen by the Standing Council on Environment and Water (SCEW) and the National Health and Medical Research Council (NHMRC).

The policy objective of the NWQMS is: ‘to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development’.

The guiding principles of the NWQMS include:

- Decision-making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations
- Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
- The global dimension of environmental impacts of actions and policies should be recognised and considered
- The need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised
- Decisions and actions should provide for broad community involvement on issues that affect them.

The principles identified above have guided the scientific investigations undertaken in the surface water impact assessment as well as the mitigation strategies that may be required to reduced or mitigate environmental impacts of North East Link on surface water.

4.3.2 State

Victorian Waterway Management Strategy

The *Victorian Waterway Management Strategy* (VWMS) provides the policy direction for managing Victoria's waterways over an 8-year period. It aims to maintain or improve the condition of our waterways so they can support environmental, social, cultural and economic values that are important to communities.

The VWMS provides direction for regional decision-making, investment and management issues for waterways, as well as the roles and responsibilities of management agencies. It includes aspirational targets for long-term resource condition outcomes (to be achieved in 8+ years) and management outcomes (to be achieved in 1–8 years). Progress against these targets is publicly reported by the Department of Environment, Land, Water and Planning.

The VWMS also requires the development and implementation of regional waterway strategies for 10 catchment management regions across Victoria. The relevant strategy, Healthy Waterways Strategy (2013) (see below) requires all North East Link works to maintain or improve the condition of rivers, estuaries and wetlands so they can continue to provide environmental, social, cultural and economic values for all Victorians.

Healthy Waterways Strategy 2013–2018

The *Healthy Waterways Strategy* states 'under the Water Act 1989, Melbourne Water is the designated caretaker of river health for the Port Phillip and Westernport region' (Melbourne Water, 2013). The Healthy Waterways Strategy sets a high level direction for Melbourne Water's role in '*protecting and improving…waterways and waterway values over the next five years*' from 2013 to 2018 (Melbourne Water, 2013). The Healthy Waterways Strategy supports the objectives of By-law No. 2 as summarised in Section 4.2.2. The Healthy Waterways Strategy is guided by the state-wide Victorian Waterway Management Strategy as described above.

The Healthy Waterways Strategy (Victorian Government, 2013) replaces the *Port Phillip and Westernport Regional River Health Strategy* (Melbourne Water, 2007).

The Health Waterways Strategy describes Melbourne Water's role in managing rivers, estuaries and wetlands in the Port Phillip and Westernport region. It identifies priority areas and management actions to improve waterway health from 2013 to 2018 and sets targets to measure progress and achievements.

North East Link works should not inhibit Melbourne Water from achieving the longer-term waterway implementation targets identified in the Healthy Waterway Strategy.

The Port Phillip and Westernport Regional River Health Strategy originally set a 5-year plan for improving the health of our rivers from 2007 to 2012, with an addendum (Melbourne Water, 2013) subsequently extending it to 2013. The Strategy provided an overview of the condition of key waterways located within the proposed works area for North East Link. The overall condition of the waterways defined in the Strategy was based on factors such as water quality, aquatic life, habitat and stability, vegetation and flow. The Strategy also set targets for each river in terms of condition and social value.

The Port Phillip and Westernport Regional Health Strategy was required as part of the Victorian Waterway Management Strategy and was implemented by Melbourne Water with assistance from the Port Phillip and Westernport Catchment Management Authority, local councils, and Victorian Government agencies.

Healthy Waterways Strategy 2018

The draft Healthy Waterways Strategy focuses on the Port Phillip and Westernport region for the next 50 years. It identifies high waterway values and priority management activities over a 10-year period and has been developed in close consultation with key partners and the community. The strategy seeks to:

1. Express the broad regional vision for our waterways shared by many organisations and people, supported by vision and goals determined by catchment communities for waterways across the region's five main waterway catchments (including the Yarra River).
2. Make waterway management a part of decision-making for land and nature conservation, social and economic development and to benefit the bays.
3. Publish the community's agreed 10 to 50-year targets for waterway values and conditions supported by 10-year performance objectives for the region's 69 sub-catchments, 81 representative wetlands and 30 estuaries published in Catchment Works Programs.
4. Describe how we will make decisions, act, evaluate and learn so we can know if our methods are working and we can change them in response to unforeseen outcomes and forces outside our control.

The Healthy Waterways Strategy sets performance objectives for the next 10 years to guide activities and indicate progress towards improving the waterway condition. It also establishes longer-term targets to improve waterway conditions as appropriate to improve waterway values. Generically these typically include improving the extent, quality and knowledge of vegetation, community and stakeholder participation in the management of the waterways, and improvements in flow regime and water quality. It provides a specific vision, goals and actions and objectives at the catchment and subcatchment level. With an entire document dedicated to the catchment works program for the Yarra River which includes specific objectives for specific subcatchments including Koonung Creek, Plenty River, Yarra River Lower, and specific wetlands including Annulus Billabong (Yarra Flats), Banyule Flats Billabong, Bolin Bolin Billabong, Burke Road Billabong, Hays Paddock Billabong and Willsmere Billabong to name a few that are within the study area.

4.4 Guidelines

4.4.1 Commonwealth

Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC 1992) is one of 21 documents forming the NWQMS and was released in 1992 as one of the first guideline documents. These guidelines were produced by the Australian and New Zealand Environment and Conservation Council (ANZECC)

The Guidelines were subsequently revised in 2000 in conjunction with the Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ) to:

- Incorporate current scientific, national and international information in a clear and understandable format
- Ensure the Guidelines complement major policy initiatives and directions undertaken at the state and federal levels in the areas of ecologically sustainable development and water resource management
- Promote a holistic approach to aquatic ecosystem management for the protection of ecosystems, industries and indigenous cultural and spiritual values
- Incorporate more detailed guidance on how to refine national or regional guidelines for site-specific application.

These revised Guidelines known as ANZECC & ARMCANZ (2000) set the water quality objectives required to sustain current or future environmental values for natural and semi-natural water resources in Australia and New Zealand. Recommended limits to acceptable change in water quality that would continue to protect the associated environmental values are identified in the document.

The 2018 revision of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality is an online guide (<http://www.waterquality.gov.au/anz-guidelines/framework>) published by the Australian and New Zealand governments and Australian State and Territory Government ANZAST (2018). It contains updated default guideline values and recognises the need for local guidelines to reflect local conditions and for the basis of the DGVs to be readily available, it no longer includes recreational and drinking water sections, it promotes an integrated weight of evidence approach and numerous other changes including an expansion of the basic Water Quality Management Framework. The new guidelines are a significant step forward which with additional data, resourcing and review will continue to improve and supersede previous guidelines.

Australian Guidelines for Water Quality Monitoring and Reporting

The *Australian Guidelines for Water Quality Monitoring and Reporting* (2000) is an integral element of the NWQMS. It provides a comprehensive framework and guidance for the monitoring and reporting of fresh and marine waters and groundwater.

The Monitoring Guidelines state that:

> *Monitoring consists of a systematic and planned series of measurements or observations that are appropriately analysed and reported, with the aim of providing information and knowledge about a water body. Monitoring (and reporting) of water quality is important for environmental protection policies and programs, and for managing water resources and controlling contaminants. It underpins State of the Environment reporting, and National Audit reporting. The information that water quality monitoring generates not only describes changes in water quality but also helps explain how ecosystems function.*

Design of the water quality monitoring program in accordance with these guidelines will enable the detection of potential impacts so that they can be appropriately addressed. The water quality monitoring program is required as part of EPR SW4 for North East Link.

Austroads

Austroads publishes a number of guides to promote a nationally consistent approach to the design, maintenance and operation of road networks (Austroads, 2018). While the guides have been developed to provide a general direction and application is discretionary, the guides have been adopted by all road agencies across Australasia. There are two guides that are relevant to surface water for North East Link:

- Guide to Road Design Parts 5, 5A and 5B: details drainage design for roads
- Guide to Road Tunnels: adoption of the risk management approach in the guide is applied to the assessment of tunnel flood immunity standards.

The Guide to Road Design provides guidance on road design in relation hydrology and drainage for aspects including roads surfaces, drainage networks, basins, subsurface drainage, open channels, culverts and floodways.

The Guide to Road Tunnels provides high-level guidance on the planning, design, operation and maintenance of new road tunnels in Australia and New Zealand. The Guide to Road Tunnels is designed for engineers and technical specialists to apply in tunnel technology, proponents of road tunnel solutions, senior decision makers, and regulators in the various jurisdictions associated with the construction of tunnels. The adoption of the risk management approach in the Guide is applied to the assessment of tunnel flood immunity standards.

Note: VicRoads provides supplements to sections of these Austroads guides available via the VicRoads website.

4.4.2 State

Integrated Water Management Guidelines

The *Integrated Water Management Guidelines* (VicRoads, 2013) set the direction for the management of water resources during road construction, operation and maintenance activities. They provide the framework for water management on VicRoads projects and associated infrastructure and includes guidance on regulation, water sensitive road design, water reuse, surface water and groundwater quality management and stakeholder responsibility. The Guidelines influence the Environmental Performance Requirements (EPRs) recommended for North East Link.

Water for Victoria (Water Plan)

In 2016 the Department of Environment, Land, Water and Planning (DELWP) released the *Water for Victoria: Water Plan*. The Water Plan recognises the need to better manage Victoria's water resources into the future and the economic benefits of doing so as Victoria responds to a changing climate and growing population.

Integrated Water Management Framework for Victoria (Department of Environment, Land, Water and Planning)

DELP developed the *Integrated Water Management Framework for Victoria* in response to the Water for Victoria (Water Plan) (DELWP, 2017b). The Framework details a number of water-related outcomes that are compatible with the building of resilient and liveable cities including but not limited to the provision of a 'diverse range of water supplies and sources' (DELWP, 2017b). This is one of the main objectives of integrated water management which focuses on the reduction of reliance on potable water supply through the treatment and re-use of water.

Melbourne Water System Strategy

Melbourne Water developed a System Strategy in response to the Water Plan. The System Strategy takes into account a long-term view that considers water resource management challenges and opportunities for Melbourne across the next 50 years. There are a number of actions in the Systems Strategy which includes 'using diverse sources of water' through the collaboration with integrated water management forums (Melbourne Water, 2017c).

Shared Pathways Guidelines

Melbourne Water developed the *Shared Pathways Guidelines* to document a standard approach to design, construction, upgrade and maintenance of shared paths along waterways—shared use paths. The guidelines also detail the most effective way to liaise with Melbourne Water to ensure successful construction of a shared path (Melbourne Water, 2009).

4.4.3 Local

While Melbourne Water is responsible for regional drainage, flood plain and waterway management and for contributing to the protection and improvement of waterway health across greater Melbourne, local councils are the responsible authorities for planning decisions made with reference to planning schemes that control land use and development. Planning schemes contain State and local planning policies, zones and overlays and other provisions that affect how land can be used and developed. Councils are also responsible for managing local drainage infrastructure in catchments of less than 60 hectares, including ownership and maintenance of drainage assets.

The following section outlines strategy and guideline documents published by the six local governments relevant to North East Link. Table 4-4 summarises these documents and links them to the particular component of the project they apply to.

Table 4-4 Local government document summary

Council	Relevant documents	Summary
Banyule City Council	Planet: Water – Water Sustainability Plan 2013 (Banyule, 2013)	The objective of the Banyule City Council's Water Sustainability Plan is to improve water quality, to prepare for the likelihood of future dry periods and to constrain rising water costs. The plan sets specific water sustainability targets. The Water Sustainability Plan states *'Water quality in Banyule's waterways is generally rated moderate to poor and it is unlikely that there has been significant long term change in this. This has a detrimental impact on waterway health and people's enjoyment of waterways'.*
	Stormwater Management Plan (SKM for Banyule, 20 03)	Banyule City Council's Stormwater Management Plan guides the Council in improving environmental management and quality of stormwater runoff from urban areas throughout the municipality.
	Banyule Planet: Environmental Sustainability Policy and Strategy 2013-2017 (Banyule, 2013)	Banyule City Council's Environmental Sustainability Policy and Strategy supports the Banyule City Plan 2013-2017 objective to 'conserve water and improve stormwater quality and impact'.
	Drainage Policy (Banyule, 1998)	Banyule City Council's Drainage Policy was developed following the amalgamation of councils. The policy documents the management of drainage assets.
Boroondara City Council	Integrated Water Management Strategy 2014-2024 (Boroondara, 2014)	Boroondara City Council's Integrated Water Management Strategy states *'The aim of this Integrated Water Management Strategy (IWMS) is to set the strategic direction and implementation approach for improving water cycle management across the municipality over the next decade'.* The strategy's vision is for *'…a healthy, green and resilient city … where a diversity of water sources is available so that the right quality of water is available when and where it is required … contributing to healthier waterways and open spaces for greater community well-being'.*

Council	Relevant documents	Summary
Manningham City Council	Drainage Strategy 2004-2014 (Manningham, 2004)	Manningham City Council's Drainage Strategy states this is *'A strategy for the provision of drainage within the municipality which ensures the continued safety of its community and improvement to the local amenity and protection from the effects of stormwater'.* This strategy provides details on the prioritisation and funding of drainage and related works for the 10 year period from 2004 to 2014. There is no publicly available version of this strategy post 2014.
	Stormwater Management Plan (Manningham, 2001)	Manningham City Council's Stormwater Management Plan states that: *'the SWMP is intended to assist Council and other stakeholders to manage the environmental quality of urban stormwater runoff in the municipality to protect and enhance environmental values of waterways. It provides a framework for integrating stormwater management as part of Council's existing management and planning activities'.*
	Water15 – Sustainable Water Management Plan 2005-2015 (Manningham, 2005)	Pending
	Strategic Water Management Plan (Manningham, 2008)	Manningham City Council's Strategic Water Management Plan states that *'The Plan identifies a number of the current water challenges facing Manningham, including an ongoing need to protect and preserve our waterways and to work collaboratively so that water is used effectively and efficiently.* *'The Plan recommends that a number of supporting actions be undertaken to ensure that the IWM approach can be effectively implemented.… '*
	Securing the Future – Responding to climate change, peak oil and food scarcity (Manningham, 2012)	Manningham City Council's Securing the Future document has been developed to *'guide Council's response to the interacting issues of climate change, peak oil and food security. It explores the likely impacts on Council service delivery and the vulnerability of Manningham residents to each of these factors and provides an action plan to prepare the community for the challenges ahead'.*
	Policy and guidelines for the provision of water tanks on Council owned and managed land (Manningham, 2007)	Manningham City Council's policy and guidelines for the provision of water tanks aims to *'.clearly articulate Manningham City Council's requirements in relation to the provision of water tanks on Council owned or managed land whether the proposal is from an external club or community group or from within Council itself'.*
	Koonung Park Management Plan (Manningham, 2016)	Manningham City Council's Koonung Park Management Plan states: *'The overarching goal for the Koonung Park Management Plan is to provide high quality recreation services that respond to community demand, respect the natural environment and are maintained effectively into the future'.*
Shire of Nillumbik	Integrated Water Management Strategy 2013 (Nillumbik, 2013)	The purpose of Nillumbik Shire Council's Integrated Water Strategy is to provide a more holistic and coordinated approach for managing water. This approach promotes the integration of multi-functional infrastructure that progressively reduces reliance on potable water whilst improving the quality of stormwater discharged to receiving waterways.

Council	Relevant documents	Summary
	Drainage Design Guidelines (Nillumbik, 2013)	The objectives of Nillumbik Shire Council's Drainage Design Guidelines are to *'provide for the efficient, environmentally sensitive and cost effective control of stormwater runoff and to ensure that a high level of safety and amenity for the public is achieved at all times'.*
	Climate Change Action Plan 2016-2020 (Nillumbik, 2016)	Nillumbik Shire Council's Climate Change Actin Plan sets goals and targets related to mitigation and adaptation for climate change impacts throughout the municipality.
Whitehorse City Council	Sustainability Strategy 2016-2022 (Whitehorse, 2016)	Whitehorse City Council's Sustainability Strategy states: *'The key liveability outcomes that guide the Strategy include; reducing the use of potable water and improved water quality of local creeks and waterways'.*
	Elgar Park Master Plan DRAFT (Aspect Studios for Whitehorse, 2016)	Whitehorse City Council developed the Elgar Park Master Plan to provide a cohesive vision for the sporting precinct. It notes existing flooding issues impacting the building near Brushy Creek.
	Climate Change Adaptation Plan (Whitehorse, 2011)	Whitehorse City Council developed its Climate Change Adaptation Plan following a recommendation in the Whitehorse Sustainability Strategy 2008-2013. The plan sets out actions to build the resilience of the municipality and aims to prevent identified climate change risks from becoming extreme by 2030 or 2070.
	Stormwater drainage policy No 1 – Outfall drainage (Whitehorse, date unknown)	The objective of Whitehorse City Council's stormwater drainage policy is *'to ensure all developed properties have an approved drainage discharge system'.*

4.5 Surface water criteria

The legislation, policy and guidelines identified above result in requirements which apply to the construction and operation of North East Link as summarised in the following sections.

4.5.1 Construction criteria

The criteria that would be applied to the construction of North East Link are shown in Table 4-5.

Table 4-5 Construction criteria for surface water

Issue	Flooding	Water Quality	Geomorphology	Water Supply
Legislation and policy	• Water Act 1989 – By-law No 2: Waterways, Land and Works Protection Management (2009) – Melbourne Water Standards – Infrastructure Projects in Flood-prone Areas (2018) – Guidelines for Development in Flood-prone Areas (Melbourne Water, 2008) – Council design standards. – Australian Rainfall and Runoff 1987 – Australian Rainfall and Runoff 2016	• Environment Protection Act 1970 State Environment Protection Policy: Waters (2018) State Environment Protection Policy: Waters of Victoria (1988) Integrated Water Management Guidelines (VicRoads, 2013) EPA Publication 275 (1991), 347.1 (2015), 480 (1996), 596 (1998) and 960 (2004)	• Water Act 1989 Victorian Waterway Management Strategy (2013) Healthy Waterways Strategy (2013) Constructed Waterways in Urban Developments Guidelines (Melbourne Water, 2009)	• Water for Victoria (Water Plan) DELWP, 2017 Integrated Water Management Guidelines (VicRoads, 2013)
North East Link Requirements	Maintain existing flood conditions for each receiving drainage or waterway system. Maintain functional capacity of floodplains. Work cooperatively with drainage authorities to reduce flood risks where practical.	No pollution of waterways such that the condition of waterways becomes detrimental to any beneficial use of the waters.	Maintain the existing waterway stability.	Maintain function of existing storage and water supply for irrigation.

4.5.2 Operation criteria

The criteria that would be applied to the operation of North East Link are shown in Table 4-6.

Table 4-6 Operation criteria for surface water

Issue	Flooding	Water Quality	Geomorphology	Water Supply
Legislation and policy	• Water Act 1989 – By-law No 2: Waterways, Land and Works Protection Management (2009) – Melbourne Water Standards – Infrastructure Projects in Flood-prone Areas (2018) – Guidelines for Development in Flood-prone Areas (Melbourne Water, 2008) – Shared Pathways Guidelines (Melbourne Water, 2008) – Council design standards. • Climate Change Act 2017 • Austroads Guide to Road Tunnels (Austroads, 2010)	• Environment Protection Act 1970 – State Environment Protection Policy: Waters (2018) – State Environment Protection Policy: Waters of Victoria (1988) – Best Practice Environmental Management Guidelines for Urban Stormwater (1999) – Integrated Water Management Guidelines (VicRoads, 2013) • Austroads Guide to Road Design Parts 5, 5A and 5B (2013) • Climate Change Act 2017	• Water Act 1989 – Victorian Waterway Management Strategy (2013) – Healthy Waterways Strategy (2013) – Constructed Waterways in Urban Developments Guidelines (Melbourne Water, 2009) – Melbourne Water Shared User Path Guidelines • Climate Change Act 2017	• Water for Victoria (Water Plan) DELWP, 2017 – Integrated Water Management Guidelines (VicRoads, 2013) • Climate Change Act 2017
North East Link requirements	Maintain existing flood conditions for each receiving drainage or waterway system. Maintain function capacity of floodplains. Flood risk assessment is required for tunnel portal locations. Consider climate change impacts. Work cooperatively with drainage authorities to reduce flood risks where practical.	Meet annual pollutant load reductions in accordance with BPEM Guidelines on a project wide scale. No pollution of waterways such that the condition of waterways becomes detrimental to any beneficial use of the waters by maintaining environmental quality objectives relative to baseline levels. Contain spills at points of discharge from pavement drainage to protect environment. Consider climate change impacts.	Maintain the existing waterway stability. Consider climate change impacts.	Maintain existing storage and water supply for irrigation. Consider climate change impacts.

5. Method

5.1 Overview of methodology

This section describes the method that was used to assess the potential impacts of North East Link. A risk-based approach was applied to prioritise the key issues for assessment and inform measures to avoid, minimise and offset potential effects. Figure 5-1 shows an overview of the assessment method.

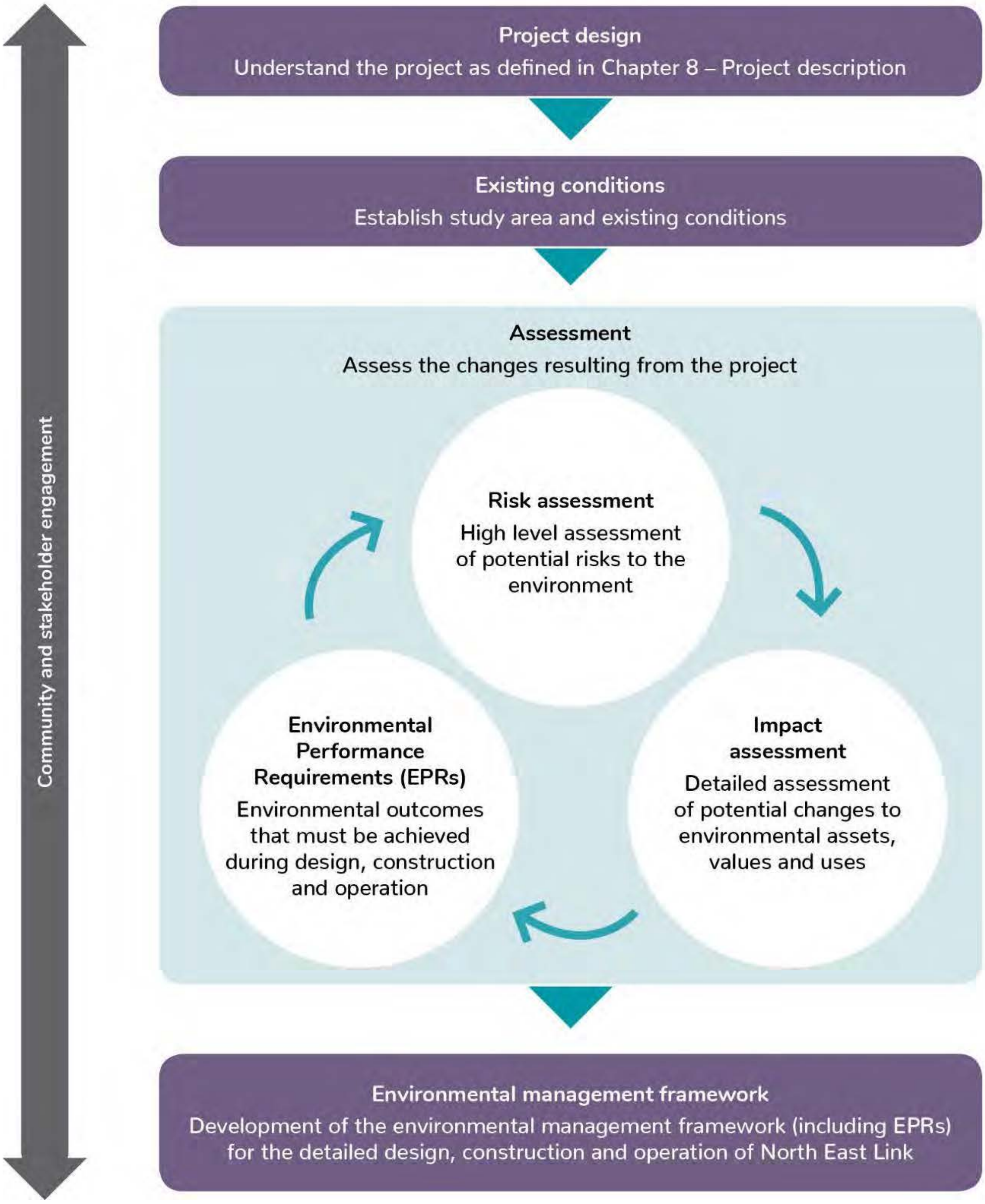


Figure 5-1 Overview of assessment method

The following sections outline the methodology for the surface water impact assessment.

5.2 Study area

5.2.1 Overview

North East Link would extend from Watsonia North and Greensborough in the north, through Watsonia, Macleod and Yallambie, before tunnelling beneath parts of Rosanna, Viewbank and Heidelberg. At Bulleen, North East Link is proposed to connect to the Eastern Freeway. Works required for the Eastern Freeway widening and the new Doncaster Busway would occur within the suburbs of Fairfield, Kew, Kew East, Bulleen, Balwyn North, Doncaster, Mont Albert North, Box Hill North, Doncaster East, Blackburn North, Donvale and Nunawading.

A high level review of surface water features including waterways, drains and other surface water bodies in close proximity to North East Link was undertaken to identify which sites were potentially impacted by the project (refer Appendix C).

The review identified that the project has the potential to impact Banyule Creek, Koonung Creek, the Yarra River, Yando Street Main Drain and Kempston Street Main Drain as well as their associated floodplains and tributaries. Potential impacts to other water bodies have also been identified and include the irrigation storage at Trinity Grammar School Sporting Complex and a number of wetlands along Koonung Creek.

5.2.2 Summary of key water features

North East Link would be located within a predominantly urban section of the Yarra River catchment. It would include twin tunnels that pass beneath the Yarra River and widening of the Eastern Freeway bridge over the Yarra River. Tributaries of the Yarra River that would intersect with the project include Banyule Creek and Koonung Creek as shown in Figure 5.2. Other tributaries of the Yarra River in this area include Merri Creek, Plenty River, Glass Creek, and Bushy Creek are not affected by the project.

An underground storm water system—the Yando Street Main Drain—and its associated overland flow paths also cross beneath the project alignment (and Greensborough Bypass) from west to east before discharging to the Plenty River. A tributary of this drain—the Kempston Street Main Drain—also crosses the alignment from west to east a little to the south.

The project alignment intersects with a number of floodplains and overland flow paths. The surface water study area is shown in Figure 5-2 and includes the following:

- Yando Street Main Drain is an underground drainage system which crosses the project under Greensborough Bypass from west to east just south of the M80 Ring Road interchange. Yando Street Main Drain and its associated overland flow path have been included in the assessment as the project would include new roads and shared use path infrastructure within the overland flow path associated with the underground drain and the associated extension of existing culverts. A detailed description of the existing conditions of Yando Street Main Drain is provided in Section 6.1.
- Kempston Street Main Drain is an underground drainage system which crosses the project at Grimshaw Street and under Greensborough Bypass running in a north to east direction towards Kalparrin Gardens where it joins the Yando Street Main Drain. Kempston Street Main Drain and its associated overland flow path have been included in the assessment as the project would include new roads and shared use path infrastructure within the overland flow path, which without appropriate mitigation may lead to an increase in downstream flooding. A

description of the existing conditions of Kempston Street Main Drain is provided in Section 6.2.

- There is an overland flow path associated with an unnamed council drainage system which runs east from Watsonia railway station car park to Melbourne Water's Watsonia Drain. This drainage system is referred to as the Watsonia Station drain in this report. A description of the existing conditions of the Watsonia Station drain is provided in Section 6.3.
- Banyule Creek starts as an ephemeral waterway within Simpson Barracks and flows south to the Yarra River. The reference project overlays the current creek alignment to the north of Lower Plenty Road adjacent to Greensborough Road. Banyule Creek was included in the assessment as North East Link would require diversion of the existing creek and connecting drains to accommodate the project alignment to the north of Lower Plenty Road. A detailed description of the existing conditions of Banyule Creek is provided in Section 6.4.
- The Yarra River is a major waterway with a catchment area of approximately 4,000 square kilometres. The Yarra River and its floodplain was included in the assessment as the project would provide a new interchange at Manningham Road comprising open cut, cut and cover and mined tunnel sections, a tunnel portal and associated ventilation facility located south of the Veneto Club and further south surface road and elevated ramps connecting to the Eastern Freeway via a new interchange. A description of the existing conditions of the Yarra River is provided in Section 6.5.
- Koonung Creek is a heavily modified creek which runs generally parallel to the Eastern Freeway from Springvale Road to its outfall into the Yarra River downstream of Bulleen Road. Koonung Creek was included in the assessment as the project would require the realignment of sections of the creek, and extensions of undergrounded sections of the creek in culverts. A description of the existing conditions of Koonung Creek is provided in Section 6.6.
- All sections of new surface road that would form part of the project where the pavement area would increase are included in this assessment, as pavement can impact the flow conditions and water quality of receiving waters.

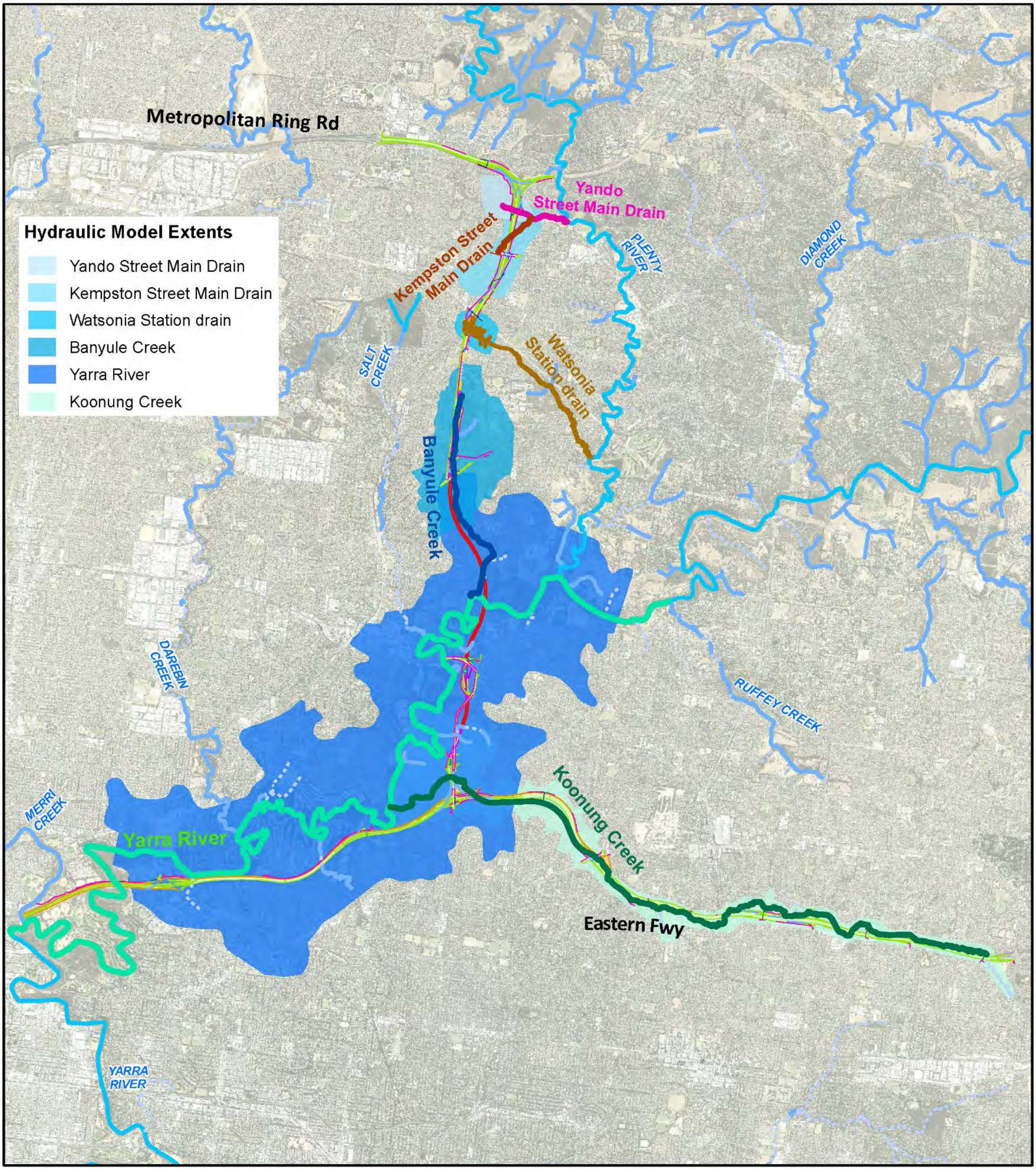
Other drains that would be in close proximity to North East Link but not directly affected by the works include Kew Mental Hospital Main Drain 4711, Kew Main Drain 4712 and Glass Creek Main Drain 4720. Peak flood levels for these drains in the lower reaches near the Eastern Freeway are dominated by Yarra River flood levels which inundate parts of the Eastern Freeway. It is unlikely, even considering the potential for blockage, that a local event on any of these catchments would result in overtopping of the Eastern Freeway, so the local catchment flooding for these catchments have not been modelled as part of this EES. The potential of impacts on flooding from local catchments have been considered in developing the Environmental Project Requirements (EPRs), refer to Section 12, and modelled where appropriate (such as some tributaries to Koonung Creek).

Surface water bodies which would be impacted by the project include the irrigation storage at Trinity Grammar School Sporting Complex and a number of wetlands along Koonung Creek. A number of other water bodies in the area include Banyule Swamp, Banyule Billabong, Bolin Bolin Billabong and the wetlands at Trinity Grammar School Sporting Complex.

The surface water assessment has evaluated the potential impacts due to construction and operation of North East Link within this study area.

This report focuses on the assessment of potential impacts resulting from the project interacting with waterways, overland flow paths and drainage alignments.

Impacts to ecological values associated with surface water bodies have been addressed in Technical Report Q *Ecology*. This includes consideration of the potential impacts to Bolin Bolin Billabong and Banyule Swamp, for example.



LEGEND

SUP Overpass	Public transport infrastructure upgrade	Cut and Cover	Tunnel	Stream
SUP Surface	Structure Viaduct	Surface	Tunnel Control Centre	Channel
Substation	Open Cut	SUP Underpass	River	Drain

Paper Size A4

0 500 1,000 2,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number 31-35006
Revision B
Date 08/10/2018

Study area for
surface water impact assessment

Figure 5-2

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

5.3 Existing conditions

Four main aspects relating to surface water have been considered in this assessment: flooding, water quality, geomorphology, and water supply. Existing conditions have been defined for each aspect, by waterway where relevant.

The importance of defining the existing conditions for each of the four aspects for is:

- **Flooding** – A key project consideration is the potential for project works to affect waterways and hydrology with respect to flooding and future climate change scenarios (see scoping requirements in Table 2-1, Section 2.2). The project seeks to avoid or minimise adverse effects on surface water and groundwater environments
- **Water quality** – A key project consideration is the potential for contaminated runoff or other water to be transported into surface waters or groundwater environments (see scoping requirements in Table 2-1, Section 2.2). The project seeks to avoid or minimise adverse effects on surface water and groundwater and floodplain environments
- **Geomorphology** – Geomorphology is the study of landforms and their origin. This geomorphological assessment is focused on the banks and beds of waterways. A key project consideration is the potential for project works to contribute to land subsidence or erosion (see scoping requirements in Table 2-1, Section 2.2). The project seeks to avoid or minimise adverse effects of erosion and subsidence on land stability from project activities, including tunnel construction and river and creek crossings
- **Water supply** – A priority for characterising the existing environment is to identify and map the natural and constructed surface water drainage systems and storages relevant to the geographic coverage of project works (see scoping requirements in Table 2-1, Section 2.2). The coverage of project works has the potential to impact the water supply for the irrigation of sporting fields.

The method used to establish the existing conditions for each aspect is discussed in the following subsections.

5.3.1 Flooding overview

To establish the existing flooding conditions for North East Link and facilitate subsequent assessment of project impacts under proposed conditions, the following methodology was used:

- A review of the existing planning overlays that indicate existing flood extents was undertaken to identify where North East Link would interact with creeks, rivers, floodplains, overland flow paths and underground drains. This considered areas covered by a Land Subject to Inundation Overlay (LSIO) and/or a Special Building Overlay (SBO).
- Models provided by Melbourne Water were reviewed for the areas where interactions were identified. This included an assessment of the suitability of the available modelling for the assessment.
- Where the available modelling was not appropriate for the assessment, updated modelling was developed.

- Modelling was undertaken in general accordance with Melbourne Water standards for infrastructure projects in flood-prone areas (considering but not adopting the draft ARR 2016 guidelines refer subsequent discussion in Section 5.6.1) and Flood Mapping Projects Guidelines and Technical Specifications (Melbourne Water, 2016). Modelling has included the assessment of climate change as per Melbourne Water standards for infrastructure projects in flood-prone areas (refer Appendix B). This included additional simulations with increased rainfall intensities to inform an assessment of potential climate change impacts.

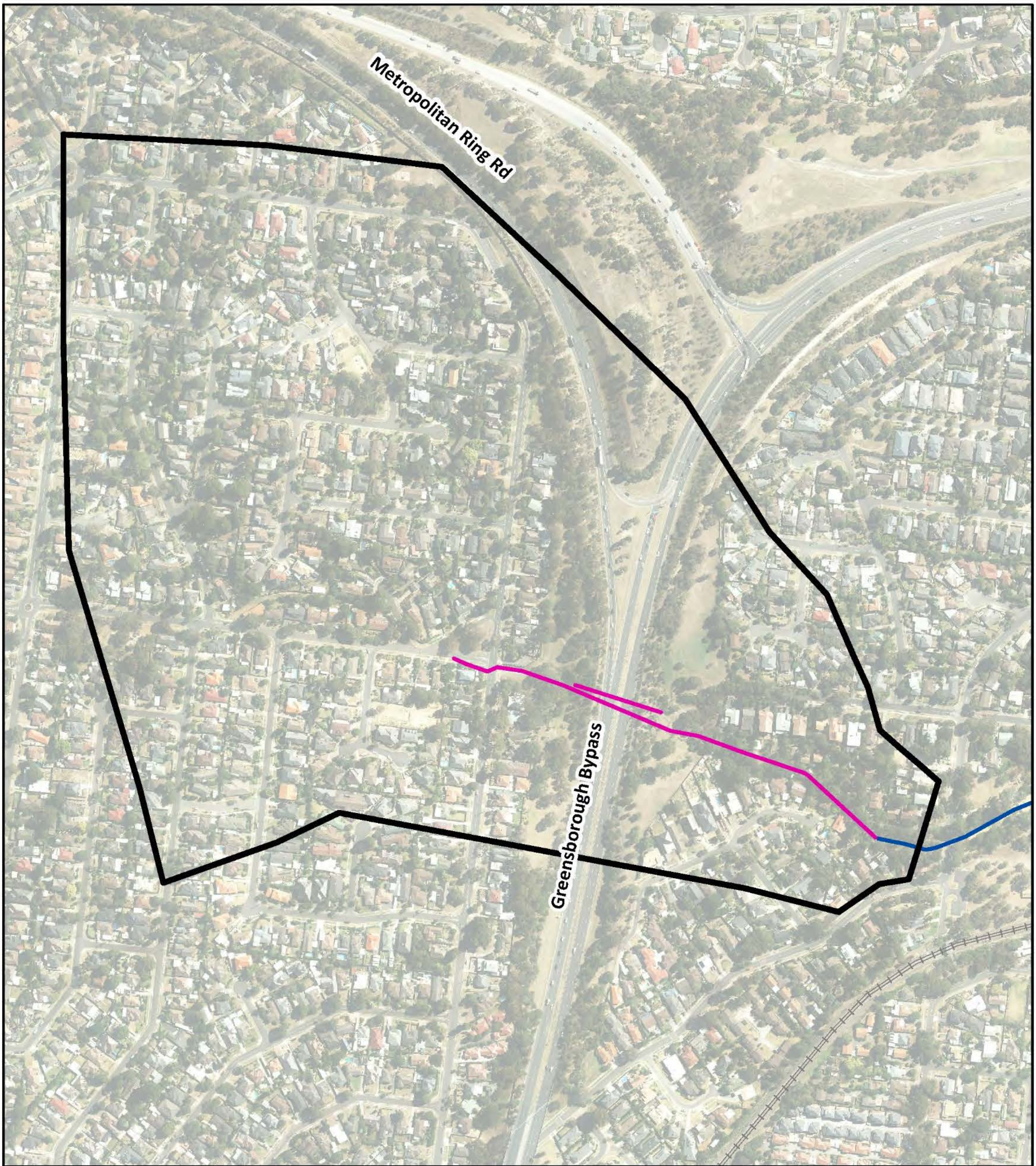
5.3.2 Yando Street Main Drain flooding

Detailed hydrologic and hydraulic modelling has been undertaken for Yando Street Main Drain to identify and map the drainage system. This was developed using RORB (a hydrologic modelling package) and TUFLOW (a two-dimensional hydraulic modelling package), in general accordance with the Melbourne Water guidelines for flood studies. These models are based on available information including an existing conditions model recently prepared by Engeny for Banyule City Council and Melbourne Water.

The key assumptions adopted for the hydrologic and hydraulic analysis are:

- The hydraulic model extent includes approximately 300 metres either side of the Greensborough Bypass, as shown in Figure 5-3.
- Hydraulic model inflows are based upon a modified RORB model initially provided by Melbourne Water (20 July 2018) and have been consistently applied for the hydraulic modelling of both existing and proposed conditions.
- In the absence of suitable historical data for calibration or verification, flood flows and resultant levels are estimated based on standard methodologies.
- A range of design events were modelled including small (frequent) and large (rarer) events for a range of durations as shown in Appendix D1.
- The potential impact of climate change has been considered using an increased rainfall intensity for the 1% AEP design event.
- Yando Street Main Drain and the culvert were modelled based upon information obtained from the GIS data provided by Melbourne Water (25 October 2017) and VicRoads As-Constructed drawings (3 August 2017).
- Inlets were modelled without blockage in both existing and proposed conditions.
- A downstream rating curve was developed based on the gradient of the channel downstream and surrounding topography.
- The topography of Yando Street Main Drain and surrounds has been developed based on DELWP LiDAR (8 August 2017); no bathymetric survey was available for the open channel upstream of Pinehills Drive.
- Hydraulic roughness (roughness) values have been developed based on different types of land use and ground cover, aerial photography and a site visit, with guidance from the Flood Mapping Projects Guidelines and Technical Specifications (Melbourne Water, 2016).

The Yando Street Main Drain hydraulic model setup is shown in Figure 5-3.



LEGEND

- Hydraulic Model Boundary
- Underground drainage included in model
- River
- Stream
- Channel
- Drain

Paper Size A4
0 30 60 120
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

North East Link
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Hydraulic model setup
Yando Street Main Drain

Figure 5-3

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulic_KBM_Yando Street 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

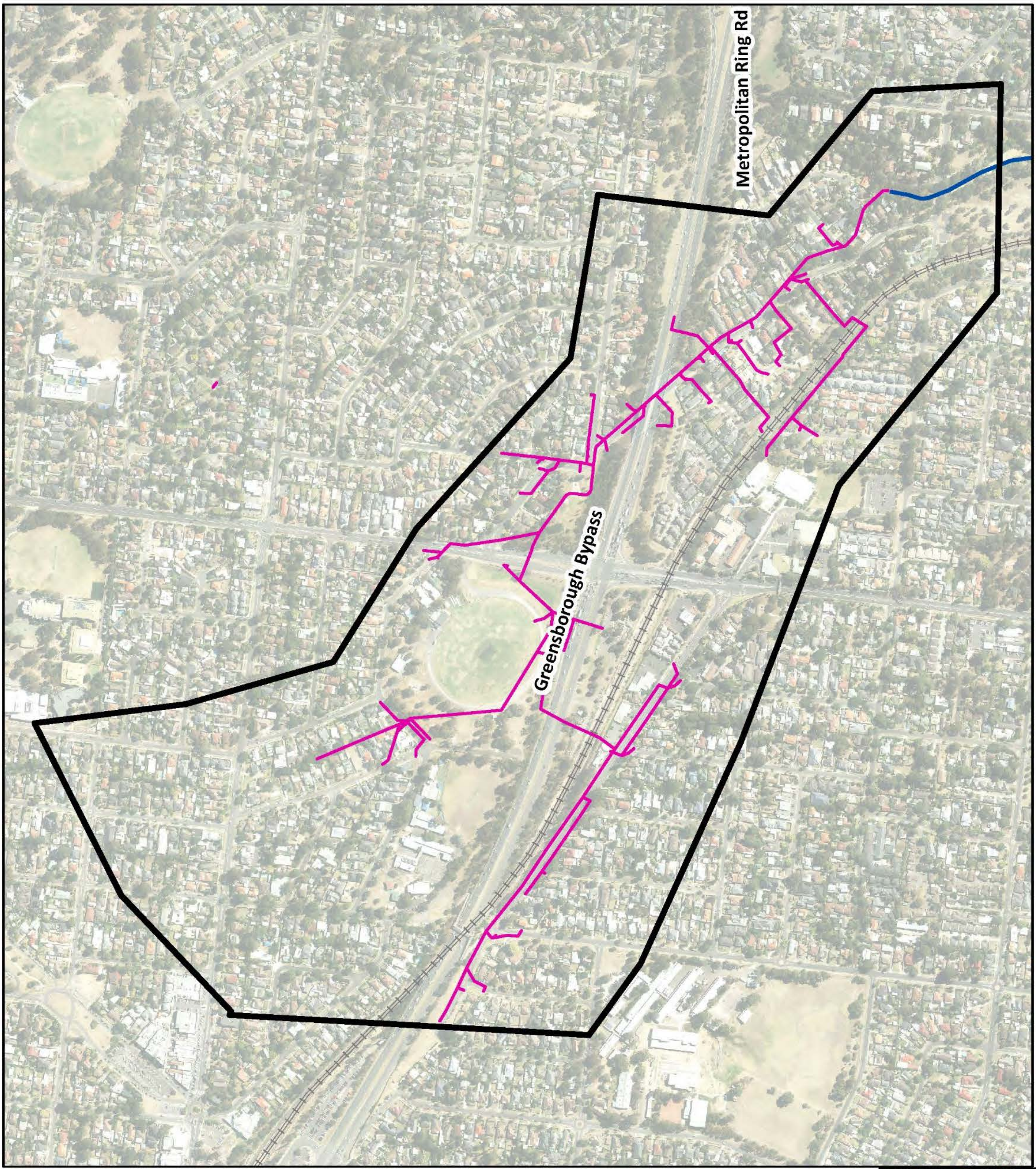
5.3.3 Kempston Street Main Drain flooding

Detailed hydrologic and hydraulic modelling has been undertaken for Kempston Street Main Drain to identify and map the drainage system. This was developed using RORB (a hydrologic modelling package) and TUFLOW (a two-dimensional hydraulic modelling package), in general accordance with the Melbourne Water guidelines for flood studies. These models are based on available information including an existing conditions model recently prepared by Engeny for the City of Banyule and Melbourne Water.

The key assumptions that were adopted in the hydrologic and hydraulic analysis are:

- The hydraulic model extent includes approximately 300 metres either side of the Greensborough Bypass, as shown in Figure 5-4.
- Hydraulic model inflows are based upon a modified RORB model initially provided by Melbourne Water (20/07/2018) and have been consistently applied for the hydraulic modelling of both existing and proposed conditions.
- In the absence of suitable historical data for calibration or verification, flood flows and resultant levels are estimated based on standard methodologies.
- A range of design events were modelled including small (frequent) and large (rarer) events for a range of durations as shown in Appendix D2.
- Inlets were modelled without blockage in both existing and proposed conditions.
- A downstream rating curve was developed based on the gradient of the channel downstream and surrounding topography.
- Roughness values have been developed based on different types of land use and ground cover, aerial photography and a site visit, with guidance from the Flood Mapping Projects Guidelines and Technical Specifications (Melbourne Water, 2016).

The Kempston Street Main Drain hydraulic model setup is shown in Figure 5-4.



LEGEND

- Hydraulic Model Boundary
- Underground drainage included in model
- River
- Stream
- Channel
- Drain

Paper Size A4

0 50 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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North East Link Project

Job Number	31-35006
Revision	C
Date	22/10/2018

Hydraulic model setup
Kempston Street Main Drain Figure 5-4

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

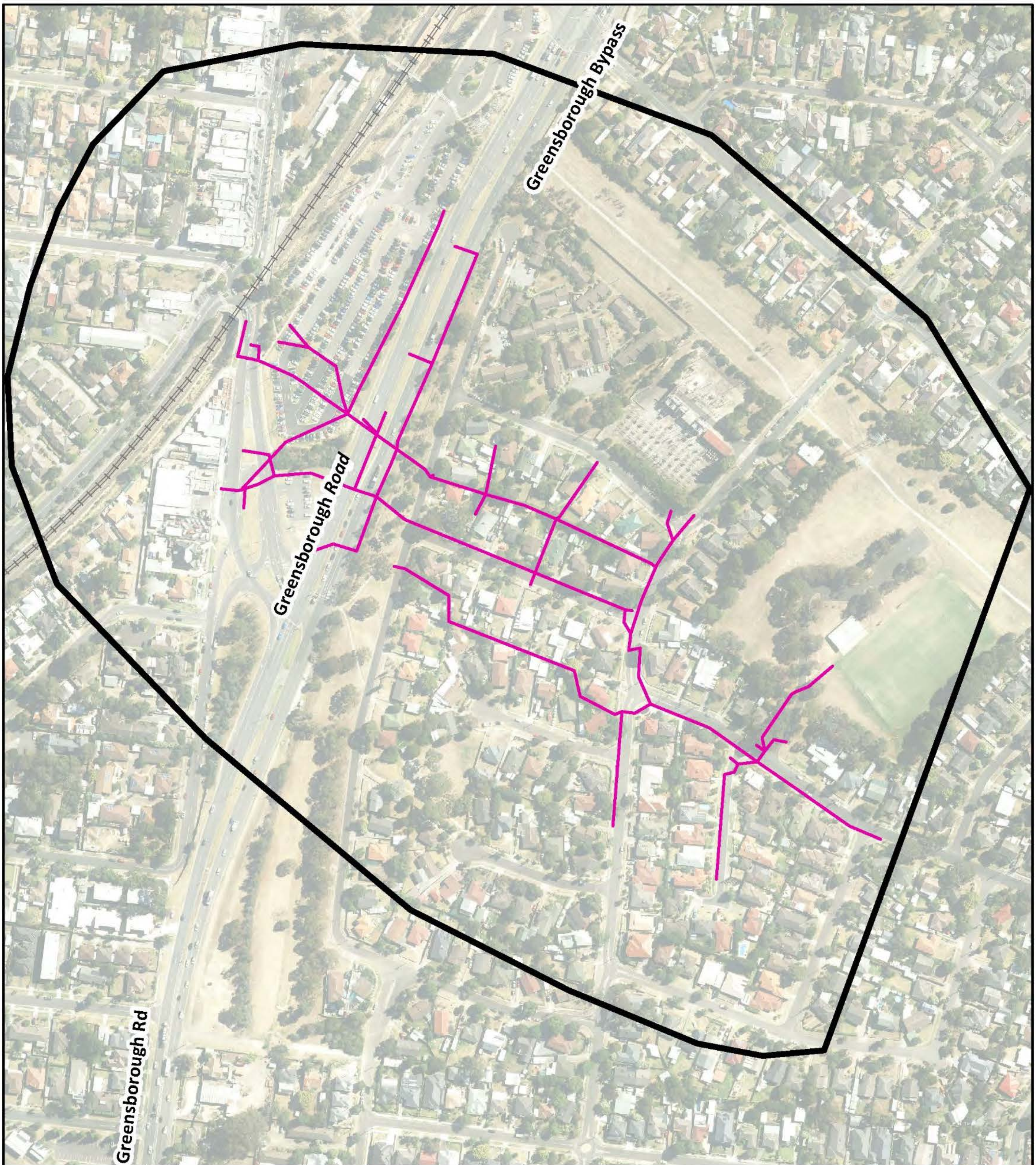
5.3.4 Watsonia Station drain flooding

Detailed hydrologic and hydraulic modelling has been undertaken for the Watsonia Station drain to identify and map the drainage system. This was developed using RORB (a hydrologic modelling package) and TUFLOW (a two-dimensional hydraulic modelling package), in general accordance with the Melbourne Water guidelines for flood studies. These models are based on available information including an existing conditions model recently prepared by Engeny for the City of Banyule and Melbourne Water.

The key assumptions that adopted in the hydrologic and hydraulic analysis are:

- The hydraulic model extent includes approximately 300 metres either side of the Greensborough Bypass, as shown in Figure 5-5.
- Hydraulic model inflows are based upon the modified RORB model data provided by Melbourne Water c/o Engeny (20 August 2018) and have been consistently applied for the hydraulic modelling of both existing and proposed conditions.
- In the absence of suitable historical data for calibration or verification, flood flows and resultant levels are estimated based on standard methodologies.
- A range of design events were modelled including small (frequent) and large (rarer) events for a range of durations as shown in Appendix D3.
- Inlets were modelled without blockage in both existing and proposed conditions.
- A downstream rating curve was developed based on the gradient of the channel downstream and surrounding topography.
- Roughness values have been developed based on different types of land use and ground cover, aerial photography and a site visit, with guidance from the Flood Mapping Projects Guidelines and Technical Specifications (Melbourne Water, 2016).

The Watsonia Station drain hydraulic model setup is shown in Figure 5-5.



LEGEND

- Hydraulic Model Boundary
- Underground drainage included in model
- River
- Stream
- Channel
- Drain

Paper Size A4

0 20 40 80

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number 31-35006
Revision C
Date 22/10/2018

Hydraulic model setup
Watsonia Station drain

Figure 5-5

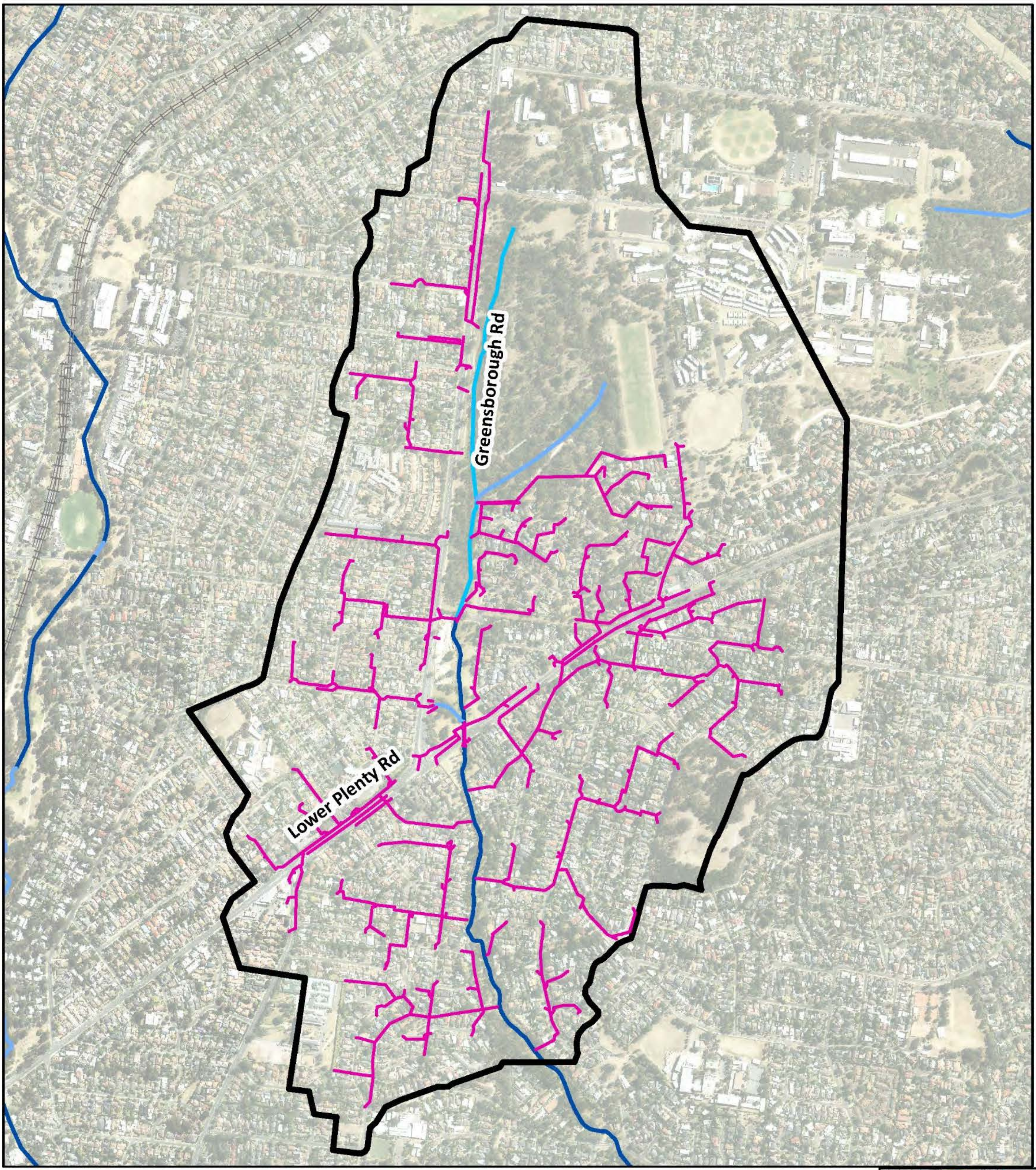
5.3.5 Banyule Creek flooding

Hydrologic and hydraulic modelling has been undertaken for Banyule Creek to identify and map the natural and constructed surface water drainage system. This was developed using RORB (a hydrologic modelling package) and TUFLOW (a two-dimensional hydraulic modelling package), in general accordance with the Melbourne Water guidelines for flood studies. These models are based on available information including an existing conditions model recently prepared by Engeny for the City of Banyule and Melbourne Water.

The key assumptions that were adopted in the hydrologic and hydraulic analysis are:

- The hydraulic model extent includes the upper catchment and reach of Banyule Creek and associated floodplain area (downstream boundary approximately 800 metres south of Lower Plenty Road) as shown in Figure 5-6.
- Hydraulic model inflows were based on data included with the provided base hydraulic TUFLOW model, although a RORB model was subsequently provided (5 October 2018). These inflows have been consistently applied for the hydraulic modelling of both existing and proposed conditions.
- In the absence of suitable historical data for calibration or verification, flood flows and resultant levels are estimated based on standard methodologies.
- A range of design events were modelled including small (frequent) and large (rarer) events for a range of durations as shown in Appendix D4.
- Inlets were modelled without blockage in both existing and proposed conditions.
- The potential impacts of climate change have been modelled using an increased rainfall intensity for the 1% AEP design event.
- The major hydraulic connections and local drainage connections and systems were modelled for the upper catchment, based on data provided by Melbourne Water (10 January 2018).
- A downstream boundary rating curve was developed based on the slope of the channel at the downstream boundary.
- The topography of Banyule Creek and surrounds has been developed based on a Digital Elevation Model (DEM) provided by Melbourne Water (10 January 2018); no bathymetric survey was available for Banyule Creek.
- Roughness values have been developed with guidance from the Flood Mapping Projects Guidelines and Technical Specifications (Melbourne Water, 2016) and the data provided by Melbourne Water (10 January 2018).

The Banyule Creek hydraulic model setup is shown in Figure 5-6.



LEGEND

- Hydraulic Model Boundary
- Underground drainage included in model
- River
- Stream
- Channel
- Drain

Paper Size A4
0 85 170 340
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

North East Link
North East Link Project

Job Number 31-35006
Revision C
Date 22/10/2018

Hydraulic model setup
Banyule Creek

Figure 5-6

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_KBM_... 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

5.3.6 Yarra River flooding

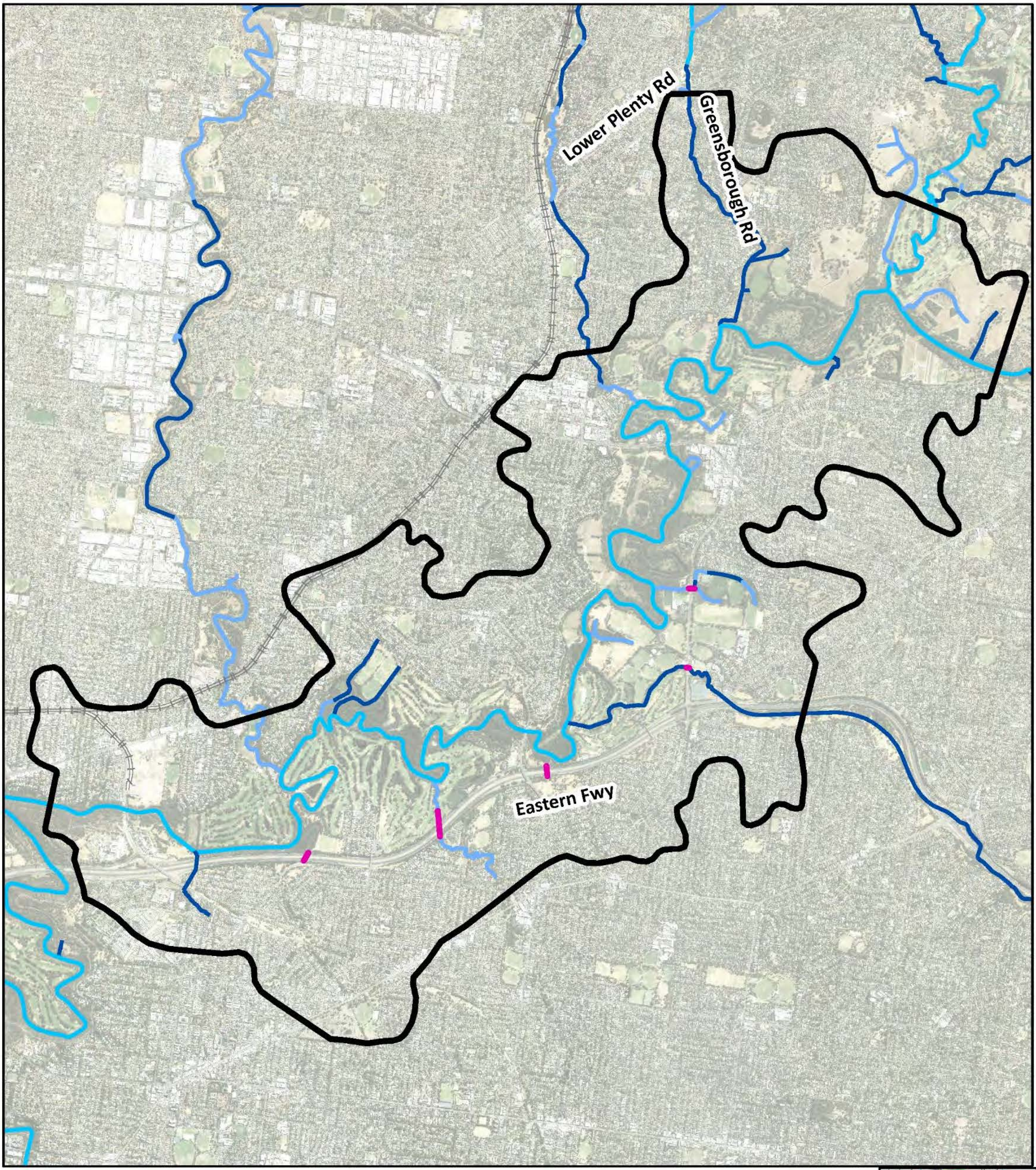
Hydrologic and hydraulic modelling has been undertaken for Yarra River to identify and map the natural and constructed surface water drainage system. This was developed using RORB (a hydrologic modelling package) and TUFLOW (a two-dimensional hydraulic modelling package), in general accordance with the Melbourne Water guidelines for flood studies. Melbourne Water has been consulted through the development of this model.

The key assumptions that were adopted in the hydrologic and hydraulic analysis are:

- The area of interest for this assessment is outlined in Figure 5-7 as the hydraulic model boundary. Additional modelling using a separate TUFLOW model was prepared downstream to improve the downstream boundary of the main model. A hydraulic model which extended further upstream was also used to better understand the potential propagation of any flooding impacts upstream.
- Flow from the Yarra River catchment upstream has been incorporated along with flows from Plenty River, Banyule Creek, Salt Creek, Koonung Creek and Darebin Creek. These flows were generated from a RORB model provided by Melbourne Water (03 July 2017). These flows were obtained using models adjusted to match Melbourne Water's designated flood levels in the Chandler Basin (referring to the extensive floodplain storage nominally upstream of the Chandler Highway in Fairfield and downstream of Manningham Road West or Banksia Street). Melbourne Water's design flows and levels are largely based on interpretation of observed 1934 flood levels.
- The events modelled included 63.2%, 39.4%, 18.1%, 10%, 5%, 2%, 1%, 0.5%, 0.2%, 0.1%, 0.05% AEPs and PMF for existing conditions to assist in understanding the potential ponding levels in Chandler Basin. For the proposed conditions the 10%, 5%, 2%, 1% and 0.5% AEP events were modelled. All events were modelled with a 72-hour duration design storm event as shown in Appendix D5.
- Assessment of the potential impact of climate change has been informed by modelling with an increase in rainfall intensity.
- The model includes a representation of the new Chandler Highway Bridge currently being constructed.
- Bridges and other structures were modelled without blockage in both existing and proposed conditions.
- Major hydraulic connections, including various shared use path conduits beneath the Eastern Freeway, Glass Creek, Koonung Creek and the culvert connection to the storage at Trinity Grammar School Sporting Complex were included based on information obtained from the GIS data provided by Melbourne Water (25 October 2017) and VicRoads As-Constructed drawings (03 August 2017).
- A downstream boundary rating curve developed based on modelling of the Yarra River reach downstream of Chandler Highway.
- The topography of floodplain and surrounds has been developed based off supplied DELWP LiDAR (13 July 2017) and Melbourne Water DEM (15 August 2017). Bathymetric survey was utilised to determine the centreline of the Yarra River as provided by Melbourne Water (20 July 2017).

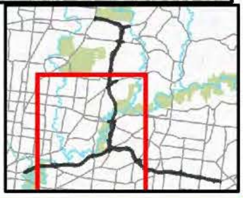
- Roughness values have been developed based on different types of land use and ground cover, aerial photography and a site visit, with guidance from the Flood Mapping Projects Guidelines and Technical Specifications (Melbourne Water, 2016).

The Yarra River hydraulic model setup is shown in Figure 5-7.



LEGEND

- Hydraulic Model Boundary
- Underground drainage included in model
- River
- Stream
- Channel
- Drain



Paper Size A4

0 280 560 1,120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

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Hydraulic model setup
Yarra River

Figure 5-7

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_KBM_NaP.mxd 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

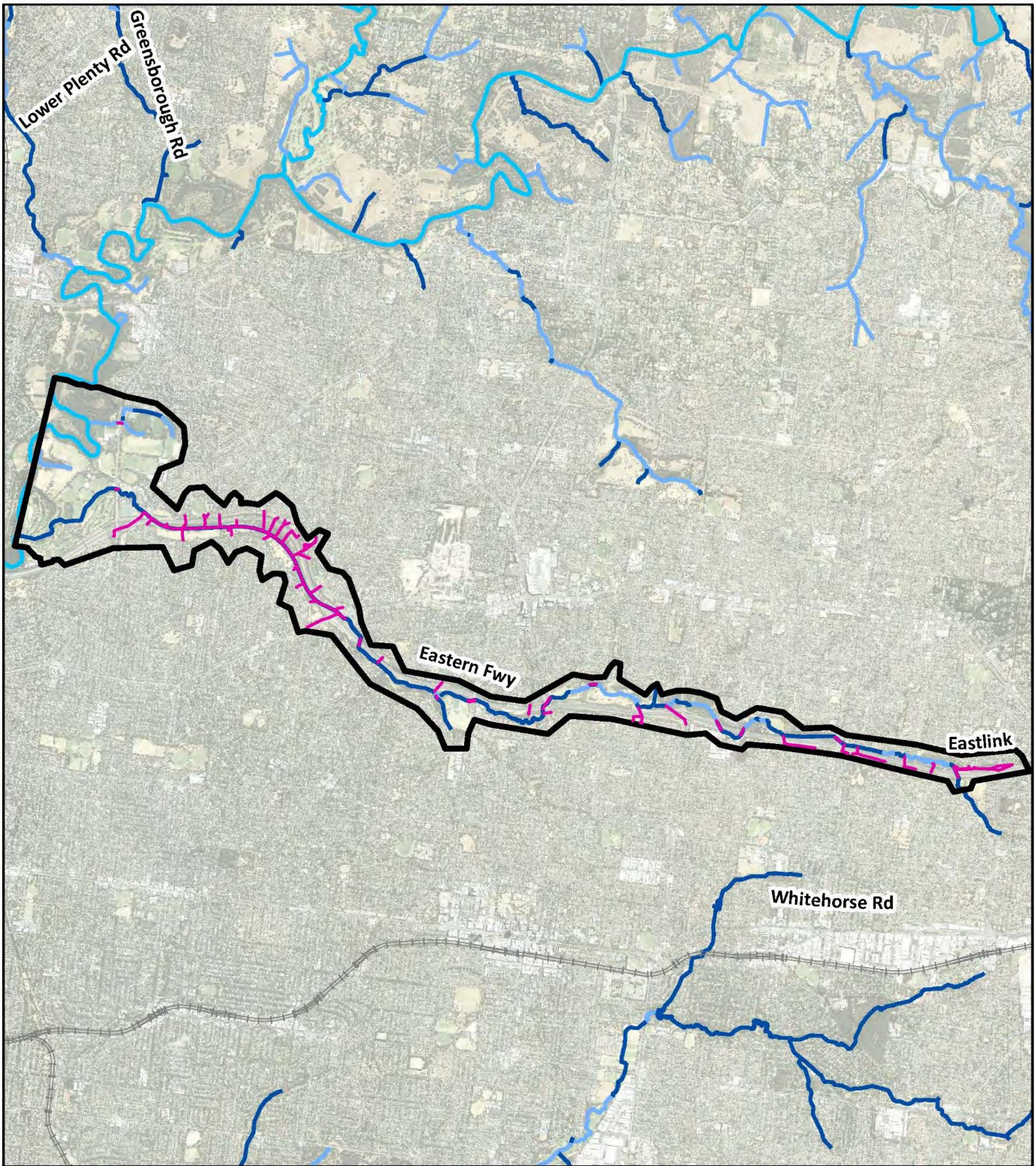
5.3.7 Koonung Creek flooding

Hydrologic and hydraulic modelling has been undertaken for Koonung Creek to identify and map the drainage system. This was developed using RORB (a hydrologic modelling package) and TUFLOW (a two-dimensional hydraulic modelling package), in general accordance with the Melbourne Water guidelines for flood studies. Melbourne Water has been consulted throughout the development of this model.

The key assumptions that were adopted in the hydrologic and hydraulic analysis are:

- The hydraulic model extent includes, the entire 12-kilometre length of Koonung Creek, as shown in Figure 5-8. While inflows have been carefully considered, flooding on the tributary streams (local catchment flooding) has not been explicitly modelled.
- Hydraulic model inflows were estimated using a RORB model of Koonung Creek and have been consistently applied for the hydraulic modelling of both existing and proposed conditions.
- In the absence of suitable historical data for calibration or verification, flood flows and resultant levels are estimated based on standard methodologies.
- A range of design events were modelled including small (frequent) and large (rarer) events for a range of durations as shown in Appendix D6.
- The key hydraulic structures were modelled, based on information obtained from the GIS data provided by Melbourne Water (25 October 2017), and VicRoads drawings (supplied by Vic Roads and Melbourne Water on 03 August 2017, 07 September 2017 and 25 July 2018). In a number of locations data gaps have been filled based on engineering judgement, these assumptions are expected to be corrected as information becomes available.
- 1% AEP Yarra River and Koonung Creek flood events do not occur concurrently.
- A downstream boundary water level of 11 mAHD was adopted based on the assumption the Yarra River would be at the top of bank level.
- The topography of Koonung Creek and surrounds has been developed based on a supplied DELWP LiDAR (03 August 2017) and Melbourne Water DEM (15 August 2017); no bathymetric survey was available for Koonung Creek.
- Roughness values have been developed based on different types of land use and ground cover, aerial photography and a site visit with guidance from the Flood Mapping Projects Guidelines and Technical Specifications (Melbourne Water, 2016).

The Koonung Creek hydraulic model setup is shown in Figure 5-8.



LEGEND

- Hydraulic Model Boundary
- Underground drainage included in model
- River
- Stream
- Channel
- Drain

Paper Size A4

0 335 670 1,340

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

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North East Link Project

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Hydraulic model setup
Koonung Creek

Figure 5-8

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_KCM_S4.mxd 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

5.3.8 Water quality

The following methodology was used to assess existing water quality:

- Data available from Melbourne Water, EPA Victoria and Waterwatch was reviewed. This data has been compared with water quality objectives as per the 2018 SEPP (Waters) and an assessment has been provided.
- An overview of water quality and waterway health in the creeks and waterways that intersect with the project has been developed based on information available in Melbourne Water's Port Phillip and Westernport Regional River Health Strategy and Melbourne Waters Index of River Conditions (IRC) ranking (Melbourne Water, 2007).

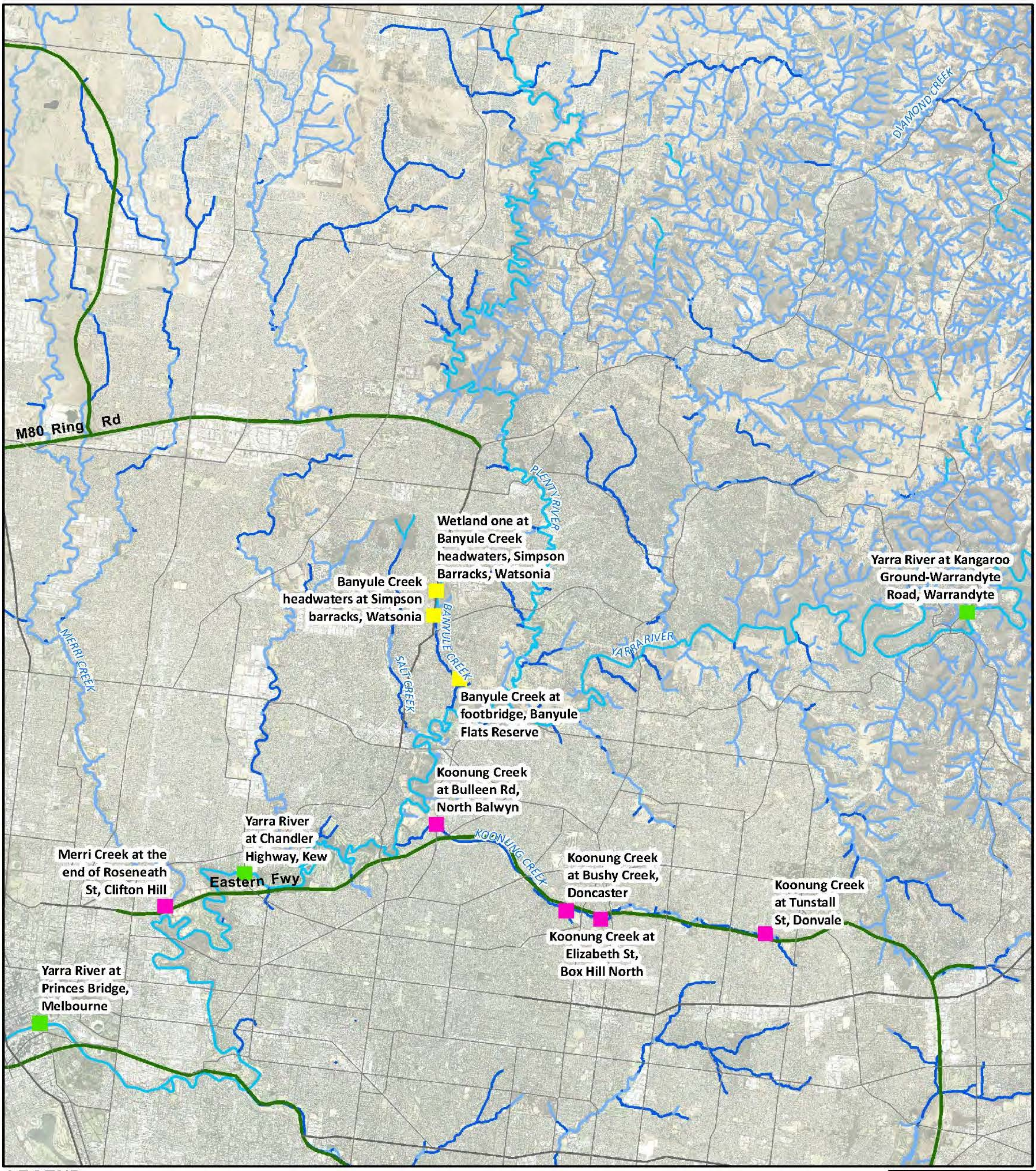
These are discussed in more detail in the following subsections.

Water quality monitoring data

To characterise the existing conditions water quality, monitoring data has been collected and collated for the creeks and rivers within the study area. Figure 5-9 shows the locations of the water quality monitoring sites used in the assessment.

The following water quality data was collected for this assessment:

- Melbourne Water: Melbourne Water has a Water Quality Monitoring Program (WQMP) that covers 136 sites across Greater Melbourne (Melbourne Water, 2015). The most recent published water quality data from Melbourne Water's WQMP is for the 12 months across 2015. Data from three sites has been used to inform this assessment of water quality in the Yarra River. The locations of these sites are shown in Figure 5-9.
- EPA Victoria: historical water quality monitoring data was provided by EPA Victoria (EPA Victoria, 2018). From this data four sites have been used to inform an assessment of water quality in Koonung Creek. The locations of these sites are shown in Figure 5-9.
- Waterwatch: water quality monitoring data was obtained from Waterwatch for three sites in the study area. From this data all three sites have been used to inform an assessment of water quality in Banyule Creek.

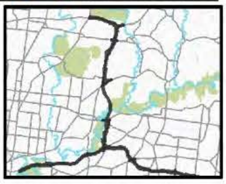


LEGEND

- River
- Stream
- Channel
- Drain

Water Quality Monitoring Sites

- EPA
- MW
- Waterwatch



Paper Size A4

0 800 1,600 3,200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number | 31-35006
Revision | B
Date | 15/03/2019

Water quality monitoring sites assessed for North East Link Figure 5-9

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_ 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

Regional River Health Strategy

The project has reviewed the Melbourne Water Regional River Health Strategy to obtain an overview of water quality and waterway health in the creeks and waterways that intersect with the project. The strategy includes condition assessments for the Yarra River, Koonung Creek, and Banyule Creek. The condition descriptions in the Regional River Health Strategy have been based on an assessment of five criteria: water quality, aquatic life, habitat and stability, vegetation, and flow.

Index of River Conditions

The Index of River Conditions (IRC) ranking system has been reviewed to obtain an overview of water quality and waterway health in the creeks and waterways that intersect with the project. The ranking system was developed by Melbourne Water to provide an overall assessment of the condition and health of the rivers and creeks within their management area (Melbourne Water, 2007). The IRC has been established using DELWP's Index of Stream Condition (ISC) (Department of Environment and Primary Industries, 2013). The IRC rankings are different from the ISC rankings as they have been modified to account for the urban rivers and creeks.

5.3.9 Geomorphology

Geomorphology relates to the study of landforms and their origin. The existing condition geomorphological assessment for surface water has focused on the waterway stability. To establish the existing geomorphic conditions for North East Link the following methodology was adopted:

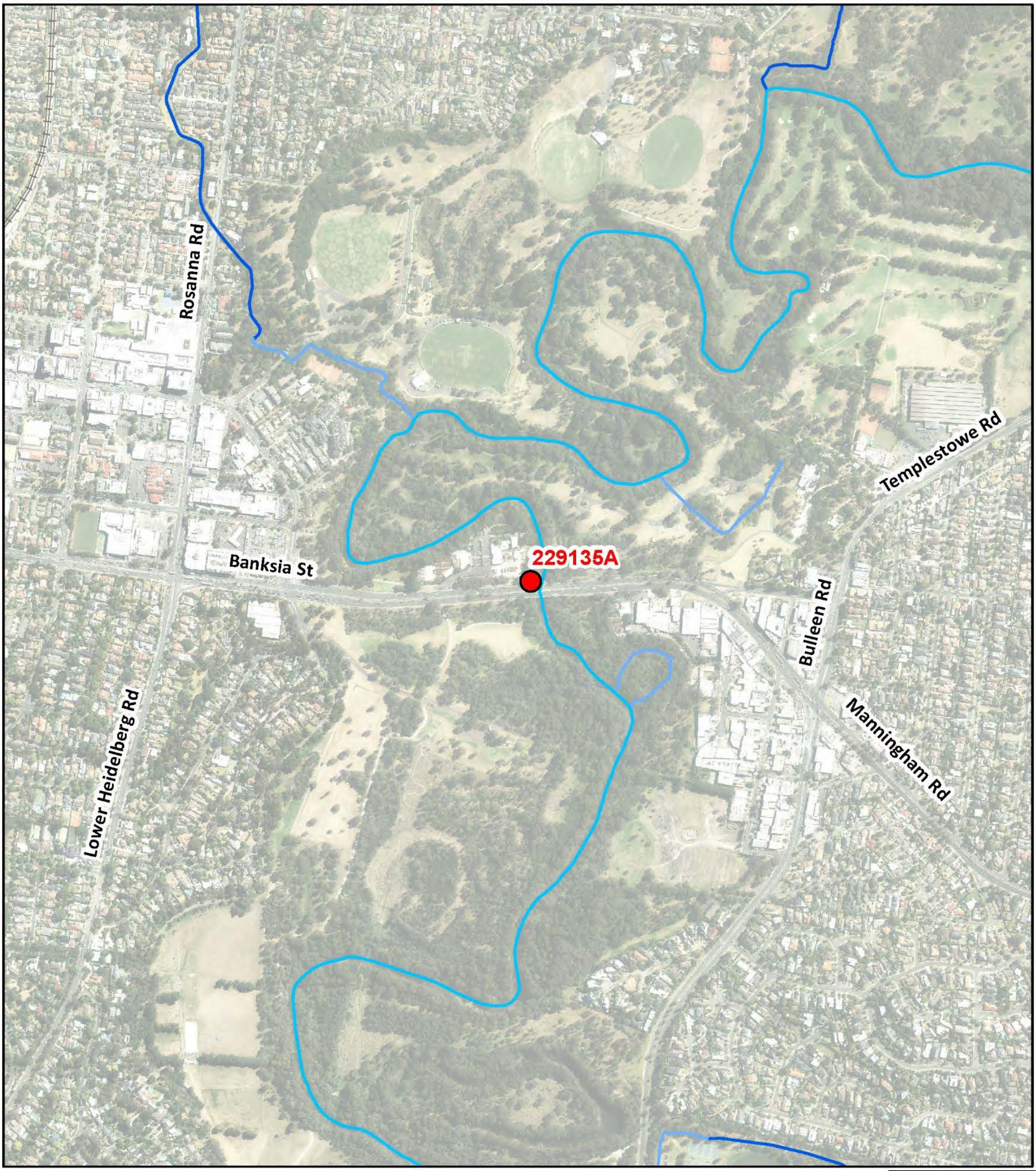
- A review of previous geomorphic assessments (Sinclair Knight Merz, 2005)
- Site inspections undertaken on 17 July 17 and 07 May 18 to provide a series of current geomorphic observations.

Information obtained from these sources has been used to determine the existing geomorphic condition with respect to waterway stability for Banyule Creek, Koonung Creek and the Yarra River.

5.3.10 Flow assessment

A flow assessment has been undertaken to document the low flow conditions for the Yarra River to inform the impact assessment for Technical report Q – Ecology (see Section 2.3).

Utilising flow gauge data provided by Melbourne Water for the location shown in Figure 5-10, flow duration curves were developed for the Yarra River.



LEGEND

- Melbourne Water gauge location
- River
- Stream
- Channel
- Drain

Paper Size A4

0 65 130 260

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

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Melbourne Water
Gauge Location

Figure 5-10

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_KBM_NoRemoved 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

5.4 Risk assessment

An environmental risk assessment has been completed to identify environmental risks associated with construction and operation of North East Link. The risk-based approach shown in Figure 5-11. Figure 5-1 is integral to the EES as required by Section 3.1 of the scoping requirements and the Ministerial guidelines for assessment of the environmental effects under the *Environment Effects Act 1978*.

Specifically the EES risk assessment aimed to:

- Systematically identify the interactions between project elements and activities and assets, values and uses
- Focus the impact assessment and enable differentiation of significant and high risks and impacts from lower risks and impacts
- Inform development of the reference project to avoid, mitigate and manage environmental impacts
- Inform development of EPRs that set the minimum outcomes necessary to avoid, mitigate or manage environmental impacts and reduce environmental risks during delivery of the project.

This section presents an overview of the EES risk assessment process. EES Attachment III Environmental risk report describes each step in the risk assessment process in more detail and contains a consolidated risk register.

This technical report describes the risks associated with the project on [technical discipline]. Wherever risks relating to this study are referred to, the terminology ‘risk XX01’ is used. Wherever EPRs relating to this study are referred to, the terminology ‘EPR XX1’ is used. The risk assessment completed for this study is provided as Appendix A.

5.4.1 Risk assessment process

The risk assessment process adopted for North East Link is consistent with AS/NZS ISO 31000:2009 Risk Management Process. The following tasks were undertaken to identify, analyse and evaluate risks:

- Use existing conditions and identify applicable legislation and policy to establish the context for the risk assessment
- Develop likelihood and consequence criteria and a risk matrix
- Consider construction and operational activities in the context of existing conditions to determine risk pathways
- Identify standard controls and requirements (Environmental Performance Requirements (EPRs)) to mitigate identified risks
- Assign likelihood and consequence ratings for each risk to determine risk ratings considering design, proposed activities and standard EPRs.

While there are clear steps in the risk process, it does not follow a linear progression and requires multiple iterations of risk ratings, pathways and EPRs as the technical assessments progress. Demonstrating this evolution, a set of initial and residual risk ratings and EPRs are produced for all technical reports. Figure 5-11 shows this process.

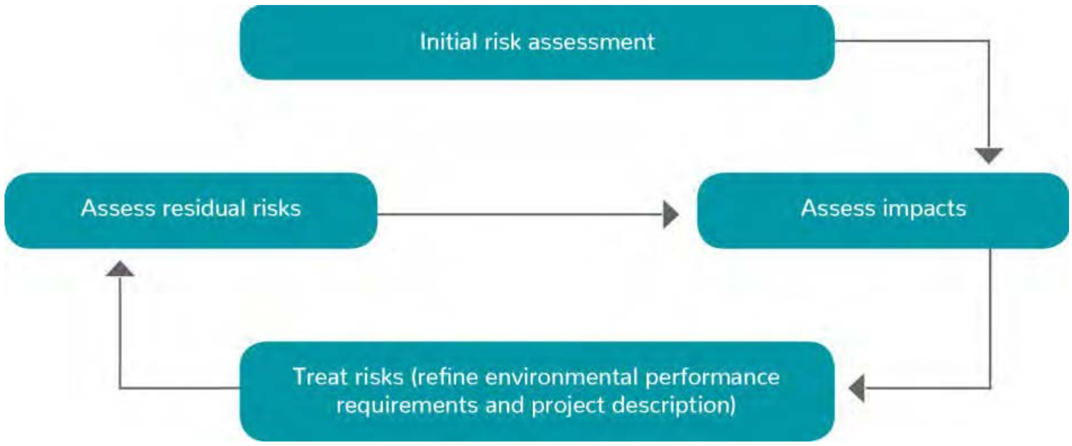


Figure 5-11 Risk analysis process

Rating risk

Risk ratings were assessed by considering the consequence and likelihood of an event occurring. In assessing the consequence, the extent, severity and duration of the risks were considered. These are discussed below.

Assigning the consequences of risks

'Consequence' refers to the maximum credible outcome of an event affecting an asset, value or use. Consequence criteria as presented in Chapter 4 – EES assessment framework, were developed for the North East Link EES to enable a consistent assessment of consequence across the range of potential environmental effects. Consequence criteria were assigned based on the maximum credible consequence of the risk pathway occurring. Where there was uncertainty or incomplete information, a conservative assessment was made on the basis of the maximum credible consequence.

Consequence criteria have been developed to consider the following characteristics:

- Extent of impact
- Severity of impact
- Duration of threat.

Severity has been assigned a greater weighting than extent and duration as this is considered the most important characteristic.

Each risk pathway was assigned a value for each of the three characteristics, which were added together to provide an overall consequence rating.

Further detail on the consequence criteria are provided in Chapter 4 – EES assessment framework.

Assigning the likelihood of risks

'Likelihood' refers to the chance of an event happening and the maximum credible consequence occurring from that event. The likelihood criteria are presented in Table 5-1.

Table 5-1 Likelihood of an event occurring

Planned	The event is certain to occur
Almost certain	The event is almost certain to occur one or more times a year
Likely	The event is likely to occur several times within a five-year timeframe
Possible	The event may occur once within a five-year timeframe
Unlikely	The event may occur under unusual circumstances but is not expected (ie once within a 20-year timeframe)
Rare	The event is very unlikely to occur but may occur in exceptional circumstances (ie once within a 100-year timeframe)

Risk matrix and risk rating

Risk levels were assessed using the matrix presented in Table 5-2.

Table 5-2 Risk matrix

Likelihood	Consequence				
	Negligible	**Minor**	**Moderate**	**Major**	**Severe**
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
Planned	Planned	Planned	Planned	Planned	Planned

Planned events

North East Link would result in some planned events, being events with outcomes that are certain to occur (ie planned impacts such as land acquisition), as distinct from risk events where the chance of the event occurring and its consequence is uncertain. Although planned events are not risks, these were still documented in the risk register as part of Attachment III – Risk report for completeness and assigned a consequence level in order to enable issues requiring further assessment or treatment to be prioritised.

These planned events were assessed further through the impact assessment process.

Risk evaluation and treatment

The risk assessment process was used as a screening tool to prioritise potential impacts and the subsequent level of assessment undertaken as part of the impact assessment. For example, an issue that was given a risk level of medium or above, or was identified as a planned event with a consequence of minor or above, would go through a more thorough impact assessment process than a low risk.

Where initial risk ratings were found to be 'medium' or higher, or were planned events with a consequence of 'minor' or higher, options for additional or modified EPRs or design changes were considered where practicable. It should be noted that the consequence ratings presented in the risk register are solely based on the consequence criteria presented in Attachment III – Risk report. Further analysis and evaluation of the impacts potentially arising from both risks and planned events and information on how these would be managed is provided in section 8 and 9.

5.5 Impact assessment

The following section describes the methodology used for the surface water impact assessment for the construction and operation phases of North East Link. Impact assessments completed for the construction phase of the project are by necessity somewhat conceptual, and qualitative, in recognition of the potential variability in the construction methodology and staging of the works.

5.5.1 Construction

The impact assessment for the construction of North East Link has reviewed the construction activities that could adversely impact flooding, water quality, geomorphology and water supply within the study area. The importance of understanding the potential impacts on these aspects is described in Section 5.2 and defined in the evaluation objectives and scoping requirements in Section 2.1 and Section 2.2 respectively.

Flooding

A qualitative assessment of the potential impacts on flooding during construction of the project has been undertaken. The qualitative assessment has identified activities that are expected to occur during construction of the project that could adversely impact floodplains and overland flow paths. Impacts on flooding from construction could include obstruction of overland flows, reduction in floodplain storage or changing existing flow conditions downstream of construction sites. Construction activities that could potentially impact floodplains and overland flow paths in the study area are described in Section 8.1.

In exceptional cases where the qualitative assessment indicated that construction activities may have impacts which may be difficult to avoid or mitigate, modelling was undertaken to further inform the assessment.

As a part of Melbourne Water Standards for infrastructure projects in flood-prone areas (refer Appendix B) it is a requirement that temporary construction works are modelled once construction activities are adequately defined to demonstrate the achievement of Melbourne Water’s guiding principles (Appendix B).

Water quality

The assessment of the potential impacts on water quality during construction of the project has been undertaken through a qualitative assessment. The qualitative assessment has identified activities that are expected to occur during construction of the project that could adversely impact the water quality of local and receiving waters. Impacts on water quality from construction could include the transportation of pollutants and hazardous materials in stormwater to surface waters. Construction activities identified that could potentially impact water quality in the study area are described in Section 8.2.

Geomorphology

The assessment of the potential impacts on geomorphic conditions during construction of the project has been undertaken through a qualitative assessment. The qualitative assessment has identified activities that are expected to occur during construction of the project that could adversely impact erosion and waterway stability. Impacts on waterway stability from construction could include the removal of soil, the changing of soil, and/or temporary diversions altering flow conditions downstream of construction. Construction activities identified that could potentially impact geomorphic conditions in the study area are described in Section 8.3.

Water supply

The assessment of the potential impacts on water supply during construction of the project has been undertaken through a qualitative assessment. The qualitative assessment has identified activities that are expected to occur during construction of the project that could adversely impact the water supply of end users. Construction activities identified that could potentially impact water supply in the study area are described in Section 8.4.

5.5.2 Operation

The impact assessment for the operation of North East Link has identified permanent new structures and activities that could potentially impact flooding, water quality, geomorphology and water supply within the study area. The importance of understanding the potential impacts on these aspects is described in Section 5.2 and defined in the evaluation objectives and scoping requirements as seen in Section 2.1 and Section 2.2 respectively.

Flooding

The assessment of the potential impacts on flooding during the operation of the project has been undertaken through a quantitative assessment. The quantitative assessment has included hydraulic modelling of the proposed design/s using TUFLOW software for Banyule Creek, Koonung Creek, Yarra River and Yando Street Main Drain. TUFLOW is a model used to simulate hydraulic behaviours in rivers, floodplains and urban drainage environments in order to examine potential changes in flood behaviour associated with the project.

Modelling of the proposed design/s has been undertaken based on the hydraulic models developed to define the existing conditions (see Section 5.3.1). The proposed design/s has been included in the models to quantify the potential impacts to floodplains and overland flow paths. Modelling has been undertaken in accordance with Melbourne Water requirements for the project (see Section 4.2.2.1). Modelling has included the assessment of climate change as per Melbourne Water standards for infrastructure projects in flood-prone areas (see Section 4.2.2.1).

The potential impacts from the operation of North East Link on flooding in the study area are described in Section 8.4.

Water quality

Additional paved surfaces from new roads and infrastructure associated with the project would increase surface water runoff, with a higher pollutant load which can impact water quality. In addition, the project is located in a metropolitan area where there is limited land available for retarding basins, wetlands and other drainage features to treat additional surface water runoff. The assessment of the potential impacts on water quality during the operation of North East Link has applied the following methodology:

- A concept drainage strategy was developed to identify where additional paved surfaces would be created as a result of the project, and to identify potential locations for retention and treatment of surface water runoff from these additional paved surfaces
- Modelling was undertaken using MUSIC (developed by eWater) to calculate resulting pollutant loads from the implementation of the proposed treatment locations to determine if these locations provide sufficient space to meet SEPP (Waters) and BPEMG objectives for urban stormwater. MUSIC is an industry

accepted model in Victoria that enables the representation of surface water pollutant generation and treatment process.

The potential impacts from the operation of North East Link on water quality in the study area are described in more detail in Section 9.2.

Geomorphology

The assessment of the potential impacts on geomorphic conditions during the operation of North East Link has been undertaken through a qualitative assessment. The qualitative assessment has identified activities that are expected to occur during the operation of North East Link that could adversely impact waterway stability. Operational activities identified that could potentially impact geomorphic conditions in the study area are described in Section 9.3.

Water supply

The assessment of the potential impacts on water supply during the operation of North East Link has been undertaken through a qualitative assessment. The qualitative assessment has identified activities that are expected to occur during the operation of North East Link that could adversely impact the water supply of end users. Operational activities identified that could potentially impact water supply in the study area are described in Section 9.4.

5.6 Rationale

The methodology for the impact assessment has been developed to address the evaluation objectives and key issues within the scoping requirements for the project. The range of issues that exist within the scope of surface water for the project has required that different methodologies are adopted for the key aspects of surface water. The rationale for the methodologies adopted is described below:

Flooding: The definition of the existing conditions and impact assessment for flooding has adopted a methodology of hydrologic and hydraulic modelling using industry accepted methods. Hydrologic modelling has been completed using RORB. Hydraulic modelling has been completed using TUFLOW. The modelling approach is generally based on Melbourne Water technical specifications for flood modelling and mapping.

Water quality: The methodology for the definition of the existing conditions for water quality was adopted based on the data availability in the study area. The comparison with SEPP (Waters) water quality objectives (see Section 4.2.2.2.1) was considered an appropriate methodology to determine the existing water quality conditions in the study area.

The methodology for the impact assessment for water quality for the construction of the project was adopted based on the scope of water quality issues identified that could adversely impact the water quality of local and receiving waters during construction. A qualitative assessment was considered appropriate for the construction of the project.

The methodology for the impact assessment for water quality for the operation phase of the project was modelling using MUSIC software. The results were assessed against BPEMG.

Geomorphology: The methodology for the impact assessment was chosen by considering how to adequately characterise the geomorphic conditions with the potential to affect bed and bank stability from the available information. A qualitative assessment was considered appropriate for the construction of the project.

Water supply: The methodology for the assessment for water supply impact was adopted based on the scope of the water supply issues. The approach of a qualitative assessment was considered appropriate for the construction of the project.

5.6.1 Use of Australian Rainfall and Runoff (ARR) Guidelines

Background to the new version

Australian Rainfall and Runoff (ARR) is the industry-recognised guideline for undertaking hydrologic investigations in Australia. For the last 30 years these investigations have adopted methodologies from the 1987 version (last updated in 1997). Around 10 years ago, Engineers Australia commenced a project to update ARR to reflect the additional data and new technologies and science available. The project has spent over $15 million developing a new guideline for use in Australia ($4 million from the Department of Climate Change and Energy Efficiency (DCCEE), $3 million from the Bureau of Meteorology (BoM), $5.15 million from Geoscience Australia (GA) and $3.5 million from Engineers Australia (EA) and its members).

ARR 2016 was released as a draft for industry comment in November 2016 by Geoscience Australia. The data and methodologies in ARR 2016 are very different to those in ARR 1987. It benefits from a more extensive database of additional rainfall stations and more than 30 years of additional data, analysed with more rigorous methodologies, as well as a greater awareness of uncertainty and variability.

The defined methodologies of ARR 1987 for calculating specific flow estimates from a catchment have been largely replaced with more rigorous and computationally intensive methodologies to produce distributions of results which can be analysed and interpreted. Experience to date suggests that although the results will typically vary as a result of applying the new data and methodologies, they are often in fairly good agreement.

At present, ARR 2016 is:

- Still a draft for industry consultation with all sections described as 'Advanced Draft' or 'Working Draft', noting that ARR 2016 states that '*where relevant this draft of ARR can be used in practice prior to finalisation*'. (<http://book.arr.org.au.s3-website-ap-southeast-2.amazonaws.com/> accessed on 20 June 2018). Updates are progressing, "Book 9 – Runoff in Urban Areas" was updated to 'Final Draft' status on the 4 December 2018. (<http://www.arr-software.org/arr_pdfs/ARR_Book9_FinalDraft181204.pdf> accessed on 21-01-2019)
- Still expected to change – in a December 2017 update it was noted that industry feedback is being progressively addressed and that '*A new version of ARR will be released in the first quarter of 2018 with the identified errors corrected*'. (<http://arr.ga.gov.au/news> accessed on 20 June 18). This new release has not yet occurred nor has there been any formal notification of known errors.
- Not readily used with existing models and results – for instance ARR 2016 includes a disclaimer '*care should be taken when combining inputs derived using ARR 1987 and methods described in this document*'. Similar statements are also made by the Bureau of Meteorology.
- Significantly different to ARR 1987 and includes processes and philosophies which are in many ways improvements – however many aspects are still being trialled with techniques and understanding still being developed and so industry is yet to fully adopt ARR 2016 although this will progressively change.

Application to North East Link

The 1987 version of ARR, as last updated in 1997, has been adopted for the EES assessment and as the basis of the reference project. In 2017 shortly after the project commenced, Melbourne Water advised that NELP should proceed on the basis of using ARR 1987. Given this advice from Melbourne Water, the characteristics of the project, and the limited experience with and draft status of ARR 2016, the use of ARR 1987 for this EES is considered appropriate.

However, in the near future it is expected that further experience with and updates to ARR 2016 will see its wide spread adoption as the dominant guideline, superseding ARR 1987. Accordingly, it is important to investigate the potential implications of the new guidelines. A sensitivity analysis to better understand the implications of the new guidelines has been commenced. Some preliminary results of this sensitivity analysis are provided in Appendix F.

A brief discussion of this sensitivity analysis is provided in Section 6.1.2, 6.2.2, 6.5.2, 9.1.1 and 9.1.2. In summary the sensitivity testing indicates that for the locations tested absolute flood levels increased slightly in both existing and with project conditions such that the afflux between existing and post project conditions remained fairly constant. Neither ARR 1987 or ARR 2016 were a good match for the Yarra River flood levels which are based on observed levels from the 1934 event. The sensitivity testing of the significance of the two guidelines indicates that:

1. Estimates of afflux are not significantly affected by the choice of either guideline.
2. For ungauged catchments the choice of guideline may affect the estimates of absolute design levels. On this project this is primarily of significance with respect to the tunnel portals:
    i) For the northern portals, the flows are generally small enough that the barriers protecting the portals would be higher than needed for the PMF for other reasons such as excluding pedestrian, cars and bicycles. This same relatively high barrier to flood level height generally also applies to the adjacent northern sections of the open cut roads.
    ii) For the southern portals, the levels are based on a hydrologic model which has been conservatively adjusted to match historic flood levels and so is less dependent on the choice of guideline.

The above findings indicate the analysis undertaken for the EES is relatively insensitive to the choice of ARR guidelines at least with respect to flooding and cross drainage. There may be implications with respect to WSUD features and longitudinal road drainage but ARR 2016 is rather limited in its coverage of these aspects. Given the above considerations it is considered appropriate for the EES analysis to be based on ARR 1987 with consideration of climate change in accordance with ARR 2016 recommendations.

5.7 Limitations, uncertainties and assumptions

The following limitations, uncertainties and assumptions apply to the study:

- Although some sensitivity analysis is ongoing, the conclusions and in particular the EPRs are well supported by the completed assessments.
- Climate change assessments have been undertaken in accordance with Melbourne Water standards for infrastructure projects in flood-prone areas.

- Hydrologic modelling of all events is based on methods and data outlined in Australian Rainfall and Runoff (ARR) 1987 and existing models except as noted otherwise.
- Any use which a third party makes of this document, or any reliance on or decision to be made based on this document, is the responsibility of such third parties. The client and the project team accepts no responsibility for damages, if any, suffered by any third party as a result of decisions or actions made based on this document.
- Information such as GIS asset databases, 'as constructed drawings' and models have been obtained from a range of external sources including Melbourne Water, councils, VicRoads, other authorities and groups. It is only practical to verify or independently review some of this information. The data is sometimes provided with caveats or with missing or obviously inconsistent information. These indicated limitations have been considered, and known limitations addressed and or documented adequately and the data has been considered suitable for the specific purpose of informing the EES. While care has been taken in interpreting the provided data, neither the original provider nor the project team take any responsibility for incorrect or inaccurate information or make any representation as to its suitability for other purposes.

5.7.1 Modelling limitations

The following limitations apply to the modelling:

- Modelling results are suitable for informing the EES process and would be subject to further checking, revision and interpretation during subsequent design stages.
- The modelling produces results with many significant figures, the precision of these results should not be taken as an indication of their accuracy.
- The modelling is in general more reliable in producing comparisons between existing and proposed conditions and less reliable in producing absolute levels.
- It should be noted that all models are simplified representations of reality. The following partial extract, from ARR Revision Project 15: Two Dimensional Modelling in Urban and Rural Floodplains (November 2012) summarises as fundamental advice:
  – All models are coarse simplifications of very complex processes. No model can therefore be perfect, and no model can represent all of the important processes accurately.
  – Model accuracy and reliability will always be limited by the accuracy of the terrain and other input data.
  – Model accuracy and reliability will always be limited by the reliability/uncertainty of the inflow data.
  – A poorly constructed model can usually be calibrated to the observed data but will perform poorly in events both larger and smaller than the calibration data set.
  – No model is 'correct' therefore the results require interpretation.
  – A model developed for a specific purpose is probably unsuitable for another purpose without modification, adjustment, and recalibration. The responsibility must always remain with the modeller to determine whether the model is suitable for a given problem (task).

5.8 Stakeholder engagement

Stakeholders and the community were consulted to support the preparation of the North East Link EES and to inform the development of the project and understanding of potential impacts. Table 5-3 lists specific engagement activities that have occurred in relation to surface water, with more general engagement activities occurring at all stages of the project.

Table 5-3 Stakeholder engagement for surface water

Activity	When	Matters discussed	Outcome
Presentation to Melbourne Water	31 August 2017	Yarra Strategic Plan	Melbourne Water provided an overview of its approach to the development of the Yarra Strategic Plan
Presentation to Melbourne Water	29 March 2018	Project overview	A wide range of Melbourne Water teams were briefed on North East Link
Meeting with Melbourne Water	3 July 2018	Yarra Strategic Plan	Shared and confirmed understanding
Regular meetings with Melbourne Water	Ongoing	Hydrological and hydraulic modelling	Ongoing discussions to confirm that surface water modelling for the project is being undertaken to Melbourne Water requirements
Correspondence with EPA Victoria	16 January 2018	Design standards for spill containment on freeways	EPA Victoria confirmed that this is a matter for VicRoads
Meeting with Manningham City Council	03 May 2018	Project overview	Exchange of relevant information to support surface water assessment and assist with further design development
Meeting with Boroondara City Council	26 July 2018	Project overview	Exchange of relevant information to support surface water assessment and assist with further design development
Meeting with Whitehorse City Council	4 June 2018	Project overview	Exchange of relevant information to support surface water assessment and assist with further design development
Meeting with Banyule City Council	4 July 2018	Project overview	Exchange of relevant information to support surface water assessment and assist with further design development
Trinity Grammar School Sporting Complex – site visit with Property Manager	20 February 2018	Dam for the irrigation of sporting ovals	Understanding of the operation of the dam and its connection to the Yarra River floodplain. Stormwater management within the complex
Parks Victoria	15 October 2018	Project Overview	Improved understanding of project and respective requirements

5.9 Community feedback

In addition to consultation undertaken with specific stakeholders, consultation has been ongoing with the community throughout the design development and the EES process. Feedback relevant to the surface water assessment is summarised in Table 5-4, along with where and how we have addressed those topics in this report.

Table 5-4 Community consultation feedback addressed by surface water

Issues raised during community consultation	How it's been addressed
Flooding at the Bulleen Road and Manningham Road interchanges and tunnel portals.	The potential for flooding of the portals has been assessed in Section 8.1 of this report. A risk based approach considering the characteristics of the floodplain led to the selection of minimum flood barrier heights as required to protect public safety, levels of service and project assets.
Impacts to Koonung Creek, particularly from realignment or covering.	Impacts associated with flooding and water quality are addressed in Sections 8 and 9 of this report. Potential impacts would be managed by a combination of design refinements and management approaches to comply with project requirements and EPRs. Ecological impacts associated with the changes are discussed in Technical report Q – Ecology.
Impacts to Banyule Creek, particularly from realignment or covering and potential downstream flows to Banyule Flats.	Impacts associated with flooding and water quality are addressed in Sections 8 and 9 of this report. Potential impacts would be managed by a combination of design refinements and management approaches to comply with project requirements and EPRs. Ecological impacts associated with the changes are discussed in Technical report Q – Ecology.
Impacts to surface water systems at Banyule Flats from tunnelling.	Ground movement and or changes to groundwater could potentially impact surface water systems at Banyule Flats for instance differential settlement may reduce the effectiveness of existing surface water controls. The risks associated with groundwater movement at Banyule Flats from Tunnelling are discussed in Technical Report M – Ground Movement
Water run-off from construction sites and pollution of creeks and waterways and requests for more information about how this would be managed.	The Project requirements and EPRs require a Surface Water Management Plan which included requirements for implementation of best practise sediment erosion and spill control measures in conjunction with monitoring to verify that the Surface Water Management Plan is adequately achieving the desired outcomes.
Water run-off from road surfaces during operation and pollution of creeks and waterways and requests for more information about how this would be managed.	Runoff from road surfaces would typically pass through a treatment train which would as required provide storage for spill capture, flow attenuation and water treatment to achieve best practise water treatment objectives and manage the risks of flooding and spills.
Water levels at Bolin Bolin Billabong.	Bolin Bolin Billabong is fed from a number of sources including Yarra River floods none of these sources would be impacted by the project. During extended dry seasons water levels in the Billabong are perhaps more reliant on groundwater sources. While Yarra River flood levels and flooding frequency would remain unchanged the potential for the project to influence groundwater levels in this area is discussed in the Technical report N – Groundwater.

Issues raised during community consultation	How it's been addressed
Interaction between groundwater and surface water systems during construction and operation, particularly impacts to creeks, rivers and billabongs.	The potential interactions between groundwater and surface water systems have been considered. These systems do have some linkages such as at Bolin Bolin Billabong as discussed above however in general there is minimal potential for impacts on one system to influence the other, for example: Changes in groundwater could potentially affect base flow in downstream surface water bodies however as any such changes are likely to be small in volume with respect to surface water timescales and because base flow is typically such a small portion of most surface flows, it is unlikely that groundwater would have any significant effect on surface water conditions except in limited circumstances under low flow conditions. Likewise change in surface water could potentially affect groundwater recharge however as such changes are likely to be small in magnitude, extent and duration they are unlikely to have any significant impact on the groundwater system which is relatively slow to respond. Increasing the area of road pavements may locally change the infiltration and runoff processes sufficiently to result in local surface water impacts in some locations which have required assessment and as appropriate mitigation. At a regional scale change in the perviousness of the catchment are relatively minor and unlikely to be significant for either surface water or groundwater systems.

5.10 Peer review

This assessment has been independently peer reviewed by David Fuller of Entura. The peer reviewer reviewed and provided feedback on drafts of this report, as well as the methodology, approach, assumptions and assessment criteria applied to the assessment. The peer reviewer's methodology is set out in his peer review report, which also included addressing whether there were any additional matters which should be considered as part of the impact assessment in order to address the EES scoping requirements, 'public works' Order or to otherwise adequately assess the likely impacts of the project relevant to this assessment or the management of those impacts. The peer reviewer also considered whether there were any gaps or matters in this assessment which they disagreed with. The final peer review report is attached as Appendix G of this report. This sets out the peer reviewer's conclusions, and whether all of their recommendations have been addressed in this report.

6. Existing conditions

The following sections describe the existing conditions of the surface water systems in the study area. The project intersects with a number of waterways as shown in Figure 5-2. These include Banyule Creek, Koonung Creek, Yando Street Main Drain, Kempston Street Main Drain and the Yarra River. Existing conditions have been defined for each of these waterways with respect to flooding, water quality, geomorphology and water supply. The importance and methodology of defining the existing conditions for these aspects of the project is detailed in Section 5.2.

6.1 Yando Street Main Drain

Yando Street Main Drain is an underground drainage system that crosses under Greensborough Bypass from west to east just south of the M80 Ring Road interchange. An overland flow path and culvert under Greensborough Bypass is associated with this drain. This drainage system outfalls into the Plenty River 800 metres downstream of the Greensborough Bypass.

The majority of the Yando Street Main Drain catchment is urbanised. The catchment includes some open space areas with a range of vegetation densities. The proportion of urbanisation within a catchment influences the volume of stormwater runoff and therefore the volume of surface water flow generated. Additionally the proportion of urbanisation has an impact on the amount of contaminants being discharged to waterways.

The extent of the drainage system for Yando Street Main Drain is shown in Figure 6-1.

The underground drain runs east adjacent to Hakea Street through parklands before crossing Greensborough Bypass. Downstream of Greensborough Bypass, the drain crosses through parklands, along residential property boundaries and becomes an open channel upstream of Pinehills Drive and Kalparrin Gardens.

Where the drain crosses Greensborough Bypass, a culvert conveys the overland flow under Greensborough Bypass. This culvert is also used as a shared use path. The shared use path follows the underground drain and connects Hakea Street in the west to Yando Street in the east.

Yando Street Main Drain is a 1.8-metre diameter pipe at the Greensborough Bypass. The culvert (shared use path) that connects Hakea Street to Yando Street is 2.4-metres high and 3.2-metres wide.

6.1.1 Flooding

Depth results from modelling of the 1% AEP flood are shown in Figure 6-2.

Overland flow along the Yando Street Main Drain occurs when the capacity of the underground drainage system is exceeded. This occurs for events with an AEP of between 10% and 5% AEP. In the 1% AEP event, the peak flows through the culvert and drainage system, documented in Table 6-1 are approximately 6 m^3/s and 10 m^3/s respectively. The Greensborough Bypass acts as a restrictive barrier to overland flows which pond on the upstream side behind the freeway.

The peak flood depths in the 1% AEP event are shown in Figure 6-2. The 1% AEP flood extent is generally confined within the vicinity of the drain where the Yando Street Main Drain crosses the freeway. The flood extent currently inundates nearby private residential properties both upstream and downstream of the Greensborough Bypass.

Depth results for a wider range of design events at selected locations are provided in Appendix D1.

Table 6-1 Yando Street Main Drain existing condition results

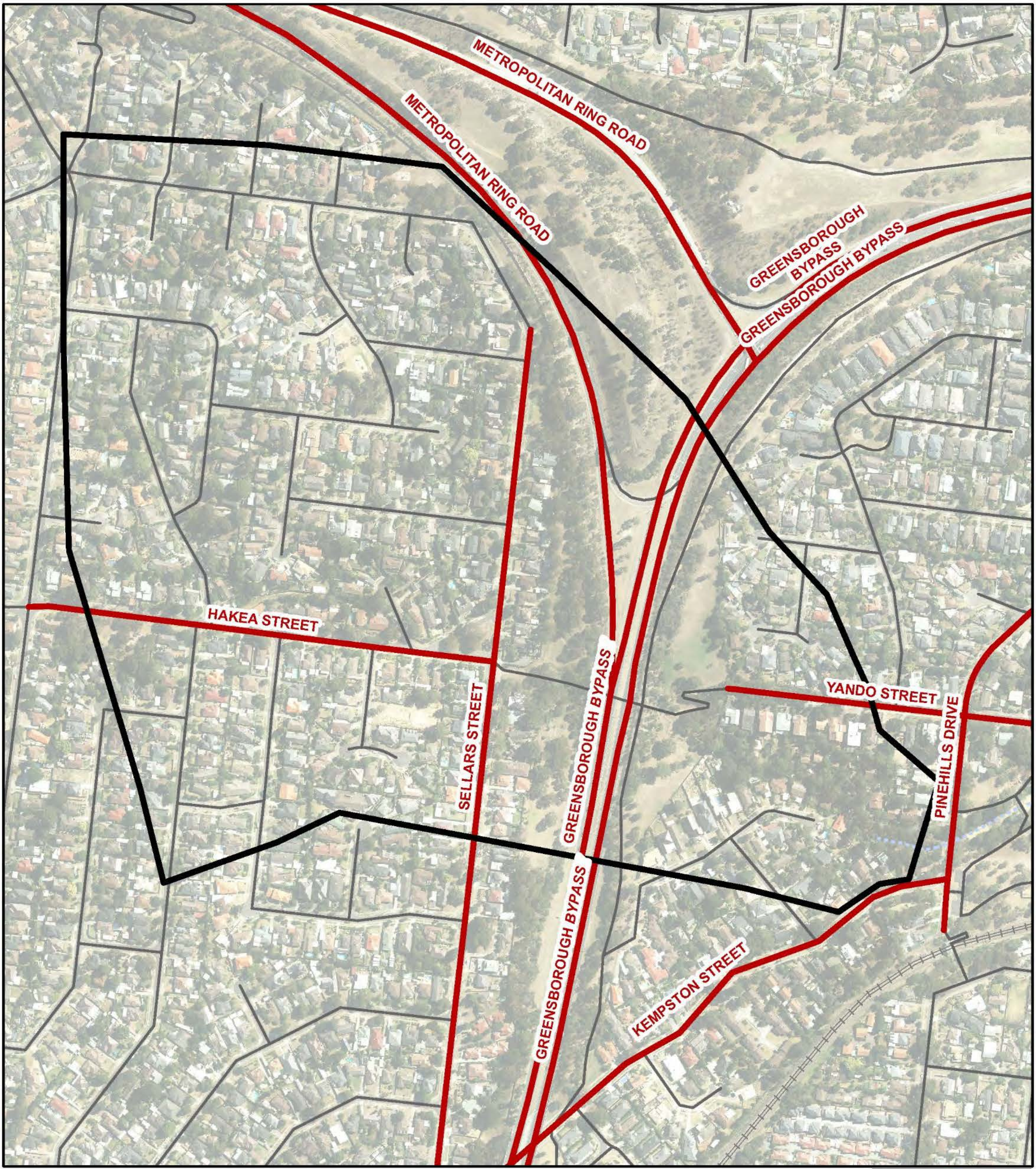
AEP (%)	Overland Flow through shared use path culvert (m^3/s)	Flows within underground drainage system (m^3/s)	Flood levels u/s of Greensborough Highway (mAHD)	Flood levels d/s of Greensborough Highway (mAHD)
63.2% (1 year ARI)	0	4.0	-	-
39.4% (2 year ARI)	0	5.4	-	-
18.1% (5 year ARI)	0	7.9	-	-
10%	0	9.1	-	-
5%	1.3	9.9	53.5	52.7
2%	4.0	10.2	54.1	52.9
1%	6.1	10.6	54.5	52.9
1% climate change	16.6	11.9	55.5	53.2

The timing of the peak flow and water level influences the nature of the flooding within a catchment. Due to the short reach lengths and steep nature of the catchment flash flooding occurs within Yando Street Main Drain, with the peak flow and or water level occurring within one to two hours of the rain starting.

6.1.2 ARR 2016 sensitivity

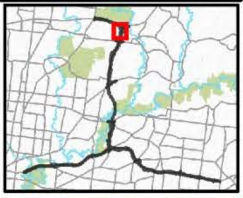
Existing condition peak 1% AEP flood depths associated with Yando Street Main Drain were estimated using ARR 2016 methodologies and compared at a number of locations throughout the catchment. A summary of these results in provided in Appendix F which indicates that higher levels were consistently estimated. All observed increases were less than 200 millimetres and most were considerably less than 100 millimetres.

As there is inadequate historic flood data available for the Yando Street Main Drain to reliably calibrate a flood model, both the ARR 1987 and the ARR 2016 estimated 1% AEP flood conditions are based on recommended parameters. Given the substantial differences between the two methodologies the small sample of results indicates that the estimates are remarkably consistent. This consistency is not necessarily representative of other larger or smaller events at this location or for other locations.



LEGEND

- Hydraulic model boundary
- Roads of interest
- River
- Stream
- Channel
- Drain



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Overview
Yando Street Main Drain

Figure 6-1

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

Peak Flood Depth (m)

<0.05	0.16 - 0.20	0.51 - 1.20	8.01 - 12.00
0.05 - 0.10	0.21 - 0.25	1.21 - 2.00	12.01 - 18.00
0.11 - 0.15	0.26 - 0.30	2.01 - 4.00	
	0.31 - 0.50	4.01 - 8.00	

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Map Projection: Transverse Mercator
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1% AEP peak flood depth
Yando Street Main Drain

Figure 6-2

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

6.2 Kempston Street Main Drain

The Kempston Street Main Drain is an underground drainage system that crosses under Greensborough Bypass from west to east just north of Grimshaw Street. The associated overland flow path runs in a north-east direction through the A.K Lines Reserve to Banyule City Council's retarding basin immediately upstream (south) of Grimshaw Street. Overtopping from the retarding basin will cross Grimshaw Street, flow through a reserve, and under the Greensborough Bypass along the Kempston Street underpass and continue along Kempston Street until it joins the Yando Street Main Drain immediately upstream of Kalparrin Gardens and ultimately discharges to the Plenty River.

The Kempston Street Main Drain catchment is fully urbanised with some grassed reserves for power transmission and recreation. The proportion of urbanisation within a catchment influences the volume of stormwater runoff and the amount of contaminants discharged to waterways.

Planning scheme flood overlays and the Banyule Flood Emergency Plan both indicate that numerous properties are likely to be flooded in a 1% AEP event.

The extent of the drainage system for Kempston Street Main Drain is shown in Figure 6-3.

6.2.1 Flooding

The peak flood depths in the 1% AEP event are shown in Figure 6-4, The 1% AEP flood extent is generally confined within the vicinity of the drain where the Kempston Street Main Drain crosses the freeway. Under existing conditions, the flood extent inundates nearby private residential properties both upstream and downstream of the Greensborough Bypass.

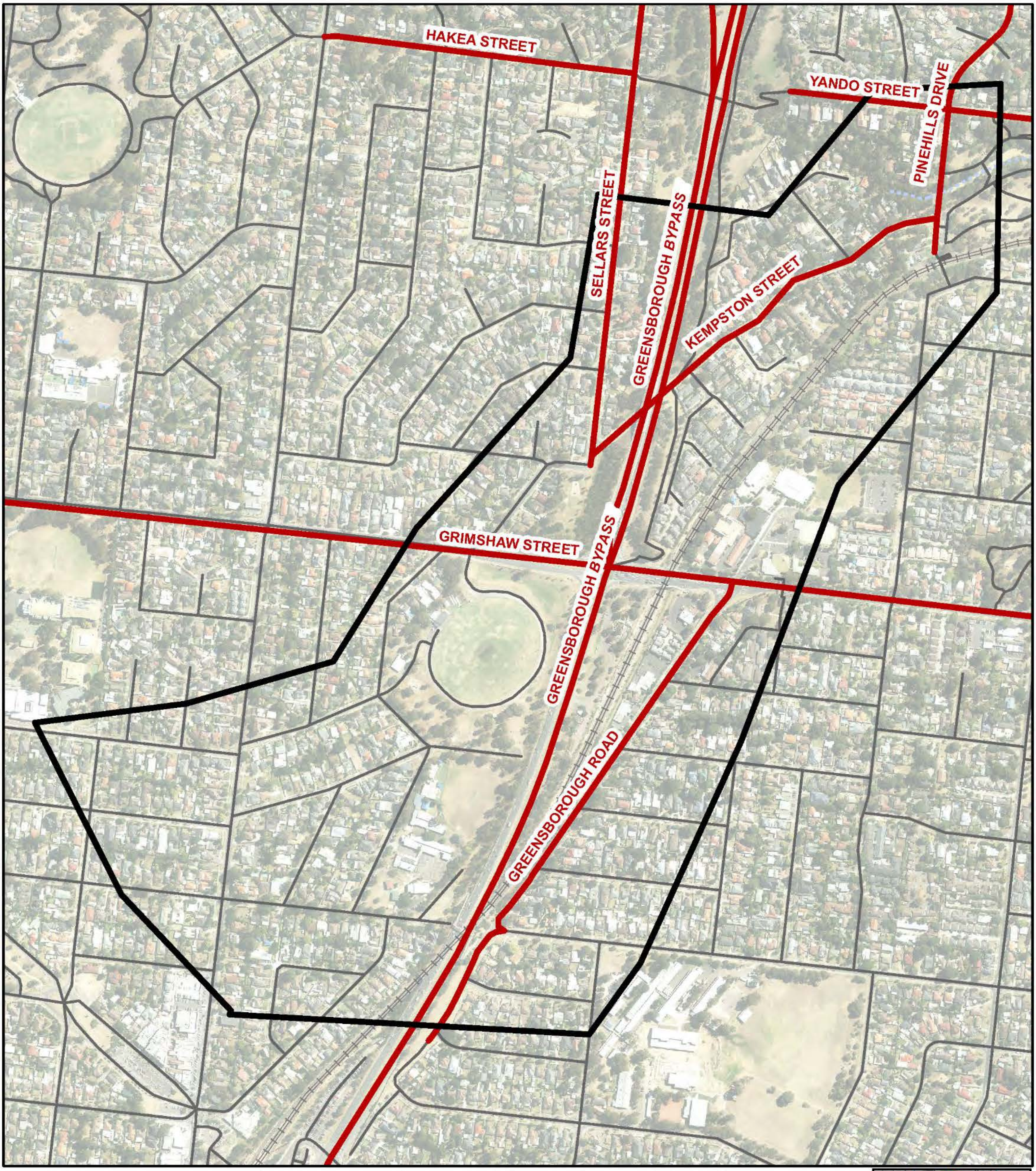
The timing of the peak flow and water level influences the nature of the flooding within a catchment. Due to the short reach lengths and steep nature of the catchment flash flooding occurs within Kempston Street Main Drain, with the peak flow and or water level occurring within one to two hours of the rain starting.

Depth results for a wider range of design flood events at selected locations are provided in Appendix D2.

6.2.2 ARR 2016 sensitivity

Existing condition peak 1% AEP flood depths associated with the Kempston Street Main Drain were estimated using ARR 2016 methodologies and compared at a number of locations throughout the catchment. A summary of these results in provided in Appendix F which indicates that higher levels were consistently estimated. Downstream of Grimshaw Street all comparison points were considerably less than 100 millimetres. Depths on Grimshaw Street were estimated to increase by around 200 millimetres with a corresponding increase in the depth in the retarding basin in the AK Lines reserve of over 450 millimetres. An independent analysis of the impact of adopting the newer guidelines and data of ARR2016 to estimate flood levels upstream (south) of Grimshaw Street undertaken for Banyule City Council by Engeny also indicated large increases in the estimate of existing levels upstream of Grimshaw Street.

As there is inadequate historic flood data available for the Kempston Street Main Drain to reliably calibrate a flood model, both the ARR 1987 and the ARR 2016 estimated 1% AEP flood conditions are based on recommended parameters. Given the substantial differences between the two methodologies the variation in the small sample of results is not unexpected. The relative consistency in results downstream of Grimshaw Street is perhaps due in part to attenuation of the retarding basin. The observed differences are not expected to be representative of other larger or smaller events at this location or for other locations.



LEGEND

- Hydraulic model boundary
- Roads of interest
- River
- Stream
- Channel
- Drain

Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Overview
Kempston Street Main Drain Figure 6-3

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

Peak Flood Depth (m)

<0.05	0.51 - 1.20
0.05 - 0.10	1.21 - 2.00
0.11 - 0.15	2.01 - 4.00
0.16 - 0.20	4.01 - 8.00
0.21 - 0.25	8.01 - 12.00
0.26 - 0.30	12.01 - 18.00
0.31 - 0.50	

Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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1% AEP peak flood depth
Kempston Street Main Drain Figure 6-4

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

6.3 Watsonia Station drain

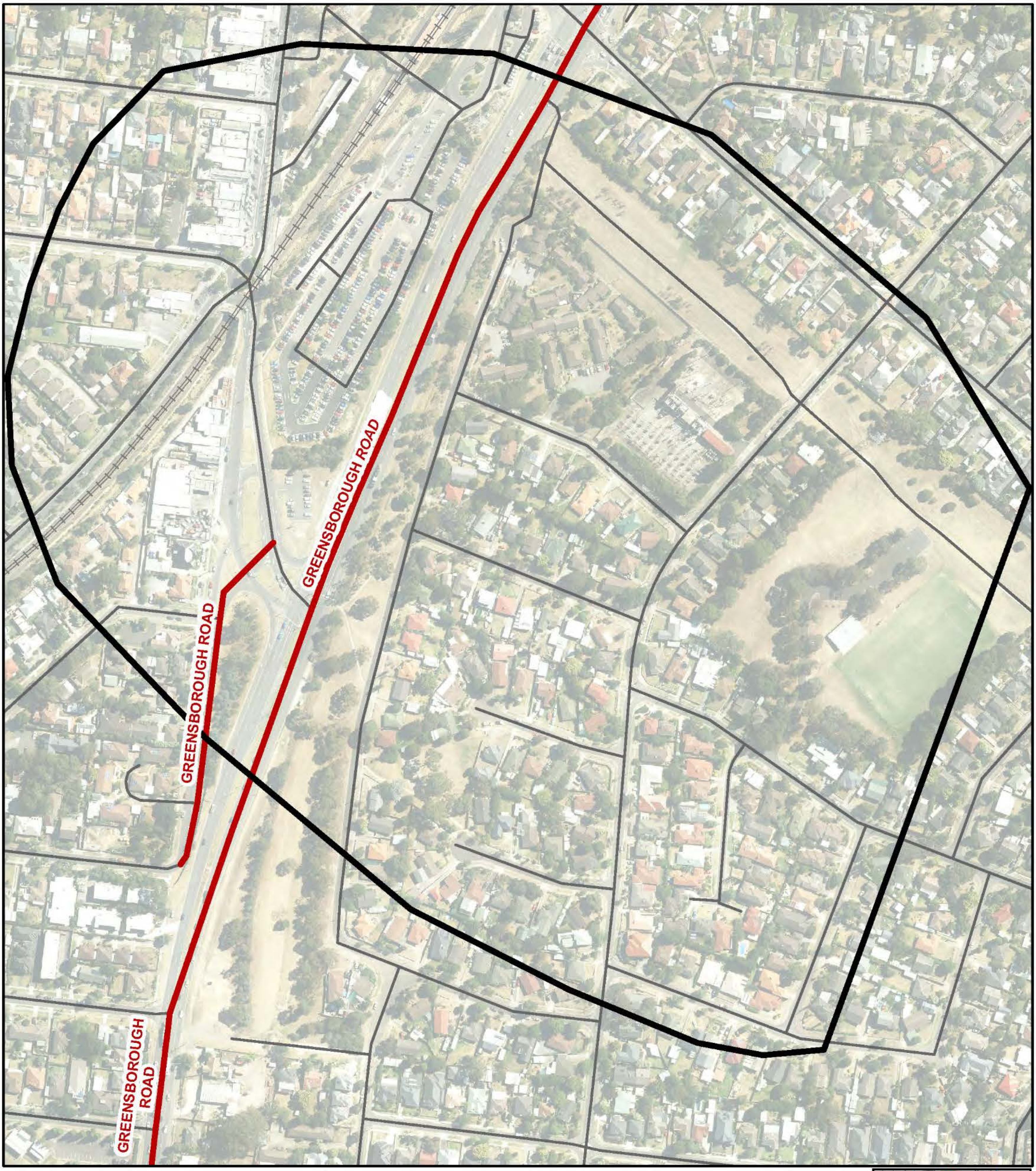
An unnamed council drainage system in the City of Banyule serves the Watsonia railway station and its catchment to the west of Greensborough Bypass. The drainage system flows east, crossing Greensborough Bypass and collecting more flow from local catchments before discharging to Melbourne Water's Watsonia drain. In the absence of a formal name, this drainage system is referred to as the Watsonia Station drain in this report.

An overview of the Watsonia Station drain is shown in Figure 6-5. The flood extent associated with the surcharge from the underground system is shown in the planning scheme as SBO and covers part of Greensborough Bypass and a number of properties downstream. The region has recently been remodelled as part of a larger mapping project undertaken by the City of Banyule and Melbourne Water.

6.3.1 Flooding

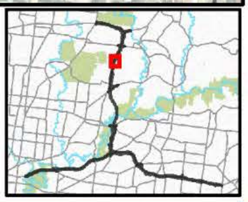
The peak 1% AEP flood depths for existing conditions are shown in Figure 6-6. Surface flooding is evident upstream of the Greensborough Bypass but is relatively shallow and mostly affects the southbound lane of Watsonia Road parts of the station car park reserve. Further downstream the more significant flooding depths are a fairly good match for the existing SBO.

Depth results for a wider range of events at selected locations are provided in Appendix D3.



LEGEND

- Hydraulic model boundary
- Roads of interest
- River
- Stream
- Channel
- Drain



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Metres

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Horizontal Datum: GDA 1994
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North East Link Project

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Overview
Watsonia Station drain

Figure 6-5

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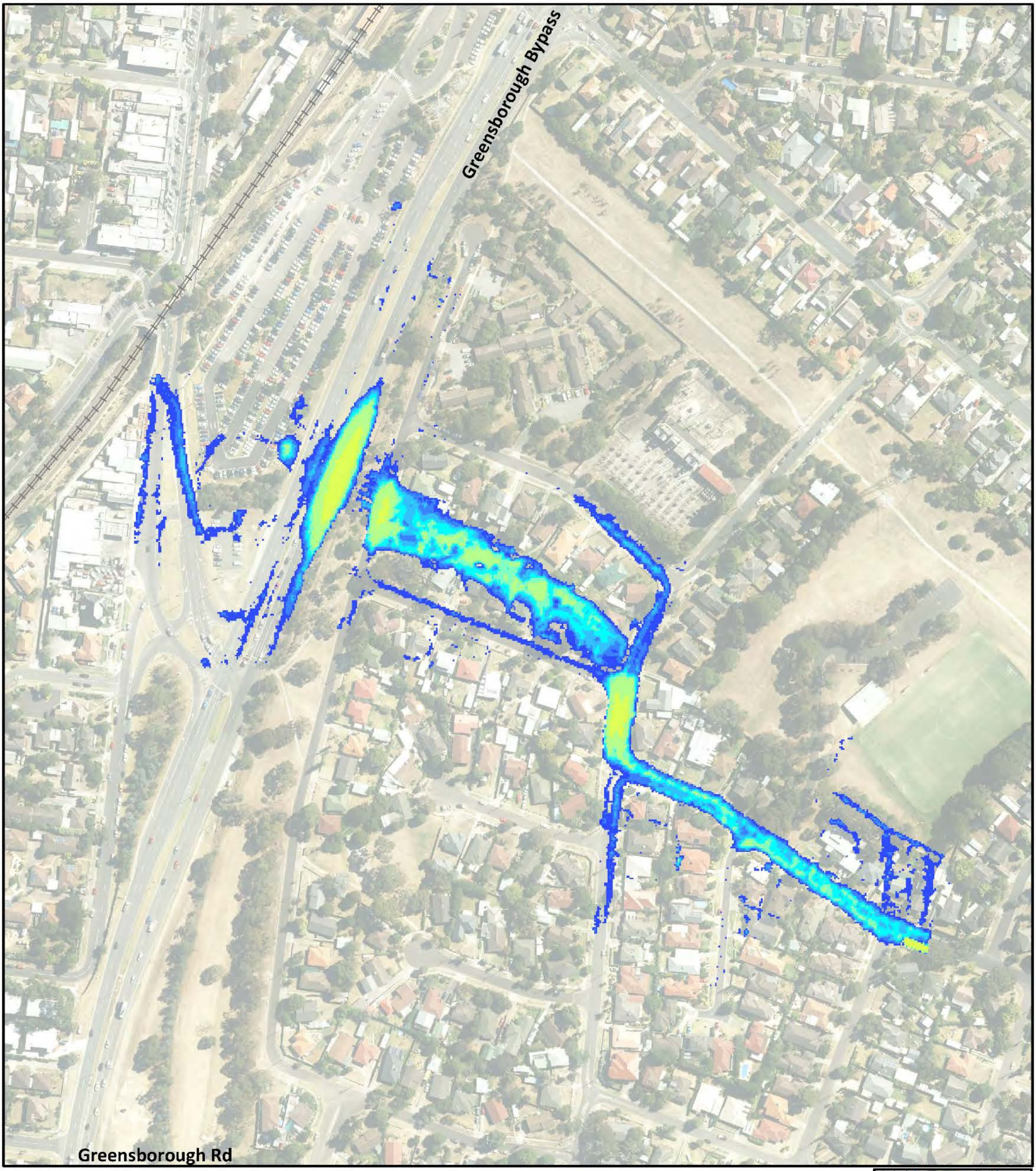
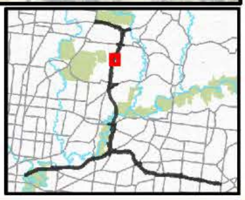
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Peak Flood Depth (m)			
<0.05	0.16 - 0.20	0.51 - 1.20	8.01 - 12.00
0.05 - 0.10	0.21 - 0.25	1.21 - 2.00	12.01 - 18.00
0.11 - 0.15	0.26 - 0.30	2.01 - 4.00	
	0.31 - 0.50	4.01 - 8.00	



Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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1% AEP peak flood depth
Watsonia Station drain

Figure 6-6

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

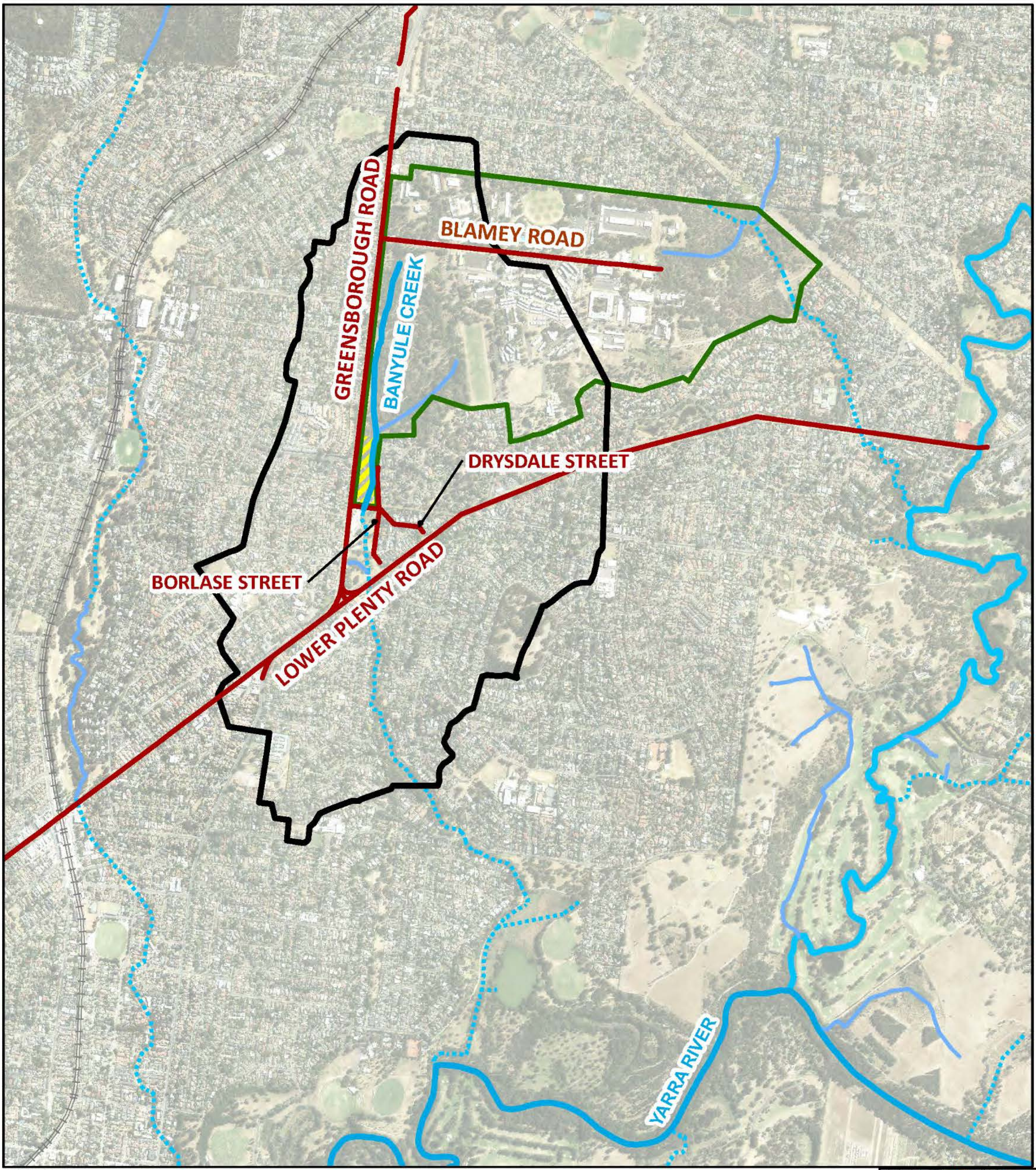
6.4 Banyule Creek

The friends of Banyule describe Banyule Creek as ‘a small watercourse, with a catchment area of only 4 square kilometres. Banyule Creek rises in the area of the Simpson Army Barracks just north of Viewbank’ (Friends of Banyule, 2017). The flow regime upstream of Lower Plenty Road Banyule Creek is an ephemeral stream, with no permanent baseflow.

From Simpson Barracks, the creek flows south and outfalls into the Yarra River. The creek is approximately four kilometres in length. The extent of Banyule Creek is shown in Figure 6-7.

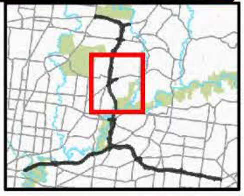
The majority of the catchment is urbanised with the exception of Simpson Barracks, which lies partly within the north-eastern corner of the catchment and is largely vegetated open space. The catchment also includes some other open space areas. The proportion of urbanisation within a catchment influences the volume of stormwater runoff and therefore the volume of surface water flow generated. Additionally the proportion of urbanisation has an impact on the amount of contaminants being discharged to waterways.

From Blamey Road, the creek runs parallel to Greensborough Road through Simpson Barracks to an open reserve north of Drysdale Street. At Drysdale Street the creek crosses under the road in a single 0.6-metre diameter circular culvert. In larger storm events, stormwater flows over the road. The open reserve continues downstream and at the time of the site visit included a temporary compound area for LXRA’s work at Rosanna railway station. At Lower Plenty Road the creek crosses under the road in two 1.6-metre diameter circular culverts. South of Lower Plenty Road the creek continues through an open reserve backing onto residential properties until it flows into the open space within Banyule Flats. The creek then continues through Banyule Flats and outfalls into the Yarra River.



LEGEND

- Hydraulic Model Boundary
- Roads of interest
- Simpson Barracks Boundary
- Publicly accessible Commonwealth land south of Simpson Barracks
- River
- Stream
- Channel
- Drain



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Date | 19/10/2018

Overview
Banyule Creek

Figure 6-7

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

6.4.1 Flooding

Detailed hydrologic and hydraulic modelling has been undertaken for Banyule Creek to understand the behaviour of the current flooding. The 1% AEP flood depths for Banyule Creek are shown in Figure 6-8**.** Within Simpson Barracks, the depth of flooding is generally less than 0.5 metres, aside from some isolated locations which are estimated to have depths up to one metre in a 1% AEP event. The elevation of Greensborough Road is higher than the surrounding properties, which results in stormwater flowing south along the western side of the road.

Within the publicly accessible Commonwealth land south of Simpson Barracks and Drysdale Street, Banyule Creek deepens and becomes more confined. Flood depths greater than two metres are estimated in a 1% AEP event. Due to the limited capacity of the council network near Drysdale Street, the 1% AEP flood extent expands onto and over Borlase Street and inundates private property. Stormwater crosses Drysdale Street with a depth of 0.5 metres.

From Drysdale Street to Lower Plenty Road the 1% AEP flood extent is confined to Borlase Reserve. The creek then flows beneath Lower Plenty Road in two 1.6-metre diameter circular culverts. The flow in these culverts is shown in Table 6-2.

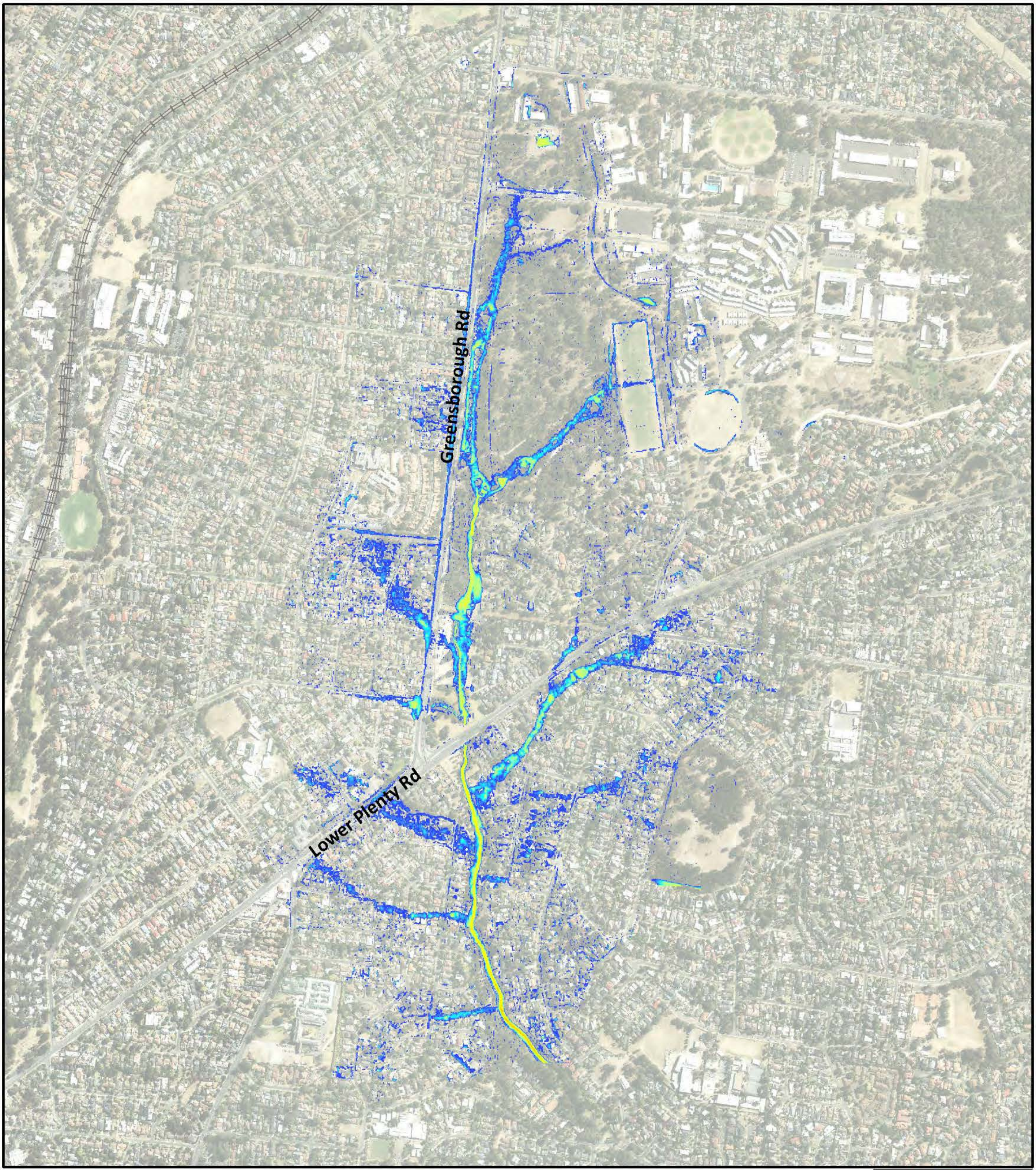
Table 6-2 Banyule Creek flows in culverts under Lower Plenty Road

AEP (%)	Flow (m^3/s)
10%	2.9
5%	4.4
2%	6.8
1%	9.3
1% climate change	12.1
0.2%	15.2
PMP	18.4

Downstream of Lower Plenty Road, the estimated flow is mainly confined to the creek reserve with depths of up to two metres.

The timing of the peak flow and water level influences the nature of the flooding within a catchment. Due to the short reach lengths and steep nature of the catchment flash flooding occurs within Banyule Creek, with the peak flow and or water level typically occurring within one to two hours of the rain starting.

Flood level results for a wider range of design events at selected locations are provided in Appendix D4.



Peak Flood Depth (m)

<0.05	0.16 - 0.20	0.51 - 1.20	8.01 - 12.00
0.05 - 0.10	0.21 - 0.25	1.21 - 2.00	12.01 - 18.00
0.11 - 0.15	0.26 - 0.30	2.01 - 4.00	
	0.31 - 0.50	4.01 - 8.00	

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Metres

Map Projection: Transverse Mercator
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Grid: GDA 1994 MGA Zone 55

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1% AEP peak flood depth
Banyule Creek

Figure 6-8

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

6.4.2 Water quality

To determine the current water quality of Banyule Creek, data was obtained from three monitoring stations (Waterwatch, 2018):

- Wetland one at Banyule Creek headwaters, Simpson Barracks, Watsonia (Site ID: ME_YBA006), 13 readings, recorded April 2007 through October 2008
- Banyule Creek headwaters at Simpson barracks, Watsonia (Site ID: ME_YBA005), 24 readings, recorded April 2007 through November 2008
- Banyule Creek at footbridge, Banyule Flats Reserve (Site ID: ME_YBA500), 44 readings, recorded June 2006 through July 2012.

The water quality results are summarised in Table 6-3.

Table 6-3 Water quality monitoring results for Banyule Creek (Waterwatch, 2018)

Parameter	SEPP (Waters) objective	ME_YBA006	ME_YBA005	ME_YBA500
Dissolved oxygen (% Saturation) (25th percentile)	≥70% (25th percentile)	71.7*	52.6*	53.4*
Dissolved oxygen (% saturation) (Maximum)	≤110% (Maximum)	76.8*	97.0*	91.7*
Electrical conductivity at 25°C (75th percentile)	≤500 µS/cm (75th percentile)	100.0	370.0	750
pH (25th percentile)	≥6.4 (25th percentile)	7.6	7.5	7.4
pH (75th percentile)	≤7.9 (75th percentile)	7.8	8.2	7.9
Turbidity (75th percentile)	≤35 NTU (75th percentile)	30	40	13
Total nitrogen (75th percentile)	≤1300 µg/l (75th percentile)	No recorded data	No recorded data	No recorded data
Total phosphorous (75th percentile)	≤110 µg/l (75th percentile)	No recorded data	No recorded data	No recorded data

Table Notes: Red numbers do not meet 2018 SEPP (Waters) objective

* Waterwatch samples recorded dissolved oxygen in mg/L and were converted to percentage saturation to compare with the SEPP (Waters) objectives.

Water quality at Banyule Creek was assessed against the SEPP (Waters) objectives which seek to protect beneficial uses of waterways. Table 6-3 shows that, from the data available, dissolved oxygen (25th percentile), pH (75th percentile) and turbidity samples exceed SEPP (Waters) objectives at monitoring sites within the investigation area along Banyule Creek. This indicates that water quality in some aspects is worse than the objectives set out in the SEPP (Waters). It is recognised this water quality data only covers the period from 2006 to 2012. These results suggest that electrical conductivity—an indicator of salinity—increases from upstream to downstream.

Banyule Creek is a minor urban tributary of the Yarra River and is not gauged; therefore no flow data is available.

6.4.3 Geomorphology

The existing geomorphic conditions for river waterway stability within Banyule Creek have been appraised through observations made during site visits. For the purpose of the EES the distinct reaches of Banyule Creek potentially impacted by the project are described in Table 6.1 below.

Table 6-4 Overview of Banyule Creek existing conditions

Reach	Description
Within army barracks	Low flow channel formation as a small incision within the relatively steep (>1:40) natural valley depression within the confined floodplain. Along the reach there are a number of local drainage connections from both east and west sides of the catchment. The stream form changes to a more defined creek channel where the bed profile locally steepens near the Simpson barracks boundary where the channel combines with the tributary flow path from the east.
Army barracks boundary to Drysdale Road	The channel profile flattens (<1:100) and becomes heavily choked with cumbungi reeds, and the surrounding floodplain also heavily vegetated with mature gum trees and understorey. The Drysdale Road culvert is a hydraulic restriction that may be influencing the characteristics of this reach.
Drysdale Road to Lower Plenty Road	Immediately downstream of Drysdale Road within Borlase Reserve the channel profile steepens (>1:50), and becomes more uniform and straightened. The surrounding floodplain becomes predominately-grass (maintained) with scattered mature trees. There are local signs of bank erosion with some placement of large edge rock observed.
Lower Plenty Road to Banyule Swamp Reserve	The formed channel downstream of Plenty Road becomes further incised within the more confined Banyule Creek corridor reserve located through the residential surrounds. The reach includes occasional bed incisions and local bank erosion with some limited and ad-hoc placement of rock protection works, as well as other locations of high energy where local drainage outfalls enter the creek channel.

Banyule Creek within Simpson Barracks effectively starts as a surface flow path immediately downstream of the culvert under Blamey Road. The top of the catchment appears to align with Yallambie Road and there is no defined flow path until downstream of Blamey Road. It is unclear as to the extent of piped network (if any) that discharges via this culvert. The flow path downstream of Blamey Road has formed a small incised channel through the vegetated depression (typically 100 to 200-millimetres wide, 300-millimetres deep) with localised deeper and wider sections along the reach. There are a number of overland flow paths and piped connections from the east from the urbanised catchments within Simpson Barracks. From the west there are several local council drainage catchments that discharge under Greensborough Road into the Simpson Barracks site into a formed channel drain that connects to Banyule Creek towards the southern end of the site.

The open drain is steeply graded and attempts at placing erosion control and check dams have suffered damage with evidence of outflanking. Banyule Creek then becomes a larger capacity channel joined by the tributary flow path from the east, fed by the catchments within Simpson Barracks as well as some of the surrounding residential catchments. At the site boundary (immediately downstream of the confluence with the tributary), the channel is intersected by a cyclone fence with a grill extending to the base of the channel for security. This would become an obstruction to flow during large events. This is evident from the localised erosion where turbulent flows have crossed the boundary.

The channel immediately downstream of the site boundary within the publicly accessible Commonwealth land south of Simpson Barracks, is a heavily vegetated channel with an approximate bed width of between one and two metres. The waterway in this area is relatively stable and protected with vegetation/grass. Between Drysdale Street and Lower Plenty Road the creek has cut downward through its bed (incised). Rock armouring is an erosion mitigation measure that has been used along much of Banyule Creek in this region. Bed incision is evident around some of the rock armouring and has the potential to undermine the erosion protection works.

South of Lower Plenty Road there is evidence of significant waterway stability issues including bank erosion, bank undercutting, localised scour pools and channel deepening. An exposed vertical bank between two to three-metres high exists immediately downstream of Lower Plenty Road. The erosion identified at this location of Banyule Creek has the potential to lead to land instability. Further downstream, between Lower Plenty Road and Banyule Flats, erosion is already adversely affecting drainage infrastructure and river health.

6.5 Yarra River

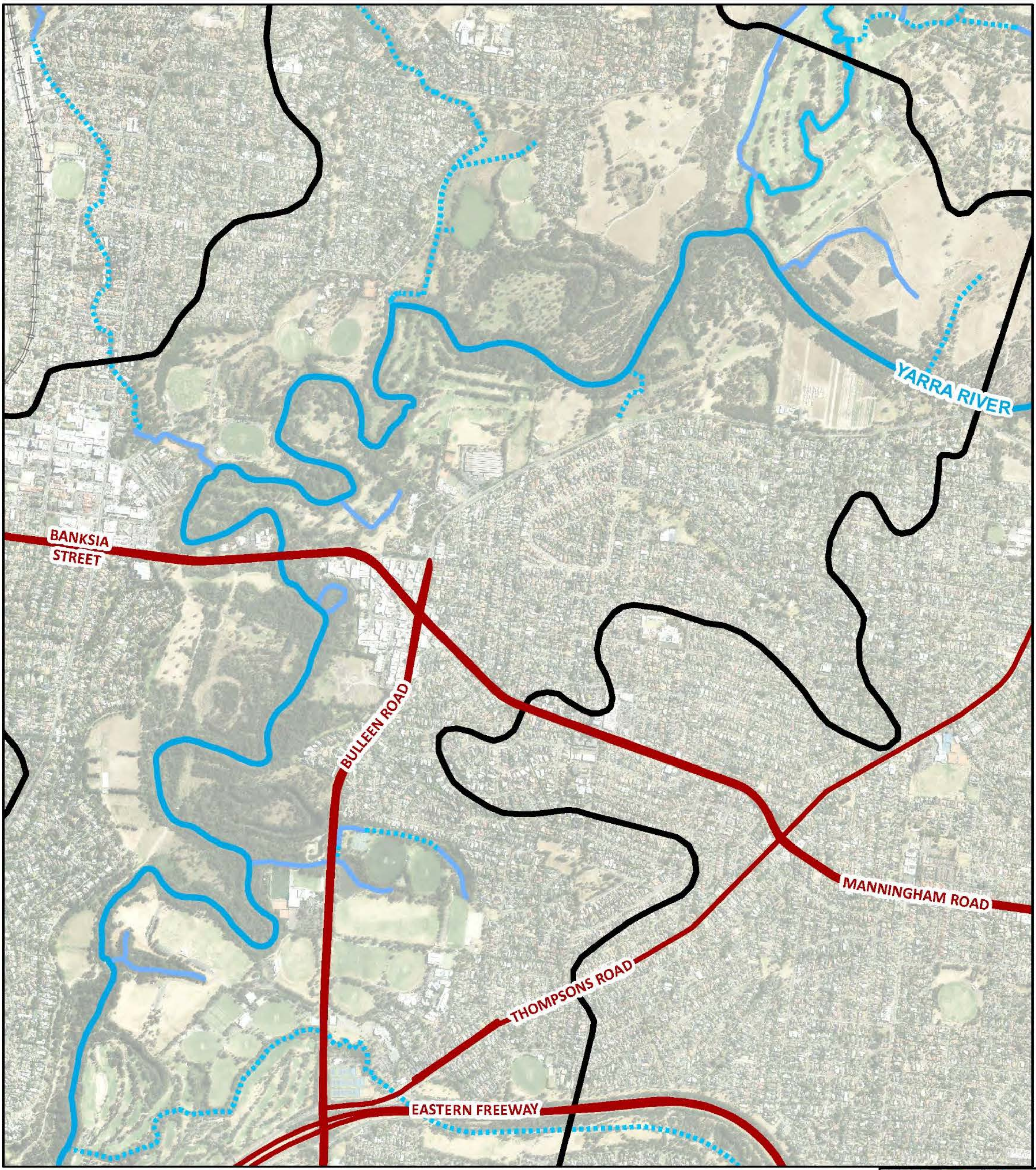
Melbourne Water describes the Yarra River as follows (Melbourne Water and Port Phillip Westernport Catchment Management Authority, 2007):

> '*The Yarra catchment lies north and east of Melbourne, beginning on the southern slopes of the Great Dividing Range in the forested Yarra Ranges National Park. Around two million people, over one-third of Victoria's population, live in the catchment, which has an area approximately 4,000 square kilometres*.
>
> *The upper reaches of the Yarra River and its major tributaries flow through forested, mountainous areas, which have been reserved for water supply purposes for more than 100 years. Around 70% of Melbourne's drinking water comes from these pristine upper reaches. Most of the land along rivers and creeks in the middle and lower sections has been cleared for agriculture or urban development'.*

The section of the Yarra River which has been investigated is shown in Figure 6-9, Figure 6-10 and Figure 6-11. Most of the flow through this area originates upstream in the Yarra River catchment.

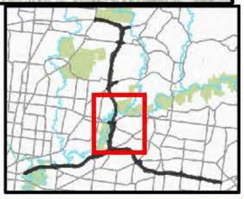
The Yarra River catchment consists of various land uses along its length, including forested, agricultural and urban development. The land use within the catchment impacts the volume of surface water runoff and volume and type of water quality contaminants. As shown in Figure 6-9, Figure 6-10 and Figure 6-11 the Yarra River floodplain is extensive and comprises a number of land uses including but not limited to public recreation, conservation and special use zones such as golf courses. Between Banksia Street and Chandler Highway the floodplain is generally well vegetated.

Within the study area, there are three bridge crossings of the Yarra River: Manningham Road West, Burke Road and Chandler Highway.



LEGEND

- Hydraulic Model Boundary
- Roads of interest
- River
- Stream
- Channel
- Drain



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Revision	C
Date	26/10/2018

Overview
Yarra River 1 of 3

Figure 6-9

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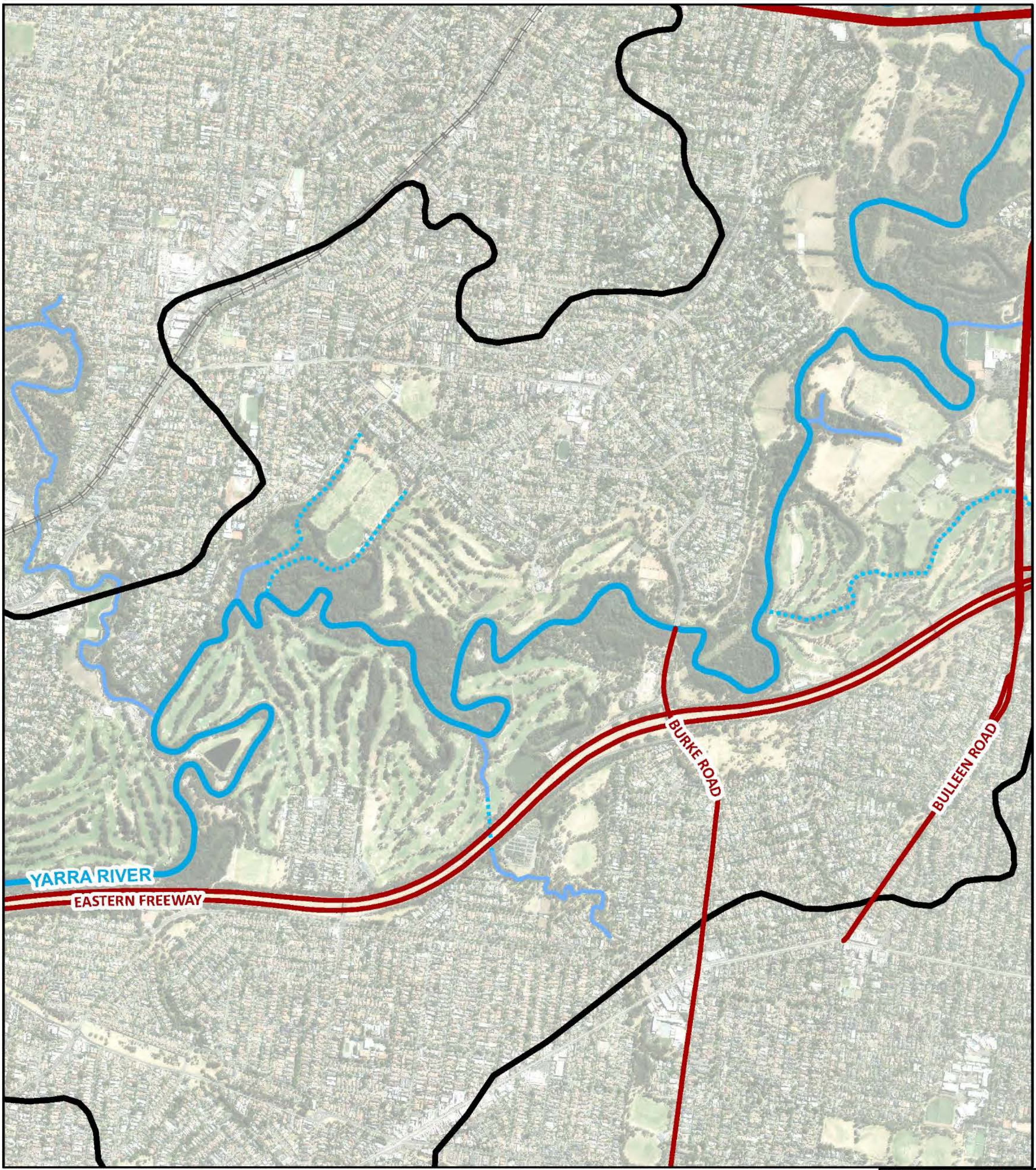
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



LEGEND

- Hydraulic Model Boundary
- Roads of interest
- River
- Stream
- Channel
- Drain

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Map Projection: Transverse Mercator
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Overview
Yarra River 2 of 3

Figure 6-10

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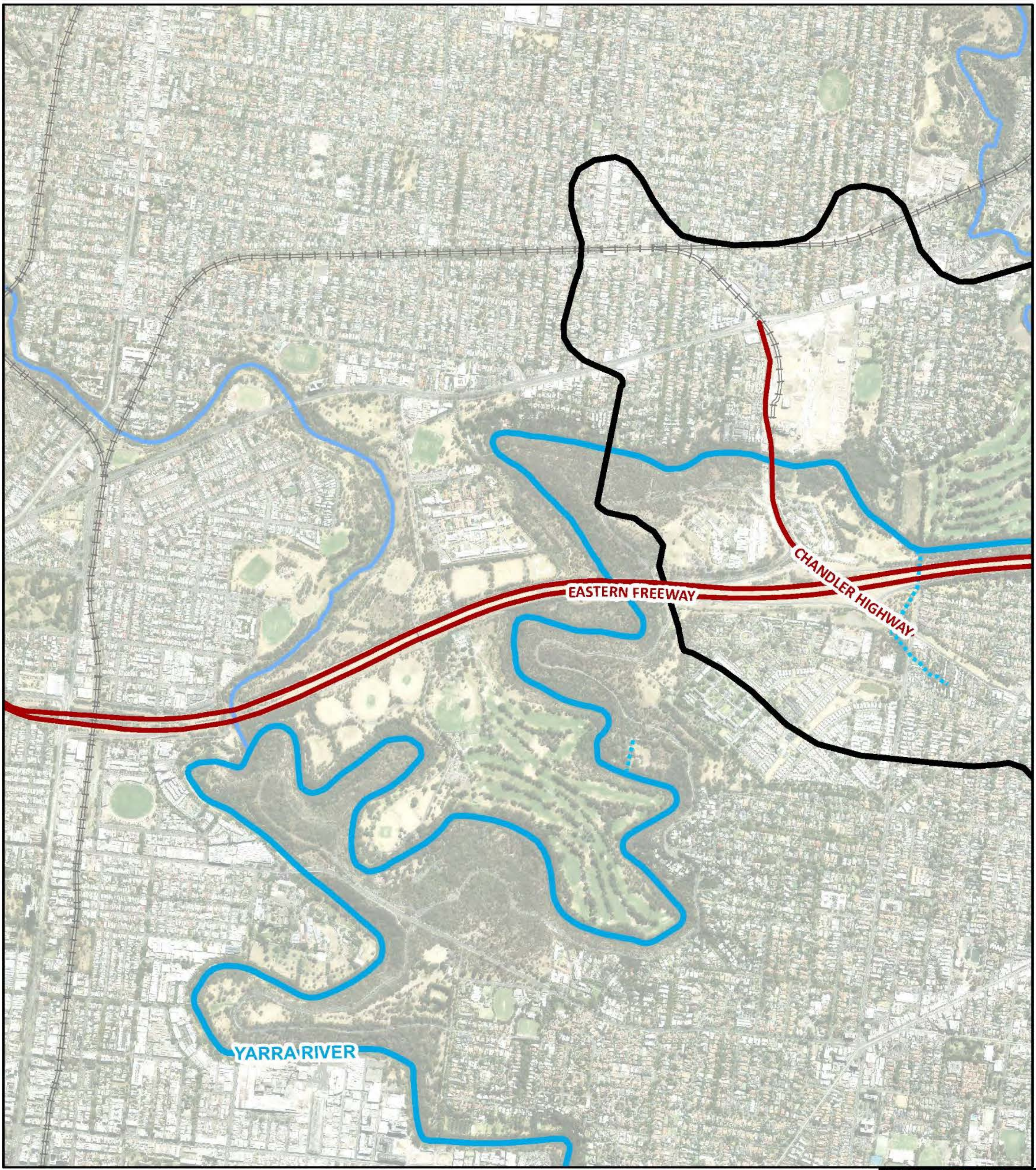
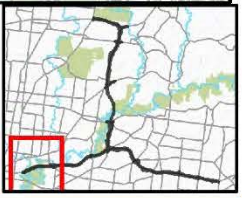


LEGEND

- Hydraulic Model Boundary
- Roads of interest
- River
- Stream
- Channel
- Drain



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Revision B
Date 19/10/2018

Overview
Yarra River 3 of 3

Figure 6-11

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

6.5.1 Flooding

Modelled existing peak 1% AEP flood depths are shown in Figure 6-12, Figure 6-13 and Figure 6-14. The 1% AEP flood extent covers an extensive area utilised for public open space and recreational facilities as well as some areas of private residential, commercial and industrial properties along the fringes of the floodplain.

The road on both sides of Manningham Road West Bridge is overtopped in a 1% AEP event, by a depth of up to two metres. Bulleen Road between the Trinity Grammar School Sporting Complex and the Eastern Freeway is overtopped by up to six metres of floodwater in the 1% AEP event. The Eastern Freeway is inundated to the west of Burke Road and east of Chandler Highway.

In a 1% AEP event, flows in the Yarra River at Banksia Street are in the order of 1,200 cubic metres per second, as shown in Table 6-5. Between Birrarrung Park and the Chandler Highway, the floodplain provides a significant amount of flood storage and as a result water surface elevations across the floodplain are relatively consistent. Flow from the Chandler Basin is controlled by a relatively confined section of the Yarra River at and downstream of the Chandler Highway.

Table 6-5 Yarra River existing condition results

AEP (%)	Flow at Banksia Street (m^3/s)	Flood levels at industrial park near Manningham Road (mAHD)
1%	1,220	18.43
1% climate change	1,480	19.75
0.5%	1,410	19.38
0.5% climate change	1,720	20.93
0.2%	1,700	20.84
0.2% climate change	2,080	22.62
0.1%	1,950	22.05
0.1% climate change	2,410	23.78
0.05%	2,230	23.24
0.05% climate change	2,780	24.66
PMP	12,070	34.51

The timing of the peak flow and water level influences the nature of the flooding within a catchment. Due to the size of the Yarra River catchment upstream of the study area, the peak flows occur several days following the rain falling in the upper catchment. Smaller local rainfall events may cause local flooding within the catchment but do not typically cause widespread flooding.

Flooding of the billabongs, wetlands and swamps within the Yarra River floodplain provides a mechanism for topping up the levels of many of these surface water bodies including Bolin Bolin Billabong, Banyule Flats and Banyule Swamp. Although the water level in many of these features is variable, some of these standing waterbodies are occasionally topped up with water extracted from the Yarra River.

6.5.2 ARR 2016 sensitivity

The designated 1% AEP Yarra River flood levels adopted by Melbourne Water are based on a range of recorded historic flood levels from the 1934 flood. The hydrologic model and to a lesser extent the hydraulic model adopted for this EES are adjusted to match these designated levels.

A hydrologic analysis of the Yarra River was undertaken using ARR 2016 methodologies and data. Even when very low loss values were adopted it predicted lower flood levels within the Chandler Basin.

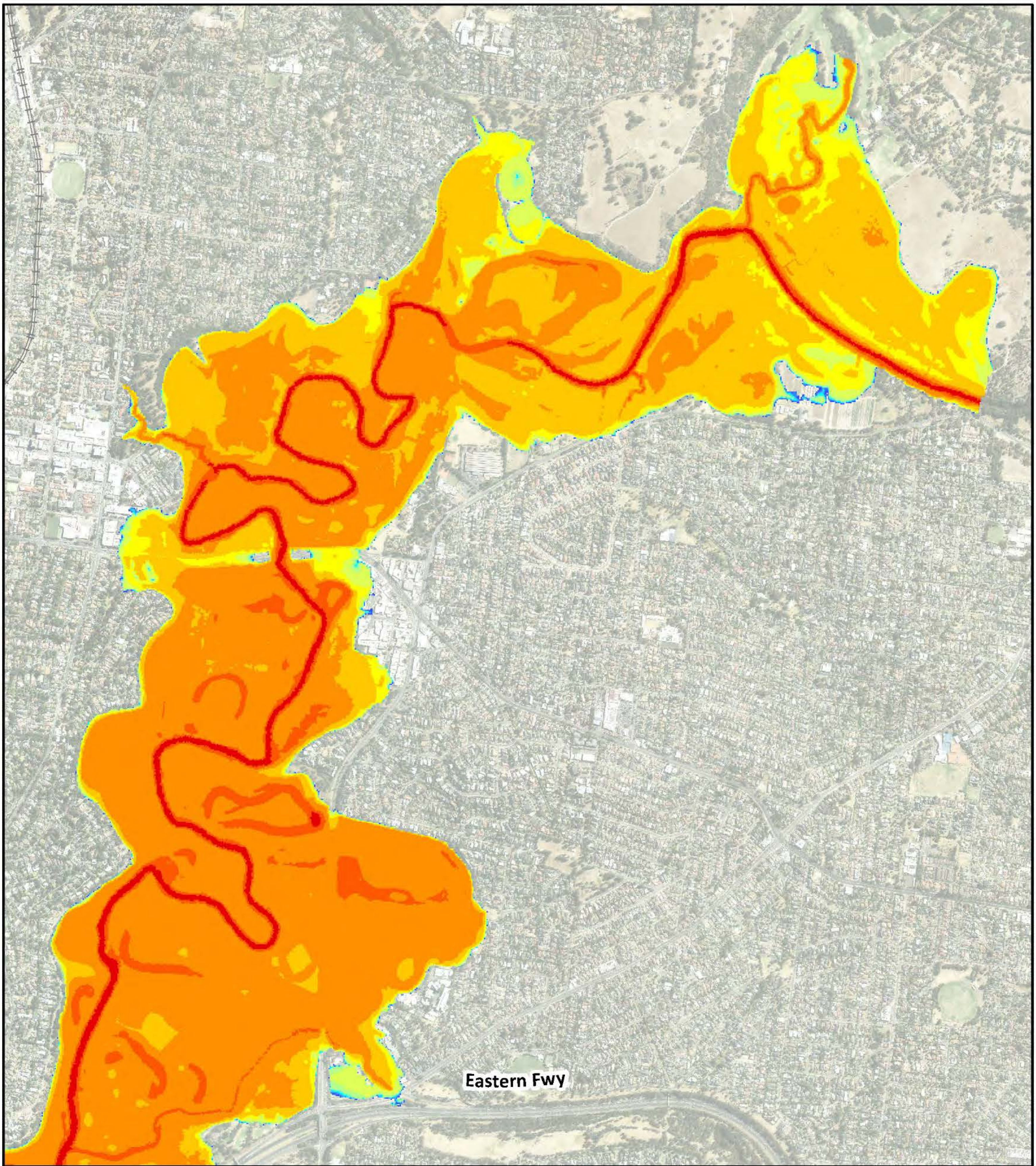
For comparison a hydrologic analysis of the Yarra River using pre ARR 2016 methodologies for ungauged catchments was also undertaken and results were also lower than those of the models which have been adjusted to match the designated levels and adopted for this EES assessment.

A summary of some comparison hydrographs and long sections are provided in Appendix F.

The apparent discrepancy is likely to be due to a number of significant differences and affected by numerous less significant differences. Reasons for this variation may include:

- Limited hydrologic data for long duration events particularly in the southern states
- Data inaccuracy, potentially in recorded flood levels, hydrologic data and numerous other parameters
- Perhaps the 1934 event was bigger than a 1% AEP event.

The above results perhaps indicate that designated flood levels and subsequently, perhaps some of the design levels for the project may be conservatively high. However, the designated levels are based on the largest flood on record, and in the absence of new information to the contrary, would generally be considered more reliable than a parameter based hydrologic model regardless of whether it adopted ARR 1987 or ARR 2016 methodologies.



Peak Flood Depth (m)			
<0.05	0.16 - 0.20	0.51 - 1.20	8.01 - 12.00
0.05 - 0.10	0.21 - 0.25	1.21 - 2.00	12.01 - 18.00
0.11 - 0.15	0.26 - 0.30	2.01 - 4.00	
	0.31 - 0.50	4.01 - 8.00	

Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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1% AEP peak flood depth
Yarra River 1 of 3

Figure 6-12

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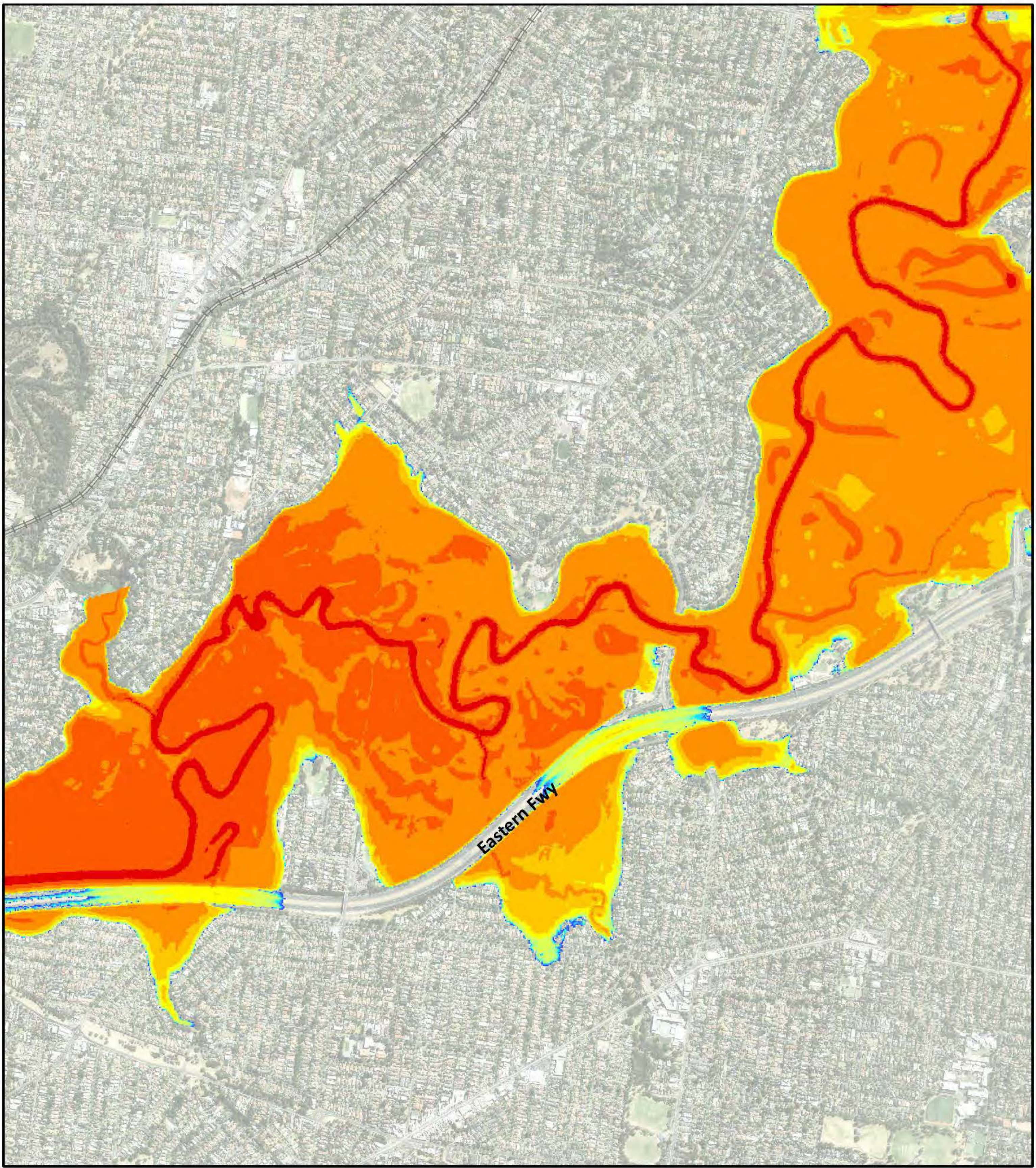

Peak Flood Depth (m)			
<0.05	0.16 - 0.20	0.51 - 1.20	8.01 - 12.00
0.05 - 0.10	0.21 - 0.25	1.21 - 2.00	12.01 - 18.00
0.11 - 0.15	0.26 - 0.30	2.01 - 4.00	
	0.31 - 0.50	4.01 - 8.00	

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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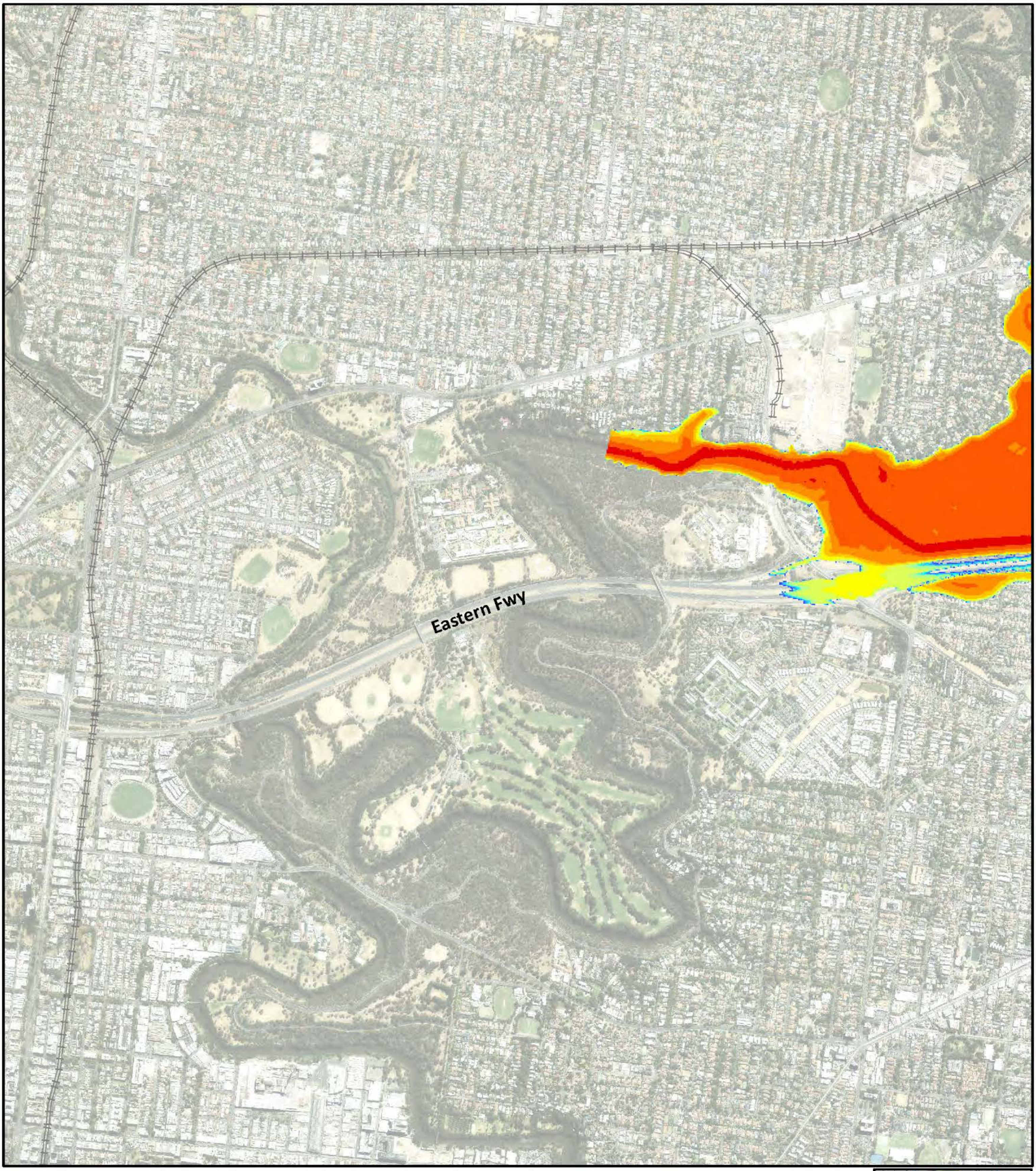
1% AEP peak flood depth
Yarra River 2 of 3

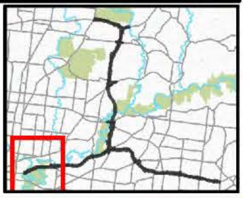
Figure 6-13

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Peak Flood Depth (m)

<0.05	0.16 - 0.20	0.51 - 1.20	8.01 - 12.00
0.05 - 0.10	0.21 - 0.25	1.21 - 2.00	12.01 - 18.00
0.11 - 0.15	0.26 - 0.30	2.01 - 4.00	
	0.31 - 0.50	4.01 - 8.00	



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Date 08/10/2018

1% AEP peak flood depth
Yarra River 3 of 3

Figure 6-14

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

6.5.3 Water quality

Water quality monitoring data was obtained for two monitoring stations on the Yarra River (Melbourne Water, 2015). The water quality results are summarised in Table 6-6.
The following data has been used for this assessment:

- Yarra River at Kangaroo Ground-Warrandyte Road, Warrandyte, six readings, recorded 2015
- Yarra River at Chandler Highway, Kew, six readings, recorded 2015.

Table 6-6 Water quality monitoring results for Yarra River (Melbourne Water, 2015)

Parameter	SEPP (Waters) objective	Yarra River at Kangaroo Ground-Warrandyte Road, Warrandyte	Yarra River at Chandler Highway, Kew
Dissolved oxygen (% Saturation) (25th percentile)	≥75% (25th percentile)	91.0	81.0
Dissolved oxygen (% saturation) (Maximum)	≤110% (Maximum)	100	91
Electrical conductivity at 25°C (75th percentile)	≤250 µS/cm (75th percentile)	138	188
pH (25th Percentile)	≥6.7 (25th percentile)	7.4	7.2
pH (75th percentile)	≤7.7 (75th percentile)	7.6	7.6
Turbidity (75th percentile)	≤25 NTU (75th percentile)	12	28
Total nitrogen (75th percentile)	≤1100 µg/l (75th percentile)	700	900
Total phosphorous (75th percentile)	≤55 µg/l (75th percentile)	30	50

Table Notes: Red numbers do not meet SEPP (Waters) objective

Table 6-6 shows that at least for this small data set, the majority of the SEPP (Waters) objectives are met for these Yarra River monitoring sites.

The most recent analysis presented on the Yarra and Bay website (State Government of Victoria, 2018) of the available sampling of Yarra River (2016 – 2017) indicates very good ratings for pH and salinity at Chandler Highway, Kew. In the same timeframe, very poor ratings are noted for water clarity, nutrients and metals due to high concentrations recorded for nitrogen, phosphorus and heavy metals (State Government of Victoria, 2018). DELWP combine the score of individual water quality parameters to produce an overall water quality index. Figure 6-15 shows that from 2000 to 2017, the water quality index for the Yarra River at Chandler Highway, Kew oscillated between very poor and poor. Since 2012 the water quality index has been generally improving.

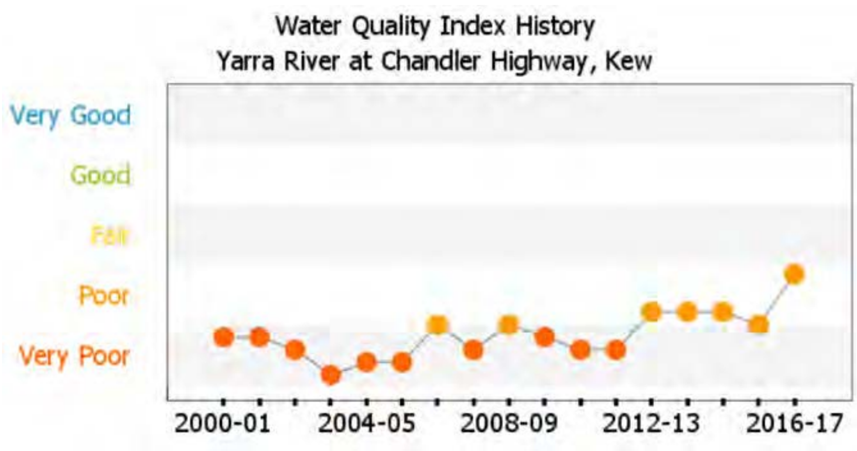


Figure 6-15 Water Quality Index, Yarra River at Chandler Highway, Kew (YAYAR3331) (State Government of Victoria, 2018)

Table 6-7 and Table 6-8 show the Yarra River existing condition descriptions from the Healthy Waterways Strategy (2018–2028) and specifically the Co-Designed Catchment Program for the Yarra Catchment (Melbourne Water, 2018) and a Yarra River conditions summary (Melbourne Water and Port Phillip Westernport Catchment Management Authority, 2007) respectively. The Yarra River is rated by Melbourne Water as having very high regional importance and its overall current condition is rated as moderate, with the lowest condition ratings for physical form and hydrology.

Table 6-7 Yarra River conditions (Melbourne Water, 2018).

Parameter	Current state	Current trajectory	Target trajectory
Stormwater condition	Moderate	Low	High
Physical form	High	Moderate	High
Water for the environment	High	Moderate	High
Vegetation quality	Moderate	Low	High
Vegetation extent	High	High	High
Instream connectivity	Moderate	Moderate	High
Water quality – environment	Moderate	Moderate	High
Access	Low	Low	Moderate
Litter absence	High	Moderate	High
Water quality – recreational	High	High	High
Participation	Moderate	Low	Very high

Table 6-8 Yarra River condition summary (Melbourne Water and Port Phillip Westernport Catchment Management Authority, 2007).

Parameter	Condition
Water quality	Moderate
Aquatic Life	Moderate
Habitat and stability	Good
Vegetation	Poor
Hydrology	Poor

6.5.4 Geomorphology

The existing geomorphic conditions within the Yarra River have been appraised through observations made during site visits and desktop assessment.

The Yarra River corridor contains some of the most valued geomorphic assets in metropolitan Melbourne. Indigenous vegetation and remnant riparian vegetation provide habitat and contribute to the protection of water quality and flow regimes. The Yarra River provides a natural landscape and key geomorphic features include river flats and billabongs.

The Yarra River reach between Diamond Creek and Merri Creek confluences has been described as having bed and banks that are relatively stable and well vegetated although somewhat weedy (Sinclair Knight Merz, 2005). The river channel comprises pools with the occasional gravel riffles and runs.

While much of the Yarra River floodplain has been cleared over time due to urbanisation, some billabongs remain relatively intact such as the Banyule Billabong, Annulus Billabong and Bolin Bolin Billabong.

6.5.5 Water supply

Various storages exist within the Yarra River floodplain, including a dam within Trinity Grammar School Sporting Complex and irrigation storages owned and operated by Manningham City Council.

The Trinity wetlands get water from a local urban catchment to the east of the site. Stormwater from these wetlands flows into a dam located on the Trinity Grammar School Sporting Complex grounds. Water stored in this dam is used for the irrigation of sporting ovals within the Trinity Grammar School Sporting Complex and the Marcellin College grounds.

Private licences to extract water from the river exist along the Yarra River. Trinity Grammar School Sporting Complex have a current licence to extract water from the Yarra River as a part of an agreement with Melbourne Water.

Manningham City Council has a licence to extract water from the Yarra River and have advised that this water is stored in both above and below ground tanks and used for irrigation of the Freeway Public Golf Course and Carey Grammar Sports Complex.

On the west side of Bulleen Road the recently completed Bolin Bolin Integrated Water Management Project collects, stores and transports irrigation water between a 1.5 ML wetland and storage on crown land adjacent Bolin Bolin Billabong which primarily collects and treats local stormwater, a 3.3 ML storage within the Freeway Public Golf Course with extraction from the Yarra River and a 0.5 ML of tank storage within Bulleen Park. Water from this project is used for the irrigation of sports grounds located at Bulleen Park, the Carey Grammar Sports Complex and the Freeway Public Golf Course.

The project is not linked to Bolin Bolin Billabong itself, however it is understood to receive stormwater from a local catchment to the north of the Trinity Grammar School College Sporting Complex.

The project has resulted from a partnership between Manningham City Council, Boroondara City Council and Carey Baptist Grammar School, and with the support of Melbourne Water, the Department of Environment, Land Water and Planning (DELWP) and the Australian Government.

6.5.6 Flow assessment

Flows in the Yarra River are significantly altered from its natural condition due to the existence of water storages along its length and development within the catchment. The flow duration curves shown in Figure 6-16 were developed using recorded gauge data at Banksia Street in Heidelberg (Melbourne Water, 2 August 2017). Significant variability can be seen between a wet year and dry year. In a dry year, flow greater than four cubic metres per second occurred 20 per cent of the time, whereas in a typical wet year, flow greater than 55 cubic metres per second occurred 20 per cent of the time. Across the total period, 18 cubic metres per second was exceeded 20 per cent of the time.

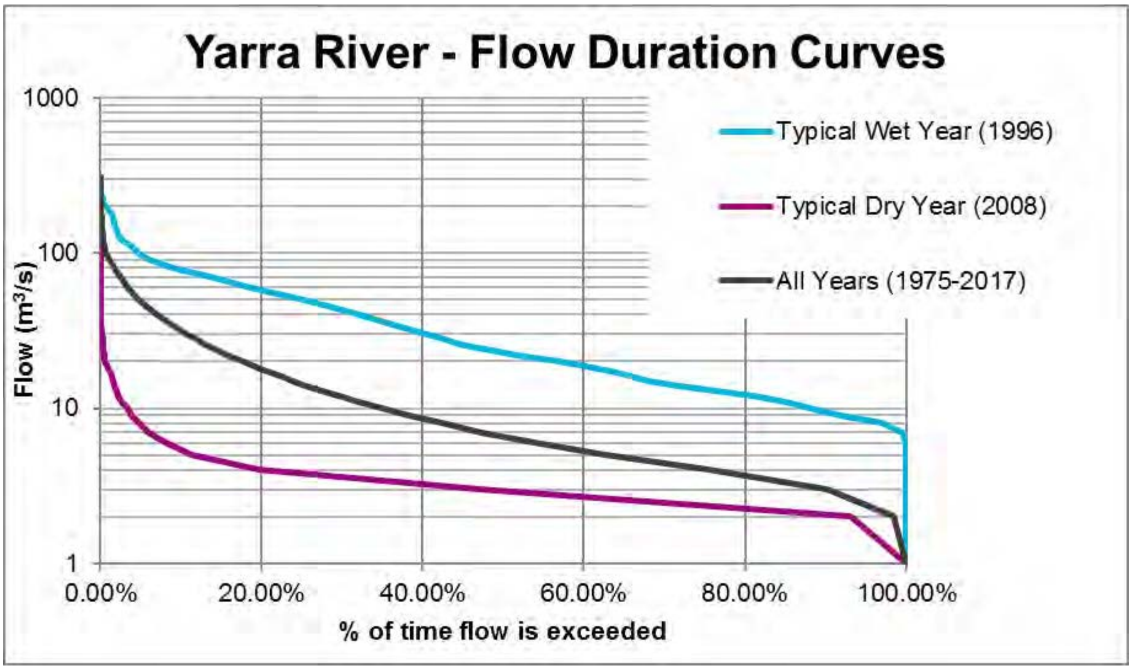


Figure 6-16 Yarra River flow duration curves

6.6 Koonung Creek

Melbourne Water describes Koonung Creek as (Melbourne Water and Port Phillip Westernport Catchment Management Authority, 2007):

> *"Koonung Creek is a small tributary of the Yarra that arises in Blackburn North and Doncaster. Its catchment is almost entirely urban, however the creek contains major parklands in some of its reaches that have high recreational value. The creek has been heavily modified by realignment and erosion control works, particularly those associated with the Eastern Freeway, however it has retained native fish species, listed water birds, the growling grass frog and the floodplain contains sites of significant Aboriginal heritage.*
>
> *The most significant risks for the creek are associated with altered hydrology, largely as a result of the urbanised catchment, loss of vegetation in the streamside zone, poor water quality, loss of in-stream habitat and barriers to fish movement".*

Consistent with the above description there are pre 2007 records documenting the presence of species of ecological value in Koonung Creek, however recent surveys indicate that the ecological condition is currently degraded, and no Growling Grass Frog are present, refer to EES Technical report Q – Ecology.

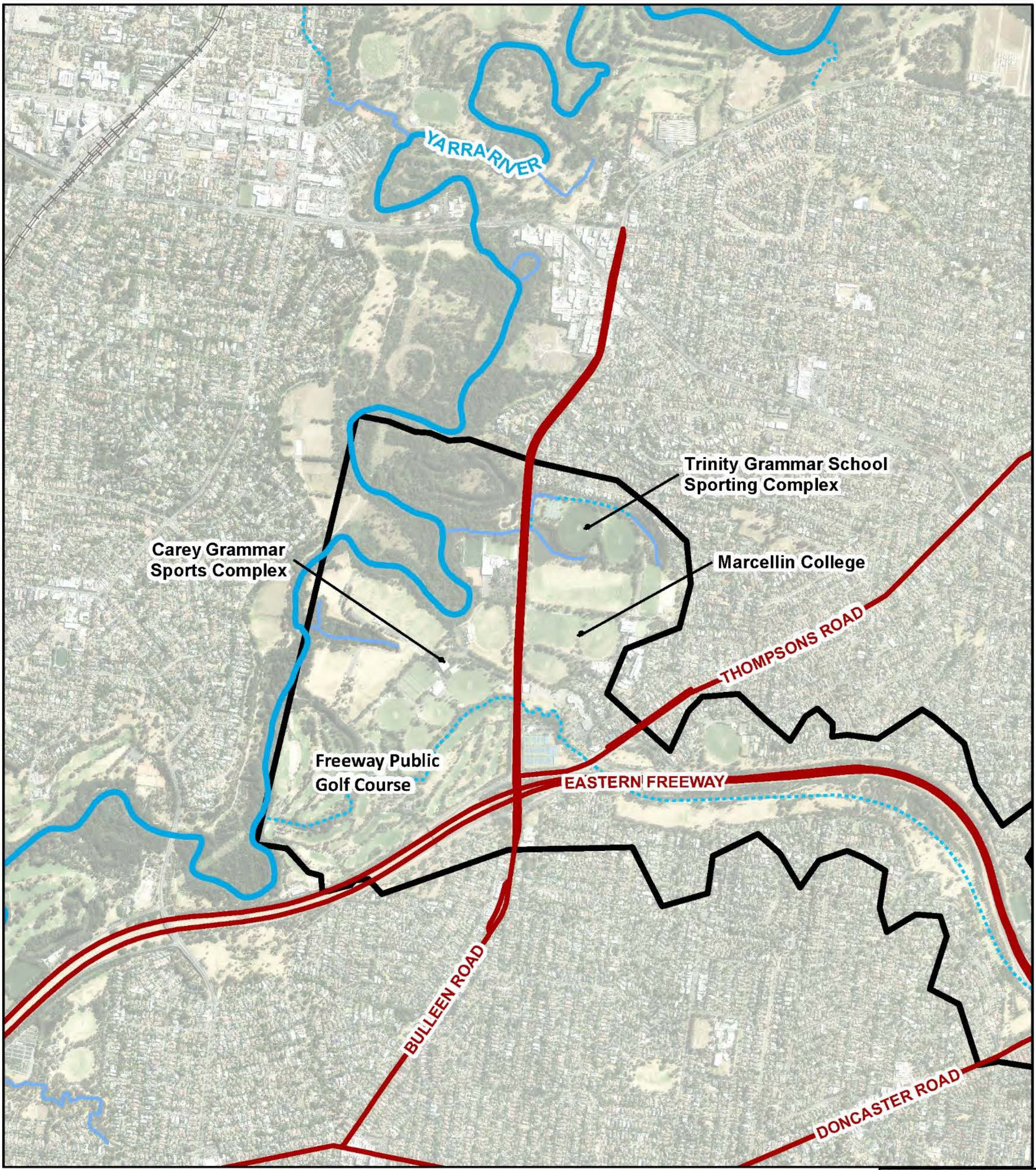
Koonung Creek is approximately 12-kilometres long and begins near Springvale Road in Blackburn North and flows west to join the Yarra River just north of the Freeway Public Golf Course. The creek meanders back and forth either side of the Eastern Freeway for much of its length. The extent of Koonung Creek is shown in Figure 6-17, Figure 6-18 and Figure 6-19.

The catchment is predominantly urban, with parklands both dispersed and concentrated along various reaches of Koonung Creek. The proportion of urbanisation within a catchment influences the volume of stormwater runoff and therefore the volume of surface water flow generated. Additionally, the proportion of urbanisation has an impact on the amount of contaminants being discharged to waterways, which may result in poor water quality.

Flows into Koonung Creek enter from local catchment drainage connections including Melbourne Water Drains (Blackburn Road Drain, Leeds Road Drain, Elms Grove Drain, Gardenia Road Drain, Ayr Street Drain and Minerva Avenue Drain), creeks (Brushy Creek) and additional overland flow paths.

In the 1980s, the construction of the Eastern Freeway between Bulleen Road and Doncaster Road resulted in Koonung Creek being 'undergrounded' into a 2.4-kilometre long 'arch drain' (Country Roads Board, 1982). In the 1990s, the extension of the Eastern Freeway between Doncaster Road and Springvale Road resulted in further modification of Koonung Creek. This included the realignment of Koonung Creek to either side of the Eastern Freeway and the installation of eight 'arch culverts', which provide connections between open channels on either side of the Eastern Freeway beneath the freeway and various intersecting roads (Laybutt, 2007). The realignment works also included significant lengths of erosion control works in some areas including rock armouring of the creek banks, between Doncaster Road and Springvale Road.

Flooding in the lower reaches of Koonung Creek is substantially influenced by flood levels in the Yarra River.



LEGEND

- Hydraulic Model Boundary
- Roads of interest
- River
- Stream
- Channel
- Drain

Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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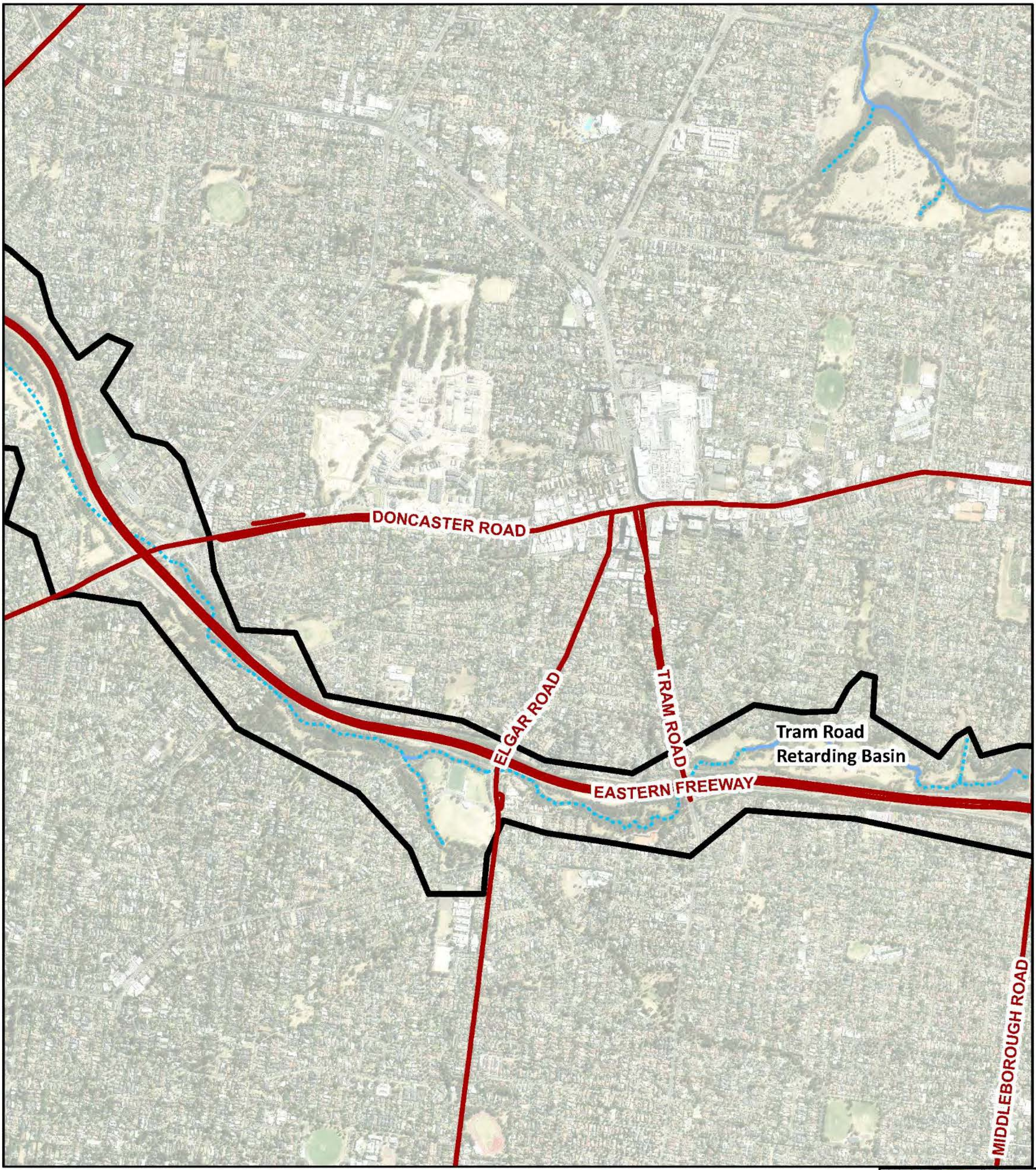
Overview
Koonung Creek 1 of 3

Figure 6-17



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- Hydraulic Model Boundary
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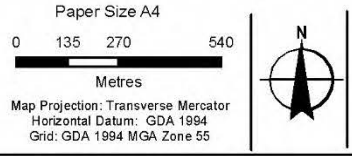
- River
- Stream
- Channel
- Drain



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Overview
Koonung Creek 2 of 3

Figure 6-18

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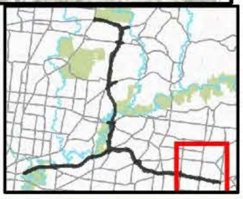
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

LEGEND

- Hydraulic Model Boundary
- Roads of interest
- River
- Stream
- Channel
- Drain



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Overview
Koonung Creek 3 of 3

Figure 6-19

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

6.6.1 Flooding

The existing flood extents along Koonung Creek as currently shown in the planning scheme are for many areas no longer representative of existing conditions. A new model of Koonung Creek has been used to assess flooding along Koonung Creek. The model includes parts of the local council drainage network and cross drainage across the existing Eastern Freeway for the purpose of appropriately modelling the creek and the impacts of the reference project. While this enables an understanding of impacts on local flooding networks, actual flooding on the local drainage system (council drainage) could and will often be greater than what is shown in this report.

The 1% AEP flood depths for Koonung Creek are shown in Figure 6-20, Figure 6-21 and Figure 6-22.

Within the upper reaches of Koonung Creek from Springvale Road to Middleborough Road the 1% AEP flood extent is confined within the creek channel, surrounding parklands or publicly accessible vegetated area and does not extend to private properties.

Downstream of Middleborough Road, flood extents expand and impact some private properties surrounding the Melbourne Water Tram Road retarding basin. Flood depths of up to eight metres occur within this basin in the 1% AEP event. Additionally, weir flow over the retarding basin wall, occurs in the 1% AEP event with a depth up to 0.5 metres.

Upstream of the 'arch culvert' under Elgar Road, the Koonung Creek flood extent expands into private properties to the south of the Eastern Freeway. Downstream of Elgar Road, Bushy Creek joins Koonung Creek. The 1% AEP flow inundates various ovals within Elgar Park on the east and private properties on the west. These ovals currently act as retarding basins, for Bushy Creek.

The inundation extent resulting from the combined Koonung Creek and Bushy Creek flows extend across a series of wetlands. The flood extent is confined to the creek further downstream through a rock cutting, which was constructed alongside the Eastern Freeway. Downstream of this cutting the flood extent widens, before entering a culvert and crossing to the north of the Eastern Freeway.

A short section of open channel connects into the long 'arch drain', beginning near the Doncaster Park and Ride. The peak flow entering into this arch drain for various AEP events is outlined in Table 6-9. Surface inundation above the 'arch drain', is evident in Figure 6-20. This surface inundation is from flows which exceeds the capacity of the 'arch drain'.

Flood extents for the length of the 'arch drain' are defined by a variety of issues including the overflow from the 'arch drain' and capacity of the local stormwater network entering the arch drain. The Yarra River 1% AEP flood extent intersects with the Koonung Creek 1% AEP flood extent, in the area that includes the Trinity Grammar School Sporting Complex, Marcellin College and the Carey Grammar Sports Complex.

Significant flooding of the Yarra River typically results from prolonged rain events covering large areas of the catchment. In contrast Koonung Creek is a significantly smaller urbanised catchment that is more likely to be flooded from shorter more intense and more concentrated rainfall events. These different types of critical events do not typically occur in the same general area at the same time. For this reason it is unlikely that a significant flood on Koonung Creek would coincide with a significant Yarra River flood. Additional discussion of the Yarra River flooding can be found in Section 6.5.

The outlet of the ‘arch drain’ is downstream of Thompson Road, where the Koonung Creek flood extent expands across the Trinity Grammar School Sporting Complex and Marcellin College adjacent to Bulleen Road. Three, 3.35-metre wide by 3.05-metre high culverts beneath Bulleen Road convey flood waters towards the Yarra River. In the 1% AEP flood event on Koonung Creek, Bulleen Road is overtopped by 0.5 metres.

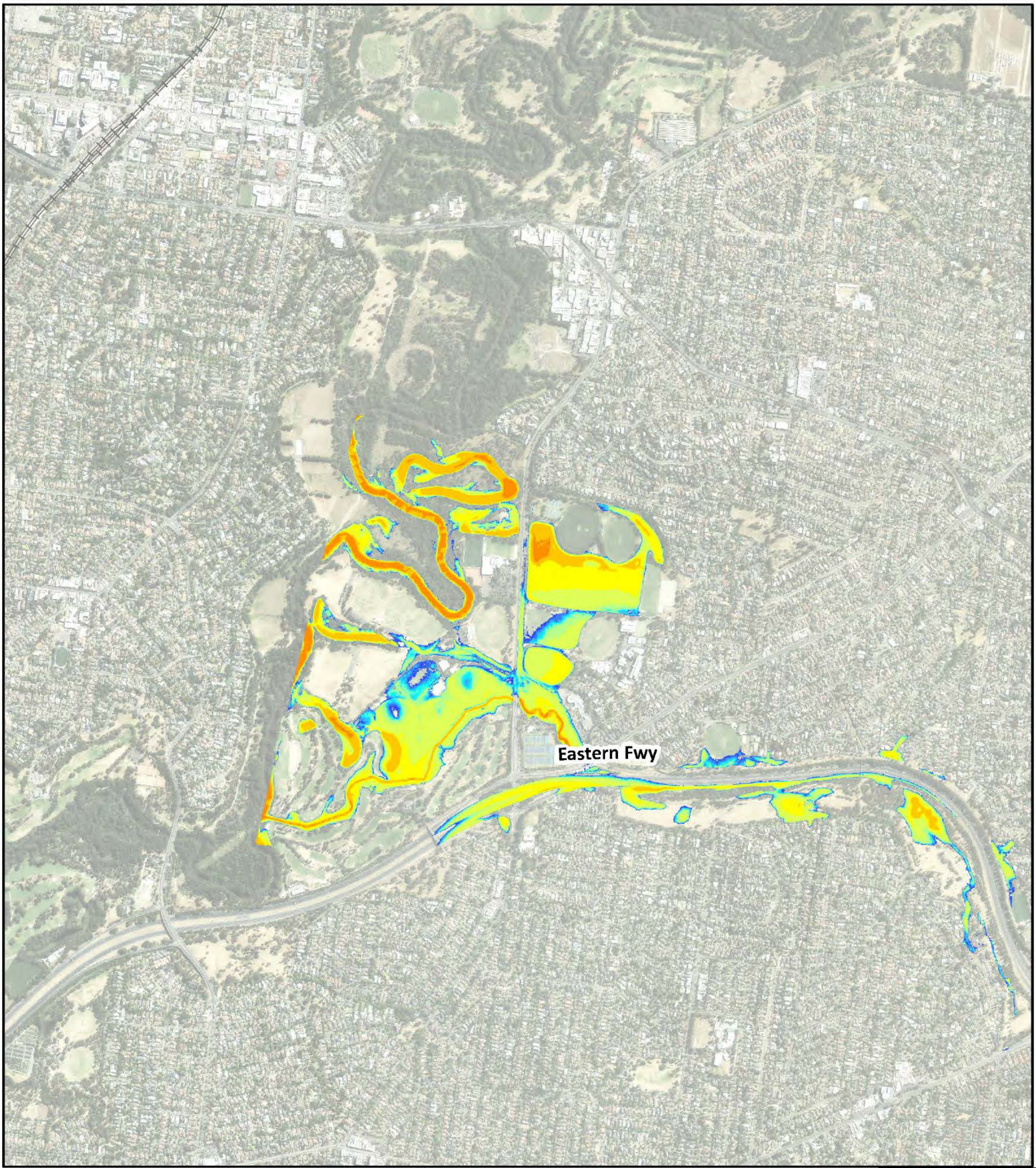
In addition to the Koonung Creek catchment the local catchment situated to the east of and including the Trinity Grammar School Sporting Complex has been modelled. Floodwaters from the 1% AEP event spread across most of the sporting ovals and water supply dam, before flowing through five 2.4-metre diameter overflow culverts beneath Bulleen Road into a wetland system on the western side of Bulleen Road, which discharges to the Yarra River.

The timing of the peak flow and water level influences the nature of the flooding within a catchment. Due to the short reach lengths and steep nature of the catchment flash flooding (quick rise and fall) occurs within Koonung Creek. Upstream of Thompsons Road, the flood peak might typically occur within one to two hours of the rain starting. Further downstream major flooding is likely to result from longer duration storms and the flooding response although still quick relative to a large river system may take several hours.

Koonung Creek is covered by an LSIO which represents the approximate flood extent for the 1% AEP storm event prior to construction of the Eastern Freeway. The LSIO has not been updated to include the various structures and realignments associated with the Eastern Freeway constructed in the 1990s and is not considered representative of existing (current) flood conditions.

Table 6-9 Koonung Creek existing condition results

AEP (%)	Peak flow into ‘arch drain’ at Doncaster Road (m^3/s)
10%	66.3
5%	81.5
2%	108.4
1%	121.1
1% climate change	122.1



Peak Flood Depth (m)

<0.05	0.16 - 0.20	0.51 - 1.20	8.01 - 12.00
0.05 - 0.10	0.21 - 0.25	1.21 - 2.00	12.01 - 18.00
0.11 - 0.15	0.26 - 0.30	2.01 - 4.00	
	0.31 - 0.50	4.01 - 8.00	

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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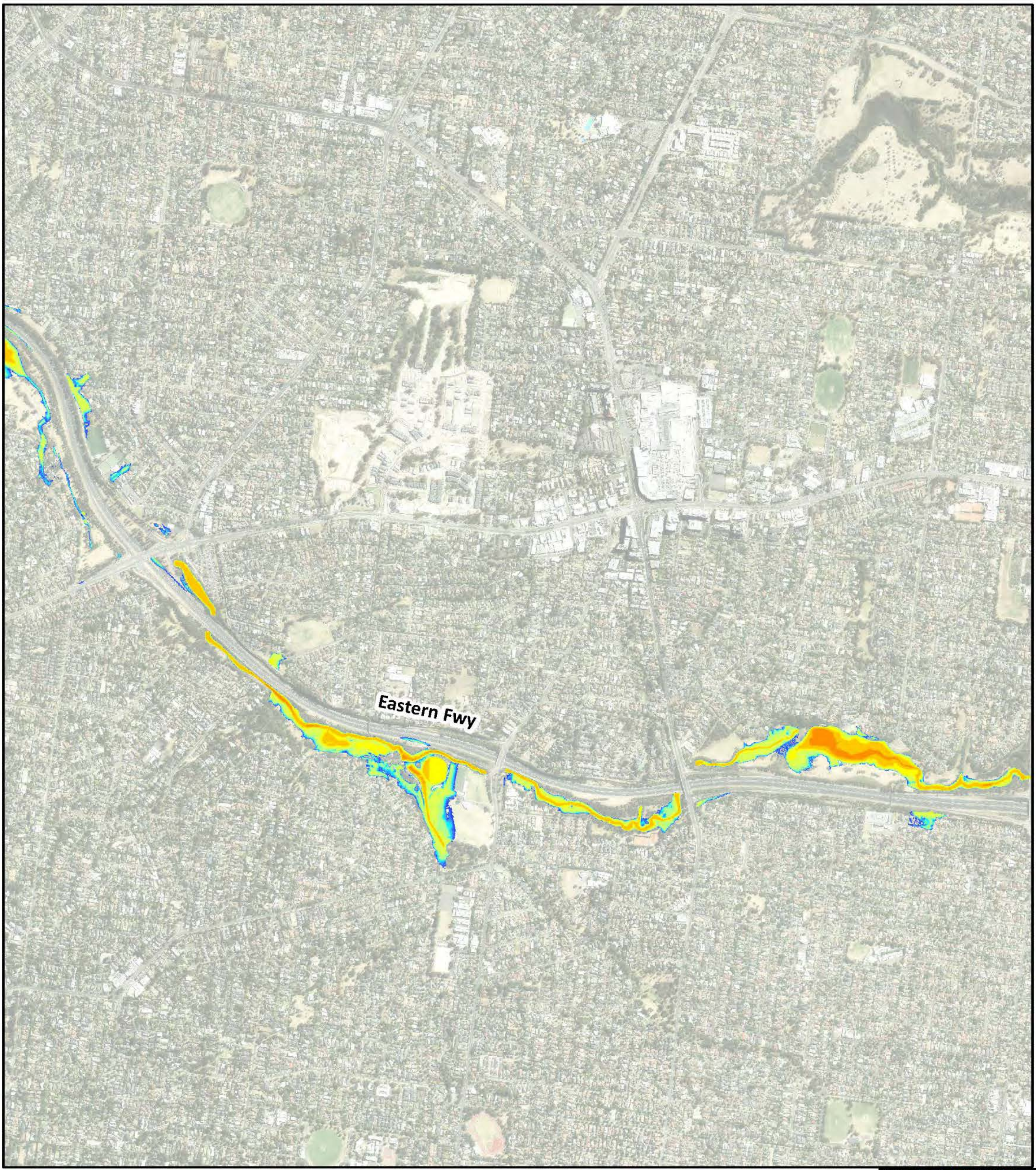
1% AEP peak flood depth
Koonung Creek 1 of 3

Figure 6-20



Peak Flood Depth (m)

<0.05	0.16 - 0.20	0.51 - 1.20	8.01 - 12.00
0.05 - 0.10	0.21 - 0.25	1.21 - 2.00	12.01 - 18.00
0.11 - 0.15	0.26 - 0.30	2.01 - 4.00	
	0.31 - 0.50	4.01 - 8.00	

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1% AEP peak flood depth
Koonung Creek 2 of 3

Figure 6-21

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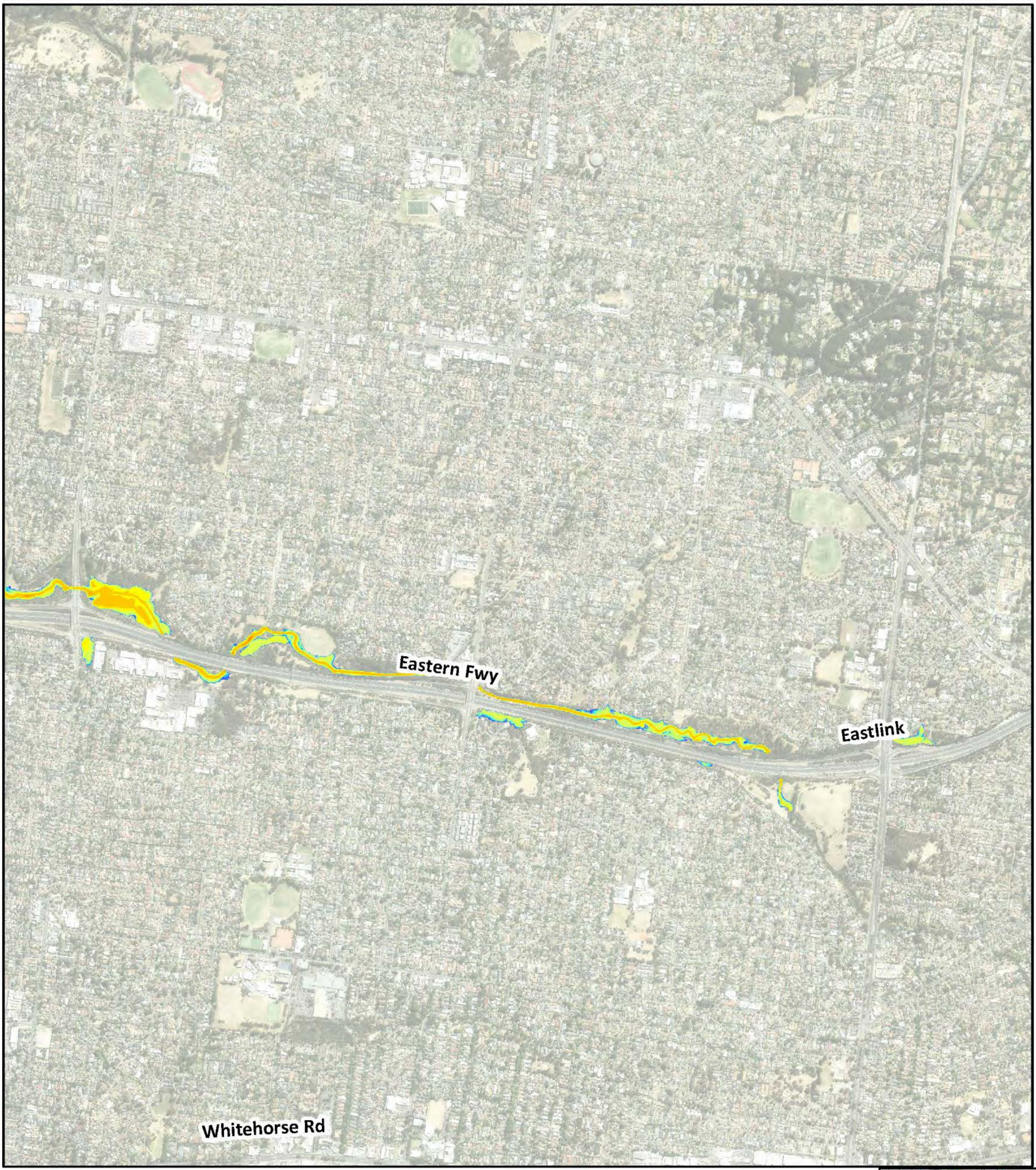
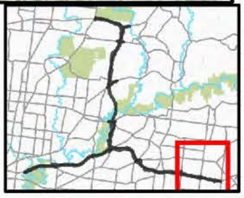
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Peak Flood Depth (m)

<0.05	0.51 - 1.20
0.05 - 0.10	1.21 - 2.00
0.11 - 0.15	2.01 - 4.00
0.16 - 0.20	4.01 - 8.00
0.21 - 0.25	8.01 - 12.00
0.26 - 0.30	12.01 - 18.00
0.31 - 0.50	



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1% AEP peak flood depth
Koonung Creek 3 of 3

Figure 6-22

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

6.6.2 Water quality

Water quality monitoring data was obtained for four monitoring stations on Koonung Creek (EPA Victoria, 2018; Melbourne Water, 2015). The water quality results are summarised in Table 6-10. The following data has been used for this assessment:

- Koonung Creek at Tunstall Street, Donvale (Site ID: 4402), 12 readings, recorded April 1998 through March 2008
- Koonung Creek at Elizabeth Street, Box Hill North (Site ID: 4400), eight readings, recorded October 1994 through March 1995
- Koonung Creek at Bushy Creek, Doncaster (Site ID: 4450), 10 readings, recorded October 2000 through March 2008
- Koonung Creek at Bulleen Road, Bulleen, 12 readings, recorded 2015.

Table 6-10 Water Quality monitoring results for Koonung Creek (EPA Victoria, 2018; Melbourne Water, 2015)

Parameter	SEPP (Waters) objective	Site ID: 4402	Site ID: 4400	Site ID: 4450	Bulleen Road
Dissolved oxygen (% Saturation) (25th percentile)	≥70% (25th percentile)	96.8	78.9	97.8	64
Dissolved oxygen (% saturation) (Maximum)	≤110% (Maximum)	118	90.1	115	95
Electrical conductivity at 25°C (75th percentile)	≤500 µS/cm (75th percentile)	990	No recorded data	846	583
pH (25th percentile)	≥6.4 (25th percentile)	7.8	7.5	7.4	7.4
pH (75th percentile)	≤7.9 (75th percentile)	8.3	7.7	7.7	7.7
Turbidity (75th percentile)	≤35 NTU (75th percentile)	108	40	216	52
Total nitrogen (75th percentile)	≤1,300 µg/l (75th percentile)	1,060	1,063	No recorded data	1,100
Total phosphorous (75th percentile)	≤110 µg/l (75th percentile)	54	96	No recorded data	90

Table Notes: Red numbers do not meet 2018 SEPP (Waters) objective

The small sample size covering the period from 1994 to 2015 shown in Table 6-10 indicates that the SEPP (Waters) objectives are only partially met for the monitoring sites along Koonung Creek.

Water quality recordings at Koonung Creek, Bulleen Road note especially high levels of E.Coli with 3,250 organisms per 100 millilitres (50^{th} percentile) (Melbourne Water, 2015) greatly exceeding the SEPP (Waters) objective of under 1000 organisms per 100 millilitres (EPA Victoria, 2003b). As outlined in the Tracking Sources of Faecal Pollution information bulletin (EPA Victoria, 2007), the human faecal biomarker (coprostanol/5a cholestenol ratio) measured from the dry and wet weather samples taken at Koonung Creek indicate human faecal matter contamination (Wangersky, 2006). Potential sources of faecal contamination include sewer blockages, seepage from the sewerage system and cross-connections between sewer and stormwater pipes (EPA Victoria, 2007).

The most recent analysis presented on the Yarra and Bay website (State Government of Victoria, 2018), of the available sampling of Koonung Creek (2016 – 2017) indicates a fair rating for pH at Bulleen Road, Bulleen. In the same timeframe, very poor ratings were noted for water clarity, dissolved oxygen, salinity, nutrients and metals due to high concentrations recorded for nitrogen, phosphorus and heavy metals (State Government of Victoria, 2018). DELWP combine the score of individual water quality parameters to produce an overall water quality index. Figure 6-23 shows that from 2000 to 2017, the water quality index for Koonung Creek at Bulleen Road, Bulleen has consistently remained very poor.

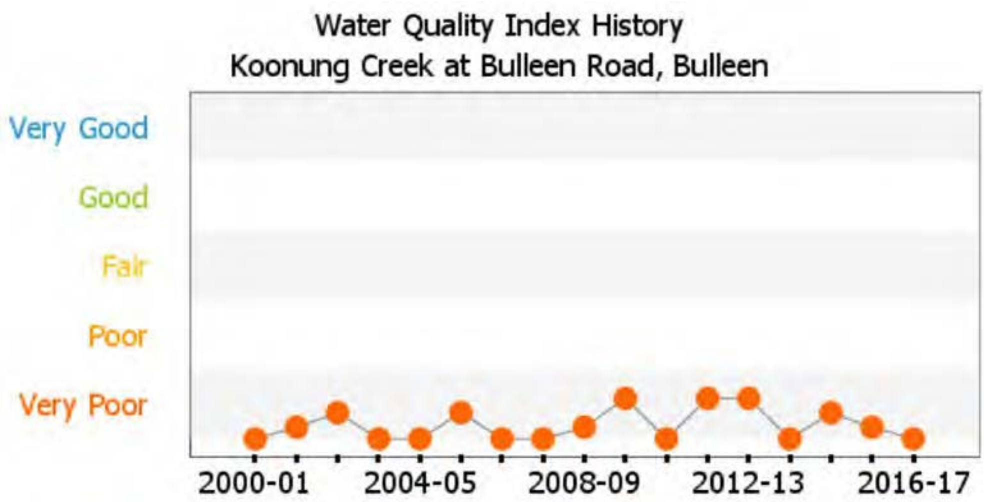

Figure 6-23 Water quality index, Koonung Creek at Bulleen Road, Bulleen (YAKOO0033) (State Government of Victoria, 2018)

Table 6-11 and Table 6-12 show the Koonung Creek existing condition descriptions from the Healthy Waterways Strategy (2018–2028) and specifically the Co-Designed Catchment Program for the Yarra Catchment (Melbourne Water, 2018) and a Koonung Creek conditions summary (Melbourne Water, 2007). Melbourne Water has rated Koonung Creek as of low regional importance and its overall current condition is rated as being very poor, with the lowest condition ratings for physical form and stormwater.

Table 6-11 Koonung Creek condition (Melbourne Water, 2018)

Parameter	Current state	Current trajectory	Target trajectory
Stormwater condition	Very low	Very low	Low
Physical form	High	Moderate	High
Water for the environment	Low	Very low	Low
Vegetation quality	Low	Very low	Low
Vegetation extent	Moderate	Moderate	Moderate
Instream connectivity	Low	Low	Low
Water quality – environment	Very low	Very low	Low
Access	High	High	Very high
Litter absence	Moderate	Moderate	High
Water quality – recreational	Very low	Very low	High
Participation	Low	Very low	High

Table 6-12 Koonung Creek condition summary (Melbourne Water, 2007)

Parameter	Condition
Water quality	Very poor
Aquatic life	Very poor
Habitat and stability	Good
Vegetation	Poor
Hydrology	Very poor

Flow data was made available for Koonung Creek but was not used due to poor data quality, and an unreliable rating curve. Therefore no flow assessment was undertaken.

6.6.3 Geomorphology

The existing geomorphic conditions within Koonung Creek have been appraised through observations made during site visits.

Koonung Creek is a heavily modified waterway due to the construction of the Eastern Freeway. The realignment works included significant lengths of erosion control works, consisting of rock armouring of the creek in some areas between Doncaster Road and Springvale Road. Despite some sections of the creek having steep longitudinal grades and confined width, significant erosion protection works along with exposed natural rock cuttings contribute to a relatively stable creek showing minimal signs of erosion.

Approximately 150 metres upstream of Elgar Road, there is evidence of localised bank erosion on the left bank (upstream of the shared use path bridge). The erosion is caused by the hydraulic flow conditions upstream of the bridge constriction and the height of the existing bank protection. The bank erosion is located above the rock armouring, and has exposed tree roots, threatening bank stability.

Approximately 80 metres downstream of the Bushy Creek and Koonung Creek confluence, there is evidence of lateral bank migration. The erosion occurs on an inner bend where the waterway has high sinuosity. Straightening of the waterway, to reach an equilibrium state through erosion is not common in this highly modified reach of Koonung Creek. Erosion in Koonung Creek between the arch culvert opposite Clifton Street and the shared used path crossing following Elgar Road (approximately 1.5 kilometres) is localised in nature and not widespread due to the significant armouring of the creek.

7. Risk assessment

A risk assessment of project activities was performed in accordance with the methodology described in Section 5.4. Risks were assessed for the construction and operation of North East Link.

The identified risks and associated residual risk ratings are listed in Table 7-1. The likelihood and consequence ratings determined during the risk assessment process and the adopted EPRs are presented in Appendix A. There are no planned events within the surface water impact assessment.

Table 7-1 Surface water risks

Risk ID	Potential threat and effect on the environment	Residual risk rating
Construction		
Risk SW01	Construction activities causing an increase in flood frequency, velocity or level which affects users or assets within the floodplain.	Medium
Risk SW02	Construction activities on existing flow paths including piped flow, causing a change in flow to downstream water quality assets impacting on the performance of the asset.	Low
Risk SW03	Construction activities causing unintended damage to drainage assets resulting in an unacceptable increase in flooding risk.	Medium
Risk SW04	Construction activities resulting in bed or bank erosion causing instability of assets adjacent to the waterway.	Medium
Risk SW05	Construction activities resulting in bed or bank erosion impacting on the beneficial uses of the receiving water.	Medium
Risk SW06	Hazardous materials used during construction of the project being released into the waterways resulting in adverse impacts on the beneficial uses of the receiving water.	Medium
Risk SW07	Construction activities causing sediment or contaminants to be released into the waterways resulting in adverse impacts on the beneficial uses of the receiving water.	Medium
Risk SW08	Construction activities leading to changes to water storages or supplies of irrigation assets affecting users.	Low
Operation		
Risk SW09	Project assets causing an increase in flood frequency, velocity or level which affect users or assets within the floodplain.	Medium
Risk SW10	Diversion of stormwater, causing a change in flow to downstream water quality assets impacting on the performance of the asset.	Low
Risk SW11	Increase in impervious area resulting in an increase in flow discharge leading to bed or bank erosion causing instability of assets adjacent to the waterway.	Low
Risk SW12	Increase in impervious area resulting in an increase in flow discharge leading to bed or bank erosion impacting on the beneficial uses of the receiving water.	Low
Risk SW13	Change in drainage alignment or discharge location concentrating flow and leading to bed or bank erosion causing instability of assets adjacent to the waterway.	Medium
Risk SW14	Change in drainage alignment or discharge location concentrating flow and leading to bed or bank erosion causing increased sediment loads impacting on the beneficial uses of the receiving water.	Medium
Risk SW15	Spills from traffic during operation of the project being released into the waterways resulting in adverse impacts on the beneficial uses of the receiving water.	Medium

Risk ID	Potential threat and effect on the environment	Residual risk rating
Risk SW16	Increase in impervious area leading to an increase in contaminants being released into the waterways resulting in adverse impacts on the beneficial uses of the receiving water.	Medium
Risk SW17	A flood event occurring during the operation of the tunnel causing inundation of the tunnel resulting in an impact to public safety.	Medium
Risk SW18	Water from tunnel drainage system being discharged to waterways resulting in adverse impacts on the beneficial uses of the receiving water.	Medium
Risk SW19	Insufficient capacity of road drainage design due to increased rainfall intensities from climate change resulting in an impact to public safety	Medium
Risk SW20	Project assets leading to changes to water storages or supples of irrigation assets affecting users.	Low
Risk SW21	Project assets reducing the effectiveness of water quality treatment resulting in adverse impacts on the beneficial uses of the receiving water.	Medium

8. Construction impact assessment

This section describes the assessment of the potential surface water impacts for the construction of North East Link. North East Link proposes a combination of new road infrastructure on the surface, in open cut, on embankments, on structural viaducts, and within cut and cover and bored tunnels. It includes the assessment of impacts associated with infrastructure such as the Doncaster Park and Ride facility associated with the Doncaster Busway, constructed barriers, ventilation structures, substations and temporary stockpiles.

The Environmental Performance Requirements (EPRs) referred to in the following section are tabulated in Table 12-1 of Section 12.

8.1 Flooding

This assessment has investigated the potential for construction activities to cause an increase in flood risk due to temporary placement of construction buildings, structures, materials or vehicles within the floodplain, or due to damage to assets (risk SW01 and risk SW03). The locations of no go zones, the likely construction footprint and potentially locations for construction compounds and stockpiles have been identified and considered in this assessment. No-go zones are located adjacent to the project boundary and define areas where surface works would not be permitted. No-go zones have been designated for the following sensitive areas:

- A vegetated patch near the intersection of the M80 Ring Road and Plenty Road
- Bolin Bolin Billabong
- A portion of Yarra Bend Park (Eastern Freeway element).

During the construction of North East Link, temporary construction compounds would be located along the alignment to facilitate construction. Construction compounds are typically occupied by site offices and amenities building and used to store vehicles, machinery and equipment as well as materials such as spoil. When located in flood-prone areas, stored material has the potential to reduce flood storage capacity, and this could increase flood frequency and levels (risk SW01).

Given the proximity of the project to the Banyule Creek, Yarra River and Koonung Creek floodplains, temporary construction compounds intersect with existing flood extents. Although structures, equipment and materials would be kept out of flood-prone areas wherever possible, it is inevitable that temporary placement within the floodplain would be necessary in a number of areas which may displace flood water and increase flood risk.

The level and location of flooding risk may vary between sites and construction phases. Increased flooding could materialise as an increase in flood frequency or an increase in flood levels, and if not mitigated may affect properties within or adjacent to the existing floodplain. Staging of construction works to reduce flooding risks would be considered when planning construction sequences.

The potential risk of increased flood levels for property within the floodplain would be mitigated through the preparation and implementation of a Surface Water Management Plan. The Surface Water Management Plan would outline the requirements and methods for the layout, usage, protection and flood mitigation of the compounds and include a suitable flood emergency response plan (EPR SW5). To avoid increasing flood risks associated with overland flow paths or alteration of the flow regimes, construction compounds would need to be set out to minimise both their impact on flooding and their vulnerability to flooding. Hydraulic modelling of critical stages and mitigation works would be undertaken to demonstrate that flood risks are appropriately managed to the requirements of Melbourne Water, the asset owner, local council and other authorities as relevant (EPR SW6).

The following sections describe the other construction activities and associated risks that are specific for each waterway and associated floodplain.

8.1.1 Yando Street Main Drain

This assessment has investigated the potential for the construction of North East Link to increase flood risk along the Yando Street Main Drain adjacent to Greensborough Bypass (risk SW01 and risk SW03). Construction of North East Link at Yando Street Main Drain may include the following works:

- Drainage modification works to the underground drain
- Temporary fencing to separate public activities from the construction sites
- Earthworks, drainage, pavement construction, barriers, and lighting installation
- Embankment construction
- Shared use path construction.

Consideration of appropriate combinations of these and or other construction activities such as stockpiling is subject to adopted construction methodologies and sequencing. Construction staging would need to consider how overland flows would be maintained during works (EPR SW6).

Increased flooding could occur as an increase in flood frequency and/or flood levels, at properties within or adjacent to the existing floodplain. The following EPRs would be implemented to reduce this risk:

- A Surface Water Management Plan to manage surface water during construction including measures such as maintaining existing flow paths, drainage lines and floodplain storage (EPR SW5)
- The assessment of flood risk through modelling of temporary works to demonstrate that the project meets the flood level, flow and velocity requirements (EPR SW6)
- Provide adequate clearances and access for ongoing maintenance of drainage assets (EPR SW10)
- Minimise impacts and interference with third party property and infrastructure that could cause damage or impacts (EPR B3).

8.1.2 Kempston Street Main Drain

This assessment has investigated the potential for the construction of North East Link to increase flood risk along the Kempston Street Main Drain from Grimshaw Street and downstream (risk SW01 and risk SW03). Construction of North East Link at Kempston Street Main Drain may include the following works:

- Temporary fencing to separate public activities from the construction sites
- Establishment, use and removal of construction compounds within the floodplain
- Earthworks, drainage, pavement construction, barriers, and lighting installation
- Modification works to the retarding basin south of Grimshaw Street
- Construction of additional embankment for north-bound on ramp from Grimshaw Street
- Shared use path construction including an underpass beneath Grimshaw Street.

Consideration of appropriate combinations of these and or other construction activities such as stockpiling is subject to adopted construction methodologies and sequencing. Construction staging would need to mitigate the loss of storage in the retarding basin and downstream floodplain before reducing the available storage to avoid the risk of downstream impacts (EPR SW6).

Increased flooding could occur as an increase in flood frequency and flood levels, at properties within and adjacent to the existing floodplain. The following EPRs would be implemented to reduce this risk:

- A Surface Water Management Plan to manage surface water during construction including measures such as maintaining existing or adequate alternative overland flow paths, underground drainage and storage capacity (EPR SW5)
- The assessment of flood risk through modelling of temporary works as required to demonstrate that the project meets the flood level, flow and velocity requirements (EPR SW6)
- Provide adequate clearances and access for ongoing maintenance of drainage assets (EPR SW10)
- Minimise impacts and interference with third party property and infrastructure that could cause damage or impacts (EPR B3).

8.1.3 Watsonia Station drain

This assessment has investigated the potential for the construction of North East Link to increase flood risk from flood flows associated with this drain. Construction activities at this location may include the following works:

- Replacement of the existing drain along a new alignment to the north of its current location to provide adequate clearance to the proposed cutting.
- Decommissioning the existing drain following its diversion
- Diversion of overland flow paths across the new land bridge to the south of the existing overtopping location and protection of the cutting from flooding.
- Excavation of the open cut section of North East Link
- Construction of new approach and bypass roads to the west (upstream) of North East Link.

- Local drainage works to re-establish upstream storage capacity and drain new low points.
- Potential to redirect flows from the backs of properties along Rasheda Street to the street
- Construction of flood barriers around land bridges
- Earthworks, drainage, pavement construction, barriers, and lighting installation
- Temporary fencing to separate public activities from the construction site
- Relocation of services as required
- Shared use path construction
- Clearance of vegetation
- Reinstatement.

Consideration of appropriate combinations of these and or other construction activities such as stockpiling is subject to adopted construction methodologies and sequencing. Construction staging would need to consider how flows both piped and overland would be maintained during works.

Increased flooding could occur as an increase in flood frequency or flood levels, at properties within or adjacent to the existing floodplain. The following EPRs would be implemented to reduce this risk:

- A Surface Water Management Plan to manage surface water during construction including measures such as maintaining existing or providing adequate alternative overland flow paths, underground drainage and floodplain storage (EPR SW5)
- The assessment of flood risk through modelling of temporary works to demonstrate that the project meets the flood level, flow and velocity requirements (EPR SW6)
- Minimise impacts and interference with third party property and infrastructure that could cause damage or impacts (EPR B3).

8.1.4 Banyule Creek

This assessment has investigated the potential for the construction of North East Link to increase flood risk at properties along the existing Banyule Creek from Simpson Barracks to Lower Plenty Road (risk SW01 and risk SW03). North East Link would include a cut and cover section of road from Blamey Road to Lower Plenty Road containing a number of open cut sections for on an off ramps. This section of Banyule Creek comprises Commonwealth land at Simpson Barracks and a section of publicly accessible Commonwealth land south of Simpson Barracks bounded by Borlase Street and Greensborough Road (see Section 6.1).

The reference project would result in the Banyule Creek being diverted into a drainage system to either side of the North East Link roadway, between Simpson Barracks and Lower Plenty Road. As a result, the existing flood regime would be significantly altered, with Banyule Creek no longer being a semi natural urban creek through Simpson Barracks. The newly constructed pipes would feed into a series of detention and treatment ponds to the north of Lower Plenty Road. These ponds would be used for treatment and storage of stormwater. The water within the ponds would be directed to the existing culvert under Lower Plenty Road and from this point the creek would follow its existing alignment through the residential area of Viewbank and Rosanna.

In addition, and to facilitate these works, construction of North East Link at Banyule Creek would include the following works:

- The temporary diversion and subsequent realignment of Banyule Creek from Blamey Road to Lower Plenty Road; this would involve temporary redirection of flows, construction of new pipes, inlet structures, overland flow paths and some bunding
- Excavating and subsequently covering the majority of North East Link between Blamey and Lower Plenty Road while protecting the works from inundation
- Construction of portals and road ramps within the floodplain
- Constructing flood barriers around the numerous on and off ramps in this section which would remain open to the surface and overland flows
- Downstream of Lower Plenty Road the project would be in tunnels roughly parallel and occasionally crossing beneath Banyule Creek
- Earthworks, drainage, pavement construction, barriers, and lighting installation
- Establishment, use and removal of construction compounds within the floodplain
- Storage of spoil
- Temporary fencing to separate public activities from the construction site along the length of Banyule Creek to Lower Plenty Road
- Temporary access tracks along the Banyule Creek floodplain
- Sewer decommission and relocation
- Water main relocation including relocation of pressure reducing valve
- Shared use path construction
- Clearance of vegetation
- Reinstatement.

Consideration of appropriate combinations of these and or other construction activities such as stockpiling is subject to adopted construction methodologies and sequencing. Construction staging would need to consider how flows in the creek would be maintained during works in the waterway.

Increased flooding could occur as an increase in flood frequency or flood levels, at properties within or adjacent to the existing floodplain. The following EPRs would be implemented to reduce this risk:

- A Surface Water Management Plan to manage surface water during construction including measures such as maintaining existing or provide adequate alternative overland flow paths, underground drainage and floodplain storage (EPR SW5)
- The assessment of flood risk through modelling of temporary works to demonstrate that the project meets the flood level, flow and velocity requirements (EPR SW6)
- Provide adequate clearances and access for ongoing maintenance of drainage assets (EPR SW10)
- Minimise impacts and interference with third party property and infrastructure that could cause damage or impacts (EPR B3).

8.1.5 Yarra River

This assessment has investigated the potential for the construction of North East Link in particular works between Manningham Road to the Eastern Freeway to increase flood risk within the Yarra River flood plain (risk SW01 and risk SW03). With the exception of bridge strengthening works on the Eastern Freeway over the Yarra River, an associated shared use path bridge immediately upstream of the existing crossing and the dual tunnels under the Yarra River, the construction of North East Link would affect the Yarra River floodplain and not the river directly. Works within the floodplain may include the following:

- Earthworks, drainage construction, pavement construction, barriers, and lighting installation
- Storage of spoil on the southern side of Manningham Road immediately west of Bulleen Road
- Constructing flood barriers around the numerous on and off ramps in this section which would remain open to the surface and overland flows
- Temporary fencing to separate public activities from the construction site
- Temporary access tracks along the Yarra River floodplain
- Clearance of vegetation
- Shared use path construction
- Construction of portals and on off ramps within the floodplain
- Construction of Doncaster Busway to the north of the current Eastern Freeway adjacent the Freeway Public Golf Course
- Potential setup, use and removal of construction compounds within the floodplain
- Reinstatement.

Consideration of appropriate combinations of these and or other construction activities such as stockpiling is subject to adopted construction methodologies and sequencing.

Increased flooding could occur as an increase in flood frequency or flood levels, at properties within or adjacent to the existing floodplain. The following EPRs would be implemented to reduce this risk:

- A Surface Water Management Plan to manage surface water during construction including measures such as maintaining existing flow paths, drainage lines and floodplain storage (EPR SW5)
- The assessment of flood risk through modelling of temporary works to demonstrate that the project meets the flood level, flow and velocity requirements (EPR SW6)
- Provide adequate clearances and access for ongoing maintenance of drainage assets (EPR SW10)
- Minimise impacts and interference with third party property and infrastructure that could cause damage or impacts (EPR B3).

The bridge strengthening works at Yarra Bend and the new shared use path crossing immediately upstream would be undertaken from the banks in accordance with the relevant EPRs (EPR SW1, EPR SW3, EPR SW4, EPR SW5, EPR SW6, EPR SW7, EPR SW8, EPR SW9 and EPR SW10).

8.1.6 Koonung Creek

This assessment has investigated the potential for the construction of North East Link to increase flood risk along the Koonung Creek from Springvale Road to Bulleen Road (risk SW01 and risk SW03). North East Link proposes the diversion and undergrounding of some sections of the existing open channel for Koonung Creek.

To allow for the widening of the Eastern Freeway, three sections of Koonung Creek would be diverted from their current course due to the reference project (totalling approximately 600 metres). The diversions would involve the installation of a naturalised channel with the shape and invert matching the existing channel, and works on the floodplain to provide compensatory flood storage that would be required due to the freeway embankment.

This would occur at the following locations:

- Between Bulleen Road and Thompsons Road, one section approximately 100 metres in length
- Between Doncaster Road and Elgar Road, one section approximately 400 metres in length, an alignment which would partially intercept the location of the existing Koonung Creek Wetlands. These wetland would be rebuilt and re-established in a new location adjacent but to the south west of their current location.
- Between Tram Road and Middleborough Road, one section approximately 100 metres in length.

In addition, a number of sections of Koonung Creek would be enclosed and covered with the reference project. At these locations, the existing creek bed would be replaced with an arch culvert pipe, which would then be covered with soil, effectively creating a piped waterway. This would occur at the following locations:

- Between Bulleen Oval and the Eastern Freeway, one section approximately 100 metres in length
- Between Bulleen Road and Thompsons Road, one section approximately 100 meters in length
- Between Doncaster Road and Elgar Road, one section approximately 500 metres in length
- Between Doncaster Road and Elgar Road, a second section approximately 100 metres in length
- Between Elgar Road and Tram Road, one section approximately 200 metres in length.

Without appropriate mitigation the above changes would result in some reduction in attenuation and increased flood levels. A number of measures including storage and flow control devices would be required to mitigate the risks of this impact. Compensating Flood Storage Locations (CFSL) have been proposed in a number of locations although during construction the need for mitigation will vary with construction methodologies and sequencing.

In addition, and to facilitate these works, construction of North East Link at Koonung Creek may include the following works:

- Clearance of vegetation
- Local drainage works including diversion of overland flow paths and redirection of flows at five locations along the creek

- Modification of existing retarding basins to manage flood waters
- Establishment, use and removal of construction compounds within the floodplain
- Excavation of area adjacent to waterway
- Construction of surface roads adjacent to the waterway
- Construction of portals and road ramps within the floodplain
- Construction of flood barriers at the southern portal
- Earthworks, drainage, pavement construction, barriers, and lighting installation
- Temporary fencing to separate public activities from the construction site
- Temporary access tracks along the open space alongside the Koonung Creek floodplain
- Shared use path construction.

Consideration of appropriate combinations of these and or other construction activities such as stockpiling is subject to adopted construction methodologies and sequencing. Construction staging would need to consider how flows in the creek would be maintained during works in the waterway.

Increased flooding could occur as an increase in flood frequency or flood levels, at properties within or adjacent to the existing floodplain. The following EPRs would be implemented to reduce this risk:

- A Surface Water Management Plan to manage surface water during construction including measures such as maintaining existing flow paths, drainage lines and floodplain storage (EPR SW5)
- The assessment of flood risk through modelling of temporary works to demonstrate that the project meets the flood level, flow and velocity requirements (EPR SW6)
- Provide adequate clearances and access for ongoing maintenance of drainage assets (EPR SW10)
- Minimise impacts and interference with third party property and infrastructure that could cause damage or impacts (EPR B3).

8.2 Water quality

This assessment has considered the potential for the construction activities required for North East Link to affect waterway health and water quality. When stormwater from rainfall comes into contact with soils it can transport pollutants from the soil into the drainage systems and waterways (risk SW07). Pollutants in the sediments of stream beds can also be released during construction within the waterways (risk SW05). This risk would be effectively managed by EPR SW8.

Hazardous materials used during construction such as fuels and machine lubricants may become mobilised in stormwater during a rainfall or flood event and be released into the waterways resulting in adverse impacts to the waterway (risk SW06). This could also occur as a result of accidental spills. The impact would vary depending on the type and quantity of pollutant and the amount transferred to a surface water environment. This risk would be managed by compliance with EPR CL5.

Construction activities such as site clearance, earthworks and excavations may also cause contaminants already present in soils such as heavy metals and waste products to be released into waterways which may adversely impact water quality (risk SW07). The impact would vary depending on the type of contaminant at the site, the quantity of the contaminant present and the amount of exposure or transfer to a surface water environment. Pollutants may include contaminated sediments, asbestos, solid inert waste, oils and chemicals.

To address this risk to water quality, EPRs would be implemented during the construction of North East Link. In consultation with EPA Victoria and Melbourne Water, existing water quality conditions would be determined through a baseline water quality monitoring program before construction started (EPR SW4). The baseline surface water monitoring program would inform methods adopted for surface water management (EPR SW5). The Surface Water Management Plan should include details of the water quality requirements for the project, (based on EPA Victoria guidelines) including any trigger levels for pollutants. Water quality monitoring undertaken during construction would also be used to confirm that environmental controls documented in the Surface Water Management Plan were being appropriately applied. Implementation of a Surface Water Management Plan would reduce the risk of contamination of waterways during construction. The Surface Water Management Plan (EPR SW5) would include a management plan for best practice sediment and erosion control and monitoring in accordance with EPA Victoria guidelines. This management plan would also outline the requirements for the location and bunding of any contaminated material. Under the SEPP (Waters) there are controls for waterway discharge and runoff which must be met during construction (EPR SW1). Implementation of the Surface Water Management Plan would assist in meeting the SEPP (Waters) requirements.

Construction activities have the potential to cause a change in flow to downstream water quality assets impacting on the performance of the asset (risk SW02). These changes may include increased or reduced flows, peakier flows (reduced attenuation) or increased pollutant loadings, such as sediment. This risk would be addressed by development of a water quality monitoring program prior to construction (EPR SW4) and the implementation of a surface water management plan (EPR SW5). This would assist the project in meeting the SEPP (Waters) requirements for discharge and runoff (EPR SW1).

8.3 Geomorphology

Geomorphology relates to the study of landforms, their origin and evolution. For North East Link, the key geomorphic features are associated with the bed and banks of Banyule Creek, Koonung Creek and Yarra River.

This assessment has considered the potential for any construction works undertaken within waterways or floodplains that involve removing/changing the soil from the bed or banks of the creek to alter the landform or geomorphic characteristics of the waterway. Additionally, any changes to the slope, flow, velocity, flow frequency and timing have the potential to change the geomorphic stability of the waterway and subsequently neighbouring assets, these have been considered (risk SW04). The assessment has also considered the potential for changes to the geomorphic conditions to result in erosion and sediment transfer downstream, which could impact water quality (risk SW05). These are discussed for the relevant waterways in the following sections.

8.3.1 Banyule Creek

Construction activities at Banyule Creek involve the diversion of approximately 1,400 metres of ephemeral creek from its headwaters (south of Blamey Road) to Lower Plenty Road and associated changes to tributaries and the local land form. This section of the creek would be replaced with culverts and overland flow paths to convey stormwater to a new retarding basin upstream of Lower Plenty Road before being discharged back into Banyule Creek just downstream of Lower Plenty Road. Downstream of Lower Plenty Road, Banyule Creek would remain functionally unchanged.

The potential for subsidence due to tunnelling is discussed in Technical report M – Ground movement, and is understood to be insignificant with respect to the function and stability of Banyule Creek. The function of all local drainage currently discharging to Banyule Creek upstream of Lower Plenty Road would need to be maintained during construction.

Waterway stability would be protected by maintaining existing flow conditions (EPR SW5) by minimising the works in or around the waterways to limit the potential for erosion, sediment plumes, bank instability and exposure or mobilisation of contaminated material (EPR SW8), by appropriate timing of works (aligned with low flow periods) (EPR SW5) and regular monitoring of the water quality downstream of the location of works to provide early indication of potential erosion and subsequent threats to water quality and bank stability (EPR SW4, SW8 and SW9).

All works on the waterways would need to meet the requirements of Melbourne Water in consultation with relevant local councils, and any waterway modifications would minimise the potential for erosion (EPR SW8). Preparation and implementation of a Surface Water Management Plan specifying the required mitigation measures, as well as drainage asset condition before construction works would avoid or minimise adverse effects on waterway stability (EPR SW5).

8.3.2 Yarra River

The construction stockpiles within the Yarra River floodplain would not be located within active conveyance areas and would be small in comparison with the available storage. As such they would be unlikely to have a significant effect on upstream or downstream flood levels respectively. The potential for cumulative loss of flood plain storage would be limited by the duration of the works and the need to comply with EPR SW6 and EPR SW8.

All works on or within floodplains would need to meet the requirements of Melbourne Water in consultation with relevant local councils and property managers, and any modifications would minimise the potential for erosion which can impact on the beneficial uses of the waterway (EPR SW8). Compliance with a Surface Water Management Plan as well as asset condition assessments before and after construction works would avoid or minimise adverse effects on bank stability.

The construction of water sensitive urban design features potentially including bioretention treatments at Manningham Road, wetlands near Burke Road and wetlands near the Chandler Highway would require a new stormwater discharge location to the Yarra River. The new outlet to the river would have the potential to cause localised scour and erosion leading to instability of the bed and/or bank of the billabong or river at the discharge location (risk SW04 and risk SW05).

Waterway stability would be protected by maintaining existing flow conditions, by minimising the works in or around the waterways to limit the potential for erosion, sediment plumes, bank instability and exposure or mobilisation of contaminated material (EPR SW8), appropriate timing of works (aligned with low flow periods) and regular monitoring of the water quality downstream of the location of works to provide any indication of potential erosion and subsequently bank stability (EPR SW4 and SW11). These would be implemented as part of the Surface Water Management Plan (EPR SW5). Implementation of these controls would also assist in meeting the SEPP (Waters) requirements and preventing water quality impacts (EPR SW1). The potential for subsidence due to the tunnelling is discussed in Technical report M – Ground movement, and is understood to be insignificant with respect to the function and stability of the Yarra River.

8.3.3 Koonung Creek

Construction of the Eastern Freeway widening would encroach on Koonung Creek and would require approximately 1,500 metres of the creek to be diverted underground or realigned. The assessment has considered the potential for construction works (for example diversions, realignments and pedestrian bridges) within the Koonung Creek waterway or floodplain to result in bed and/or bank erosion.

Waterway realignment works would require the clearing of vegetation in the floodplain prior to the re-establishment of new vegetation. Any works undertaken within the waterway or floodplains of the Koonung Creek that involve removing soil from the bed or banks of the creek could alter the landform or geomorphic characteristics of the waterway (risk SW04 and risk SW05). Mitigation measures such as the provision of suitable erosion protection on banks, efficient vegetation establishment or other erosion control measures could be used to mitigate any bed or bank instability (EPR SW9). These would be implemented as part of the Surface Water Management Plan (EPR SW5).

Bank stability would be maintained through maintaining existing low flow conditions by minimising the works in or around the waterways, appropriate timing of works (aligned with low flow periods) and regular monitoring of the water quality downstream of the location of works to provide early indication of potential erosion and subsequent threats to bank stability (EPR SW4). Implementation of these controls would also assist in meeting the SEPP (Waters) requirements and preventing water quality impacts (EPR SW1).

All works on the waterways would need to meet the requirements of Melbourne Water in consultation with relevant local councils, and any waterway modifications would minimise the potential for erosion (EPR SW8). Preparation and implementation of a Surface Water Management Plan specifying the required mitigation measures, as well as drainage asset condition assessments before and after construction works would avoid or manage adverse effects on waterway stability.

8.4 Water supply

Construction of the tunnels at Bulleen Road would impact the operation of the private dam on the Trinity Grammar School Sporting Complex. The existing dam may need to be significantly modified during construction of the tunnel entrance (cut and cover). This assessment has investigated the potential that stormwater storage of any significance would not be accessible during the construction period, affecting existing users (risk SW08). Alternative stormwater supply for irrigation purposes would be required during construction to meet the irrigation demand of both the Trinity Grammar School Sporting Complex and Marcellin College. Other secondary functions of this system such as local drainage and flood mitigation would also need to be adequately maintained by the proposed works (EPR SW6).

The Trinity Grammar ephemeral wetland is located between the upstream catchment diversion and the downstream water storage dam. It is important that the upstream diversion is not altered without considering the potential effect of changes in flow regime downstream on for instance this wetland (EPR SW8).

The recently constructed Bolin Bolin Integrated Water Management Project is understood to receive stormwater from a local catchment to the north of the Trinity Grammar School Sporting Complex. If local drainage is rerouted during the construction of the tunnel entrance (cut and cover), there is potential for the supply to this water management project to be reduced or cut off.

To prevent these impacts, a suitable water supply would need to be maintained (EPR SW12). A suitable water supply would potentially be maintained using the existing water extraction licence from the Yarra River, or an alternative water supply provided during construction.