



# Appendix J
# Concept Summary

February 2018

# Contents

# Figures

# Tables

# Abbreviations

| Acronym/Term | Description |
|---|---|
| AEP | Annual Exceedance Probability |
| AGPT | Austroads Guide to Pavement Technology |
| AGRD | Austroads Guide to Road Design |
| AGRT | Austroads Guide to Road Tunnels |
| ASS | Acid Sulphate Soils |
| ATAP | Australian Transport Assessment and Planning |
| Bolin Bolin | Bolin Bolin Billabong |
| C-D | Collector Distributor |
| C&CT | Cut and Cover Tunnel |
| CPT | Cone Penetrometer Testing |
| CPTED | Crime Prevention Through Environmental Design |
| DA | Detailed Appraisal |
| DART | Doncaster Area Rapid Transit |
| DBYD | Dial Before You Dig |
| DDA | Disability Discrimination Act 1992 (Cth) |
| DTF | Department of Treasury and Finance |
| EES | Environmental Effects Statement |
| EPR | Environmental Performance Requirement |
| F&LS | Fire and Life Safety |
| FCC | Freeway Control Centre |
| I&M | Instrumentation and Monitoring |
| IPWEA | International Infrastructure Management Manual |
| ITS | Intelligent Transport Systems |
| IV | Infrastructure Victoria |
| Landbridges | Landscaped Bridges |
| LUD | Landscape and Urban Design |
| M80 | M80 Ring Road (Metropolitan and Western) |
| M&E | Mechanical & Electrical |
| MFB | Melbourne Fire Brigade |
| MTM | Metro Trains Melbourne |
| MW | Melbourne Water |
| NEL | North East Link |
| NELA | North East Link Authority |
| O&M | Operations & Maintenance |
| OHS | Occupational Health and Safety |
| OMR | Outer Metropolitan Ring Road |
| PAO | Planning Acquisition Overlay |

| Acronym/Term | Description |
|---|---|
| PASS | Potential Acid Sulphate Soils |
| PBN | Principal Bicycle Network |
| PMF | Probable Maximum Flood |
| PTV | Public Transport Victoria |
| RA | Rapid Appraisal |
| RSA | Road Safety Audit |
| RSS | Reinforced Soil Structures |
| SCC | Strategic Cycling Corridors |
| SEM | Sequentially Excavated Mined (tunnel) |
| SiD | Safety in Design |
| SMT | Strategic Merit Test |
| SPT | Standard Penetrometer Testing |
| SUP | Shared User Path |
| SPUD | Single Point Urban Diamond |
| TBM | Tunnel Boring Machine |
| TIA | Transport Integration Act |
| WSRD | Water Sensitive Road Design |
| YVW | Yarra Valley Water |
| ITS Abbreviations | |
| AID | Automatic incident detection |
| AVID | Automatic video incident detection |
| CCTV | Closed circuit television |
| LED | Light emitting diode |
| LUMS | Lane use management system |
| LUS | Lane use sign |
| METS | Motorist Emergency Telephones |
| MM | Managed Motorway |
| OMCS | Operation Management and Control System |
| PMCS | Plant Management and Control System |
| SCATS | Sydney Coordinated Adaptive Traffic System |
| STREAMS | Freeway management system used by VicRoads |
| TMCS | Traffic management and control system |
| TMS | Tunnel management sign |
| TMSS | Tunnel management systems |
| TIRTL | The Infra-Red Traffic Logger |
| UPS | Uninterrupted power supply |
| VESI | Victorian Electricity Supply Industry |
| VMS | Variable message signs |
| VSLS | Variable speed limit signs |
| WIM | Weigh-in-Motion |

# 1 Overview

## 1.1 Purpose

The purpose of this Concept Design Summary Report is to summarise the design that supports the Business Case for the North East Link Project (the Project).

The concept design presented in this report should not be considered to be the finalised scope for the Project. This scope was developed in order to have reasonable basis on which to develop a robust Business Case and a range of cost estimates. Should the project proceed past the Business Case stage, the State will undertake a more exhaustive consideration of all aspects in refining any project scope.

This report should also be considered within the wider context of the Business Case including with respect to traffic modelling. The traffic analysis and inputs are not documented in this report, but are a key driver to design outcomes. Please refer to the broader Business Case and relevant appendices for further detail.

## 1.2 Background

The North East Link (**NEL**) was identified as Victoria's next priority road project in Infrastructure Victoria's (**IV's**) 30-year strategy, which set out a pipeline of initiatives to be delivered over the next three decades to help create the best possible future for the State. It also nominated NEL as a short to medium-term project that would enhance access to major employment centres and improve the capacity of the freight network.

In December 2016, the Victorian Government committed to preparing a Business Case for NEL. The Government also announced that the Business Case would be completed by 2018, with planning approvals and tender processes also beginning that year. The North East Link Authority (**NELA**) was established to develop the Business Case, undertake community consultation, and recommend the route for NEL.

## 1.3 Limitations of the Report

This report has been prepared by GHD for the NELA and may only be used and relied on by NELA for the purpose of accompanying the "Concept Design" drawings associated with the aforementioned design. GHD otherwise disclaims responsibility to any person other than NELA arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report. The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD as described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by NELA and others who provided information to GHD, which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

# 2 Existing Conditions

## 2.1 Overview

As Melbourne has grown and its economy has evolved, demand for movement across the city and around its periphery has increased significantly. Between Melbourne's west and north, orbital movements are facilitated via the M80 Ring Road (**M80**), which runs from the Princes Freeway in Altona to the Greensborough Bypass in Greensborough. Movements between the east and south-east are enabled by the Eastern Freeway and EastLink, which traverses the outer eastern suburbs between Donvale and Seaford.

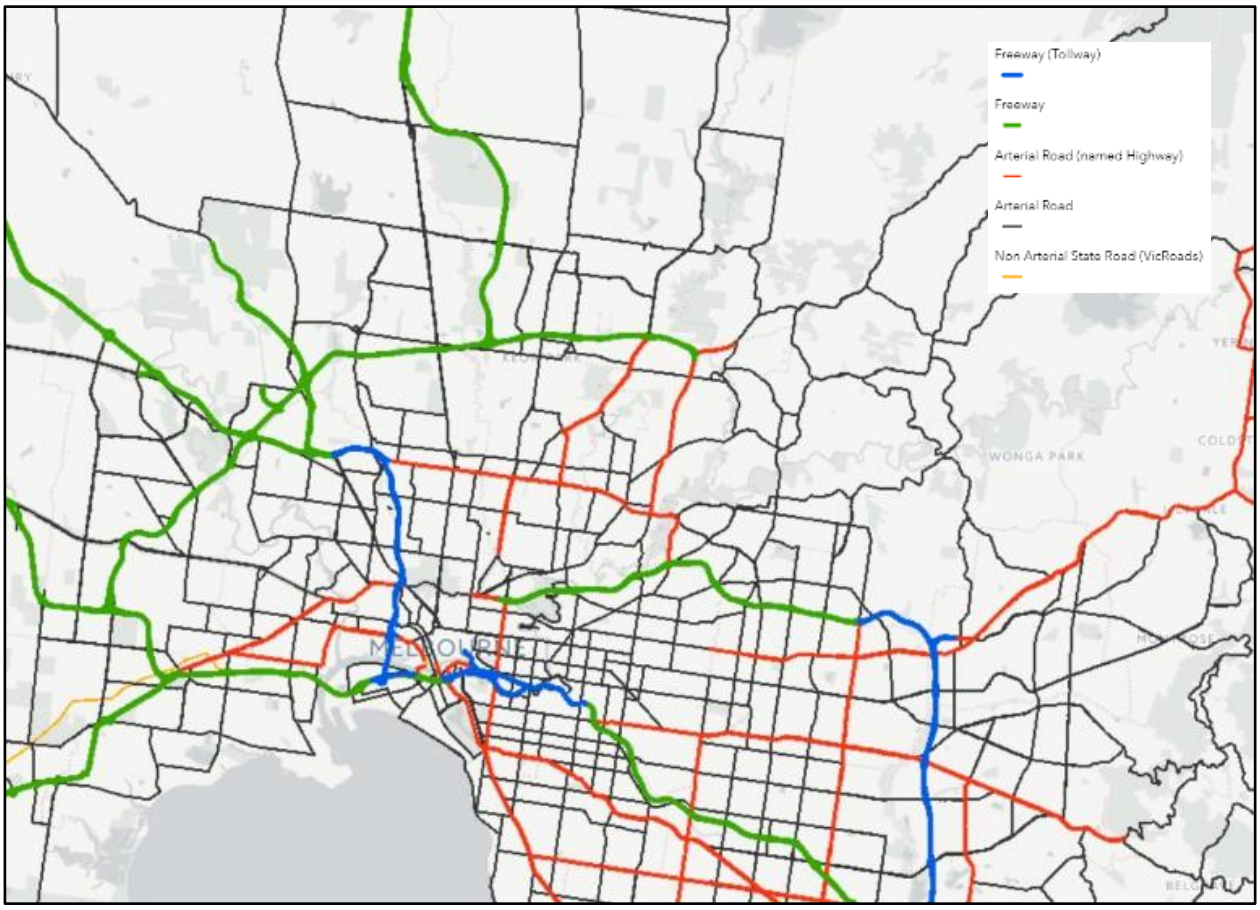
The limited arterial road network in Melbourne's north-eastern suburbs shown in Figure 1 has to cater to a range of local and orbital movements; including commuter and business traffic, heavy freight vehicles, buses and active transport. All of these routes are operating at or well above their capacity, which is resulting in longer and less predictable travel times. For further details refer to the other Business Case appendices.

Land use and planning factors outside the area are also likely to have implications for the Project, such as its proximity to Melbourne's northern and south eastern growth corridors:

- The North Growth Corridor Plan generally straddles the Hume Highway extending through to the Whittlesea, Hume and Mitchell local government areas. These northern growth fronts include future major employment precincts as well as large tracts of industrial land; and
- The South East Growth Corridor Plan includes land within the Casey and Cardinia local government areas for future commercial, business and industrial uses.

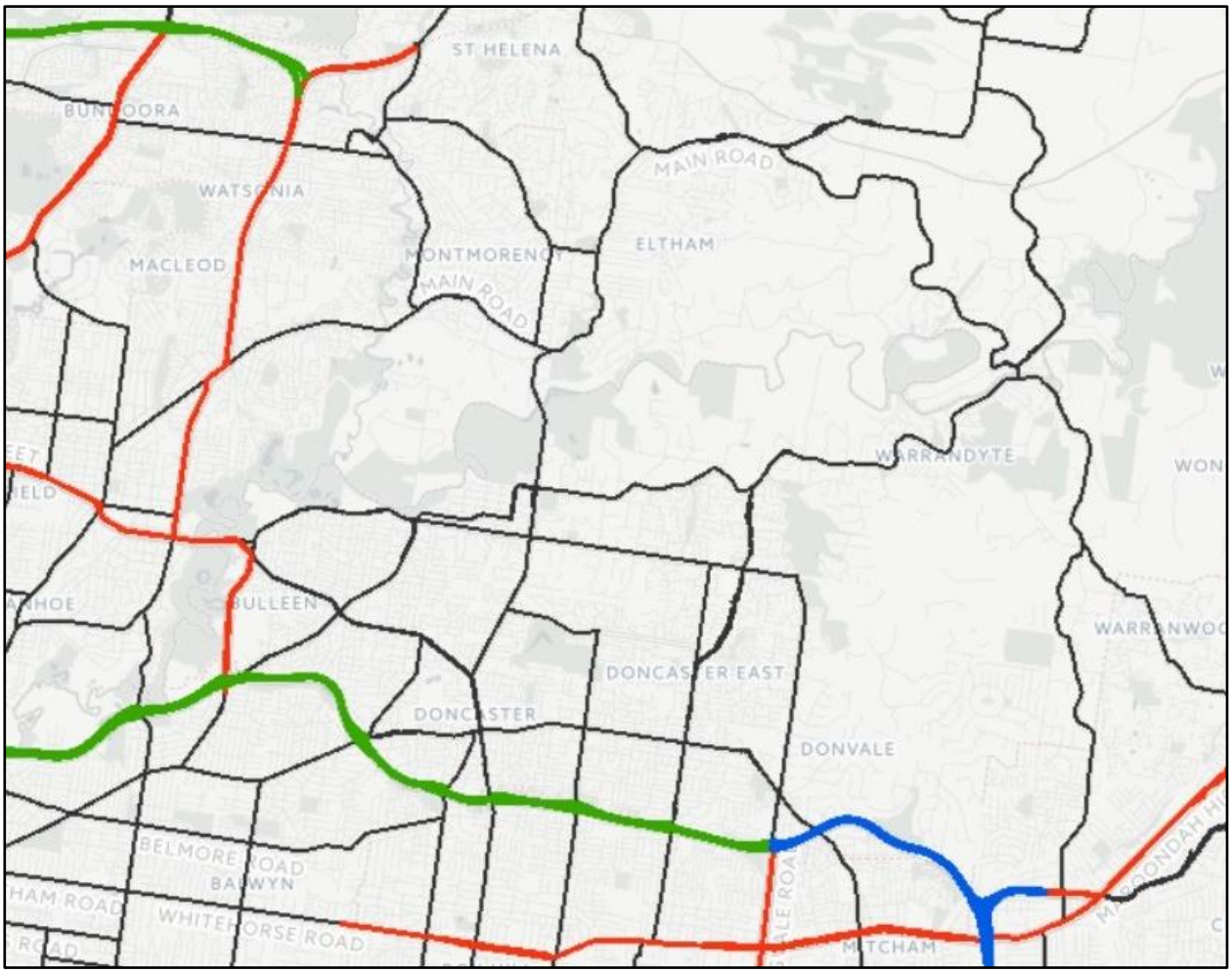
This is expected to place additional pressure on Melbourne's north-east transport network in the coming years.

Figure 1 VicRoads declared arterials across Melbourne




There are also natural barriers to orbital movements in the north-east, including in particular the Yarra River which funnels traffic on to a few key routes. While the need to complete freeway standard links surrounding Melbourne is appreciable, the critical nature of the key routes crossing the Yarra River is more evident when considering a smaller viewpoint of declared arterial roads within the project area, as shown in Figure 2.

Figure 2 Key declared arterial roads in the project area




Many of the transport challenges have been influenced by the local prevailing terrain. The terrain is generally steep, with many areas unsuitable for the construction of surface roads meeting current guidelines concerning gradients for heavy vehicles. This difficulty has been exacerbated by other considerations such as protection of sensitive environmental areas and the need to minimise impact to properties.

The topography is such that the existing levels are considerably higher at the northern end of the Project (at the M80) and steadily fall towards the south. This has implications for both the horizontal and vertical geometry when developing the concept design.

## 2.2 Road Network

### 2.2.1 M80 Interchange to Watsonia Station

The M80 from Plenty Road to the Greensborough Bypass presently has two lanes in each direction, terminating at the bypass with a signalised intersection and slip lanes facilitating movements on and off the M80. The intersection is below natural surface in parts. To the north, Greensborough Bypass continues as two lanes eastbound and three lanes westbound with bridges over the Plenty River and Plenty River Drive. It then connects to Civic Drive and Diamond Creek Road at a large roundabout.

The Greensborough Bypass becomes Greensborough Highway as it continues south at grade with a bridge over Kempston Street (no connectivity) just prior to the at-grade intersection with Grimshaw Street. South of the Grimshaw Street, Greensborough Highway becomes Greensborough Road and continues on embankment to the west of the Hurstbridge rail line and passes over the rail line approximately 500 m south of Grimshaw Street. South from the rail crossing, there is signalised local access to Elder Street and Watsonia Station carpark, and a signalised intersection with Watsonia Road.

Shared User Paths (**SUPs**) exist on the north side of the M80 and east side of Greensborough Bypass, and respectively are known as the known as the Metropolitan Ring Road Path and Greensborough Bypass Path.

### 2.2.2 Watsonia Station to Lower Plenty Road

Greensborough Road continues with two lanes in each direction undivided before terminating at a signalised intersection at Lower Plenty Road. Signalised intersections provide access to Yallambie Road and Erskine Road, with a number of side entry junctions providing access to minor roads and Simpson Barracks.

The area is mostly residential with the Commonwealth land comprising Simpson Barracks occupying a significant area on the east side of the Greensborough Road.

### 2.2.3 Lower Plenty Road to Manningham Road

A mix of residential properties and river flat parklands exist here. South of the residential areas, the alignment passes the area known as the Banyule Flats comprising the Yarra Valley Country Club, the Heide Sculpture Park at Banksia Park and parklands.

Manningham Road is a three-lane dual carriageway road that becomes Banksia Street to the east and provides direct connectivity to Bridge Street, Templestowe Road and Bulleen Road. To the south of Manningham Road an Industrial Zone surrounding Greenway Street occupies the land between the Yarra River and Bulleen Road.

### 2.2.4 Manningham Road to Eastern Freeway Interchange

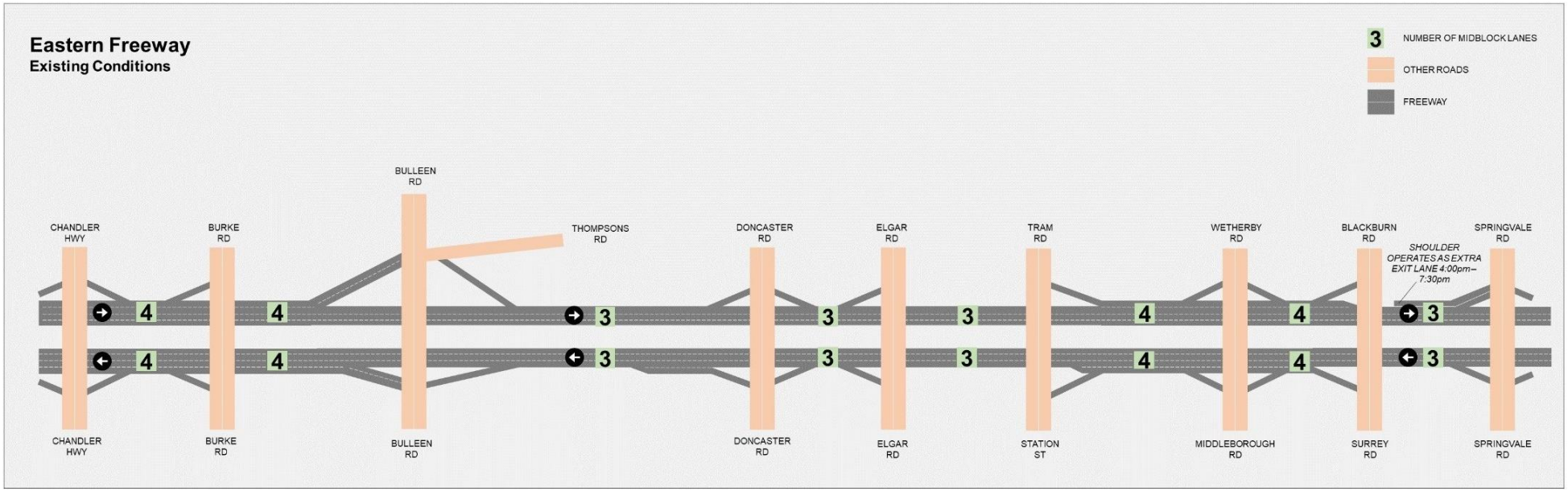
Bulleen Road is a two-lane dual carriageway at grade that provides local connectivity to the adjacent schools, sporting facilities and the Veneto Club. It continues south past the Bulleen Swim and Tennis Centres, before intersecting with the Eastern Freeway and Thompsons Road. There is a difference in surface levels on Bulleen Road with the southbound carriageway lower than the northbound and more susceptible to flooding.

The Bolin Bolin Billabong (**Bolin Bolin**) is situated between Bulleen Road and the Yarra River and has important environmental value. South of Bolin Bolin is the Veneto Club, the Freeway Golf Club and Carey Sports Complex, which abuts the Eastern Freeway.

### 2.2.5 Eastern Freeway

The Eastern Freeway is an urban freeway providing connectivity between Springvale Road and Eastlink in the east and Alexandra Parade, Hoddle Street and the CBD to the west. Most interchanges are signalised urban diamonds with the exception of Springvale Road which is a Single Point Urban Diamond (**SPUD**) interchange. From Chandler Highway to Springvale Road, the number of through lanes vary as shown in Figure 3 (refer overleaf). A series of SUPs also run the length of the Eastern Freeway and are known for the most part as the Koonung Creek Trail.

Figure 3 Eastern Freeway existing conditions schematic



## 2.3 Public transport

Public transport within the project area is mostly limited to on-road bus services providing a mix of orbital, radial and cross-town routes. Metropolitan train and tram services cover much of the northwest and southern portions of the project area along radial routes on the Hurstbridge and Lilydale railways lines. The Hurstbridge rail alignment also intersects the NEL alignment in Watsonia, a key vertical constraint for NEL in that area.

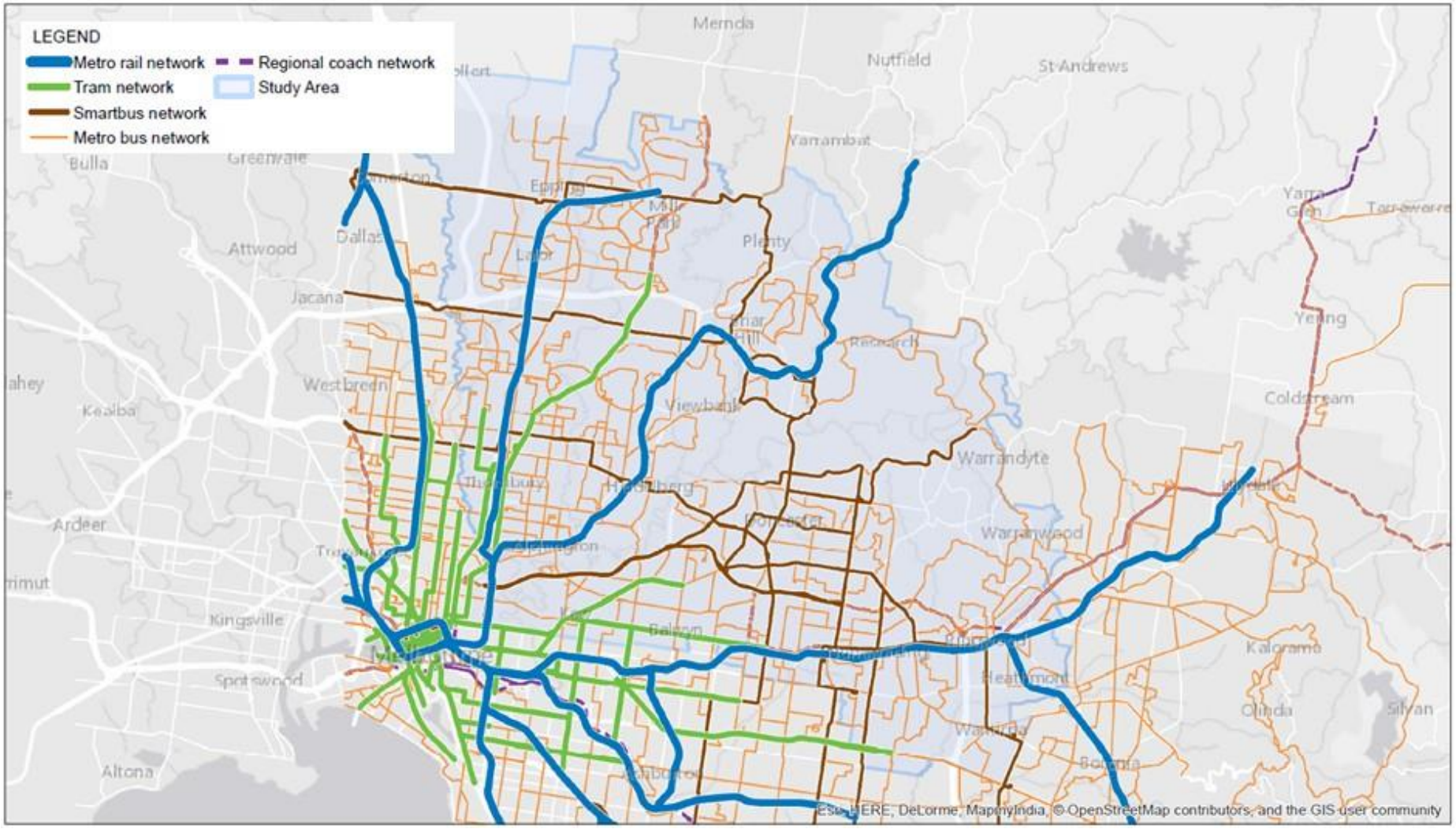
The bus services suffer from similar constraints to that of the increasingly congested road network. Doncaster Area Rapid Transport (**DART**) and SmartBus bus services provide four major arterial bus routes operating at high frequency throughout the day, connecting the eastern suburbs to the CBD. The DART bus operates along the Eastern Freeway, running in the emergency lane providing priority over general traffic. Other regular bus routes such 303, 305, 309 and 318 also utilise the Eastern Freeway corridor between Hoddle Street and Doncaster Road. Given the large distance of 5-20 km between the Lilydale and Hurstbridge rail lines, bus routes have the greatest coverage and patronage in the study area and are a high public transport priority in Melbourne's north-east.

Additionally, orbital SmartBus routes are high frequency services that provide a cross-town service, connecting activity centres and train lines, rather than servicing the CBD and include routes on Fitzsimons Lane (bus routes 901 and 902) and Banksia Street (bus route 903). Congestion is impacting the performance and predictability of existing on-road public transport, particularly those orbital routes reliant on key Yarra River crossings.

The Eastern Freeway has a wide reservation which may be suitable and has in the past been retained for future public transport use. This includes previous studies which explore the feasibility to provide improvements to the pavement or to potentially provide for a future rail connection to Doncaster.

The routes for all the public transport in the project area are presented in Figure 4.

Figure 4 Public transport routes



# 3 Functional Requirements

This section provides a high level overview of the functional requirements for the Project which have been broadly derived from the Project Objectives and Guiding Principles. It is acknowledged that for some specific elements all of the functional requirements may not be able to be fully met and these requirements may be subject to further refinement during future design stages. In these circumstances an appropriate and acceptable balance between functional requirements is to be achieved.

This document provides a preliminary listing of standards and design criteria adopted in the preliminary development of concepts. The Concept Design is generally based on experience on similar projects designed in accordance with similar criteria and is subject to further design development during future design stages.

## 3.1 Design Principles

The Concept Design of the NEL generally aligns with the following design principles:

- Design to be in accordance with all relevant Austroads and VicRoads design guidelines, and applicable Australian and International Standards;
- Incorporation of features that consider and support value for money across the life cycle of the assets must be a key consideration;
- Planning and allowances should be made for future road cross sections and relevant Precinct Structure Plans;
- Incorporation of the requirements of Safety in Design (**SiD**) and the consideration of Safe Systems design principles (refer Section 15.2 for further details);
- Consideration must be given to the incorporation of Water Sensitive Road Design (**WSRD**) and other design features affecting the environment;
- Incorporation of infrastructure sustainability considerations and other initiatives supporting sustainable outcomes must be included; and
- A focus should be given to innovative design solutions that support positive network, urban design and amenity outcomes.

## 3.2 Roads and Civils Requirements

### 3.2.1 Freeway Functionality

A freeway standard connection (i.e. systems interchange) is to be provided between the M80 and Eastern Freeway/Eastlink with free flow movements in all directions.

The junctions of the Eastern Freeway and the M80 will be designed to maximise the safe movement of diverging and converging traffic streams including the separation of traffic streams in a staged manner to eliminate or minimise weaving where possible.

### 3.2.2 Interchange Locations & Functionality

Interchanges are to be provided where the NEL carriageways cross major arterial roads e.g. Grimshaw Street, Lower Plenty Road, and Banksia Street / Manningham Road. All movements will be provided between these roads and the NEL carriageways.

All existing interchanges on the M80 and Eastern Freeway and all movements at these interchanges are to be retained. Access between these interchanges and the NEL carriageways in both directions is to be provided/maintained.

### 3.2.3 Arterial Road and Local Road Functionality

Existing arterial road functionality must be retained. Alternative equivalent functionality is to be provided where the NEL carriageways adversely impact upon existing arterial roads.

Local road connectivity and functionality will be retained where possible. Alternative equivalent functionality is to be provided where modifications to local roads are required.

### 3.2.4 No-Go Zones and Impact Objectives

No-go zones where modification of the existing surface is not acceptable, either permanent or during construction, include:

- Banyule Flats and Heide Museum of Modern Art (North of Bridge Street); and
- Bolin Bolin (west side of Bulleen Road, north of the Veneto Club).

The Project is to be designed to minimise if not eliminate impacts on:

- Residential properties and other sensitive receivers (e.g. schools) as well as local businesses, for example, the Veneto Club;
- Public open space, waterways and known sites of environmental significance; and
- Simpsons Barracks (Defence Land on the east side of Greensborough Road).

### 3.2.5 Operating Speeds

The operating speeds for the Project are to be in accordance with the Austroads Guide to Road Design (**AGRD**) Part 3 and the relevant VicRoads Supplements. Table 1 summarises the key design speed standards to be applied to the design.

Table 1 Operating speed requirements

| Road | Design Speed (Desirable) |
|---|---|
| NEL – Non-tunnel | 100 km/h |
| NEL – Tunnel | 80 km/h |
| Freeway to freeway ramps | 80 - 100 km/h |
| Freeway to arterial ramps | In line with AGRD and relevant VicRoads Supplements |
| Existing roads | No less than the current posted speed |

### 3.2.6 Traffic Performance

The Project is to achieve an operating performance of at least Level of Service D utilising the design traffic volumes (Level of Service as defined by the Highway Capacity Manual).

### 3.2.7 Grades

Grades are to be minimised to optimise the traffic throughput of the Freeway.

Grades are to meet the VicRoads and Austroads guidelines and be no greater than 4% on the main carriageways. Where possible ramp grades are to be kept to less than 6%.

### 3.2.8 Freeway Management System

The Project is to incorporate Intelligent Transport Systems (**ITS**) to ensure it can operate as a Managed Motorway in accordance with VicRoads policy and guidelines.

### 3.2.9 Property Access

Access to existing properties, unless acquired for the Project, is to be maintained.

### 3.2.10 Public Transport

All existing public transport (both on and off road) routes are to be provided for in the design and maintained during construction and operation of the Project.

### 3.2.11 Noise

Noise attenuation is to be provided in accordance with requirements of the VicRoads Noise Policy as a minimum.

### 3.2.12 Street Lighting

Lighting is to be provided to ensure the project roads are adequately lit in accordance with the design standards. Street lighting is to be designed to comply with VicRoads TCG 006: Guidelines for Street Lighting Design, Australian Standards for lighting of roads and public space, and other applicable industry standards and reference documents.

Any lighting installed or modified on arterial roads is to meet the requirements of the Victorian Electricity Supply Industry (**VESI**) standards and returned to those asset owners. Any modifications to existing lighting will be reinstated at a minimum to an equivalent level as that which existed prior to commencement of works.

Dedicated lighting luminaires, poles, pits and conduits are to be provided to facilitate the provision of lighting on the Project. Underpass lighting is to be documented as part of the tunnel system.

### 3.2.13 Drainage

Drainage is to be provided in accordance with AGRD, the applicable VicRoads Supplements to AGRD, and the flooding and drainage requirements for relevant drainage authorities including Melbourne Water and the relevant local Council.

All major drainage channels, pipes and basins crossing the alignment are to be designed to meet AGRD Part 5A Guidelines. The design is to also ensure that the potential for flooding of adjacent residents or properties is not increased by the works for the 1% Annual Exceedance Probability (**AEP**) event and any other impacts are minimised. Further work is required however to determine the level of flood protection to be afforded to the both the northern and southern tunnel portals.

The design of the drainage network for the Project is to take into consideration upstream and downstream flows from and into drainage assets outside of the project area to ensure the drainage and overland flows are to the satisfaction of the relevant authorities.

### 3.2.14 Shared Use Paths (SUPs) and Pedestrian Paths

A continuous SUP is to be provided for the full length of the NEL corridor to link the M80 and Eastern Freeway SUPs. Where feasible, new connections are to be provided to complement the main project works, and support strategies for Strategic Cycling Corridors and pedestrian connectivity as set out in local council plans and the Principal Bicycle Network (**PBN**).

All existing bicycle and pedestrian connections are to be maintained. There is to be no deterioration in connectivity or safety for existing designated cycle routes where practicable. Where removal of an existing bicycle or pedestrian connection is unavoidable, an alternative connection to an acceptable standard is to be provided.

### 3.2.15 Safety in Design

Safety in Design (**SiD**) will apply to the design development in accordance with VicRoads requirements and relevant Australian Standards (e.g. Occupational Health and Safety (OHS) legislation).

## 3.3 Tunnel Requirements

### 3.3.1 Operations

The NEL tunnels are to provide for the safe and efficient movement of the design traffic volumes (excluding placarded vehicles) during normal operation. Consideration will however be given to future proofing the design in the event that placarded vehicles are permitted to use the tunnels in the future.

The tunnels are to have three lanes in each direction along with minimum width inner and outer shoulders. Tunnel standards are to be based on Austroads Guide to Road Tunnels (**AGRT**) – Parts 1 to 3, and relevant international standards where appropriate.

### 3.3.2 Gradients in Tunnel

Gradients in the tunnels will not exceed 4.0% and comply generally with the relevant requirements of the AGRD and VicRoads Supplements as shown in Table 2.

Table 2 Tunnel gradient requirements

| Grade % | Desirable Maximum Length (m) |
|---|---|
| 2-3 | 1800 |
| 3-4 | 900 |
| 4-5 | 600 |
| 5-6 | 450 |
| >6 | 300 |

### 3.3.3 Ventilation Station Location

The ventilation stations are to be placed in a locations that will not negatively impact existing surrounding properties, taking into consideration both visual impacts and emissions. The vent stations are to be located away from residential areas and schools as far as is practicable.

### 3.3.4 Clearance Heights

The tunnels will be designed to cater for clearance heights up 4.9 m with an additional 0.2 m allowance for the protection of soft infrastructure from flapping tarpaulins, ropes, loose loads, etc. Provision will also be made for vehicle roll in the tunnel space proofing.

### 3.3.5 Over-Height Vehicle System

An automatic over-height vehicle system is to be provided for. The over-height vehicle system must detect and classify over-height vehicles alert drivers and activate portal barriers. Provision must also be made for over-height vehicles to either safety park prior to the tunnel portal or to be diverted off NEL prior to entering the tunnel.

### 3.3.6 Fire and Life Safety

Fire and Life Safety (**F&LS**) considerations are to be incorporated as part of the tunnel design and meet current industry best practices and any requirements as determined as part of developing the Fire Engineering Brief (**FEB**) (for tunnel occupants and users, operations and maintenance staff and emergency services personnel and to minimise the impact on adjacent infrastructure and road network). The F&LS system is to incorporate appropriate fire rated materials, egress routes, automatic water based suppression and cross passages.

### 3.3.7 Tunnel Plant

Tunnel plant is required and must be incorporated in the Concept Design in order to facilitate the operation of the tunnel system. This generally includes:

- A tunnel control room where the Operation Management and Control System (**OMCS**) operates, and a pumping plant for the tunnel drainage system
- Motorway management systems including the physical signage, communications and electrical cabling
- Ventilation system including jet fans, and a sprinkler system including storage tanks, pumps and pipelines
- Tunnel lighting system including luminaires and cabling, and electrical systems including transformers, Uninterrupted Power Supply (**UPS**), switchgear and cabling.

This will also include public utility plant including electricity supply, communications system, stormwater drainage system, wastewater system and water supply.

### 3.3.8 Traffic Management and Control System

A Traffic Management and Control System (**TMCS**) is to be provided that allows for the monitoring, control, recording and reporting of all mechanical and electrical plant and equipment associated with in-tunnel motorway management system for the operation of the tunnels. This includes the CCTV and ITS, including lane control and lane use signs, variable speed limit signs, directional and traveller information, real time information, variable message signs, and emergency information within the tunnel.

The TMCS is to provide automated monitoring and control for the motorway management systems and the communication network. This system is required to interface with the overall NEL ITS, as well as any applicable motorway systems for safe operation of the tunnel and to provide a coordinated approach for motorway control across the NEL and connecting freeways (i.e. Eastern Freeway and Eastlink) and arterial roads.

The TMCS must also allow for the real-time processing, reporting and control of tunnel systems and record any and all faults, emergencies or states of operation in real-time status, and for logging and retrieval of data at a subsequent date.

### 3.3.9 Mechanical and Electrical Requirements

As part of the OMCS, a Plant Management and Control System (**PMCS**) is to be designed to facilitate the safe and efficient operation of the tunnel Mechanical and Electrical (**M&E**) plant and equipment, to facilitate the tunnel operations. Within the OMCS framework, the PMCS must interface with the TMCS to ensure any incidents that arise as a result of M&E plant systems failure or maintenance can be coordinated with the traffic management within the tunnel.

The function of the PMCS is to provide real-time monitoring and fault logging for all tunnel plant, and notifying tunnel Operations and Maintenance (**O&M**) staff where incidents of performance degradation, failure or non-operation of M&E plant.

Suitable electrical generators and UPS will be provided in the event of local power grid failure to ensure continued operation of the tunnel and for the OMCS and tunnel control centre room. All mechanical and electrical plant is to be installed such that there is a minimum 600 mm freeboard above the 1% AEP flood level.

### 3.3.10 Cut and Cover Structures and Wall Troughs

For the purposes of the concept design, cut and cover structures exceeding 80 m long have been considered tunnels. For these sections the tunnel requirements for space proofing (including shoulders and traffic envelope), F&LS, ventilation, lighting and drainage are applied as detailed above.

Access and egress passages in Cut and Cover Tunnels (**C&CTs**) will be similar to the cross passages of the driven tunnels and be located at maximum 120 m spacing. Depending on proximity of the adjacent carriageway, passages may either connect directly to the adjacent tunnel, to ground level or run longitudinally as fire isolated passages to an exit or other point of safety.

Where extended lengths of cutting are partially covered such that open sections of wall and roof equating to no more than 35% of the aggregate roof area and no greater than 80 m length is fully covered natural ventilation is to be assumed.

Where cut and cover structures are less than 80 m long they are treated as a bridge or underpass and standard bridge provisions applied. On approach to/departure from tunnels walled slots may retain the tunnel cross section elements with vertical walls.

It should be noted that the length of structure, potential for natural ventilation and approach/departure conditions all affect the assessment of ventilation, access and egress, lighting and signage requirements, and these elements will be considered further as design progresses (i.e. into Reference Design and beyond).

Cover (depth to natural surface) over Cut and Cover elements will vary to suit the land use above. Areas where traffic passes over may be detailed similar to a bridge deck with a wearing course placed directly on structure, and areas without utility services and drainage may be subject to light landscaping with cover of approximately 600 mm whereas other areas requiring heavier landscaping and/or surfacing are likely to require 1500 – 3000 mm cover. Specific building envelopes and loading areas may also be required in some areas and a nominal 50 kPa is to be assumed for the concept design.

The trough structures and the cut and cover structures will be developed as either drained or undrained (tanked) structures based on existing ground and surface water conditions, geotechnical permeability and predicted inflow/groundwater draw down estimates associated with a drained solution. Groundwater quality and levels and predicted seepage rates along the alignment are subject to ongoing site investigations and analysis.

## 3.4 Bridge / Structure Requirements

### 3.4.1 Structural Form

Typical structural forms adopted for the new road bridge concepts are listed in Table 3. Further information on their application is contained in Section 7 (Structures). Many bespoke arrangements will also be required but all are required to comply with AS5100 and other relevant requirements.

Table 3 Typical bridge structural forms

| Span Length (m) | Structural Form | Application | Approximate Structural Depth (m) |
|---|---|---|---|
| **Pedestrian and SUP bridges** (Many alternative urban design treatments exist depending on location) | | | |
| Span up to 35 m | Precast Plank or Tee-Roff Girder with in-situ deck | | Span/25+0.15 m |
| Span up to 35–70 m | Steel through girder with concrete deck | | Span/30 |
| | Cable stay & through girder truss are also viable options | | Cable stay - NA |
| **Road Bridges** | | | |
| Span up to 15 m | Precast Plank with in-situ deck | Typically used for short single span integral underpasses or low level creek and flood plain crossings. | Span/20+0.2 m |
| Span 16 m to 38 m | Precast Tee-Roff Girder with in-situ deck | Typically used for structures <300 m long over valleys, low lying areas and road over road bridges of 1 to 3 spans<br>Slightly longer spans achievable for structures continuous over the piers. | Span/20+0.2 m |

| Span Length (m) | Structural Form | Application | Approximate Structural Depth (m) |
|---|---|---|---|
| Span 39 m to 60 m | Steel Box Girder with transfloor and in-situ deck<br>Continuous up to 300 m with end spans 50-80% of the adjacent spans | Steel box girder generally applied in bridges of 300-500 m length and on tight curves. Need for skewed supports or integral pier/portal frame cross heads may also influence selection over concrete box solutions.<br>Large spans can be placed, spliced and completed in relatively short periods of time. Launching is also possible if minimisation of disturbance below the bridge is critical. | Span/25+0.25 m |
| | Segmental Concrete Box Girder, simply supported span by span construction | Generally applied in bridges of longer length (>500 m) or where large spans and improved aesthetics are required. The match cast span by span method enables rapid construction from above minimising disruption below. | Span/15-20 |
| Span 61 m to 80 m | Four to six span Continuous Haunched/Tapered Steel box girder with transfloor and in-situ deck | Refer Span 39 – 60 m for applicability. | Varies Span/25 to Span over 20 |
| | Continuous Segmental Concrete Box Girder, with or without tapered depth at pier. | Refer Span 39 – 60 m for applicability. | Span/22-25 or variable. |

### 3.4.2 Design Life

The design life of elements of the Project vary according to best practice and reasonably achievable requirements. For significant elements of structure the design life is up to 100 years whereas other components have shorter design life requirements where the impact and cost of replacement or rehabilitation at more frequent intervals is acceptable.

### 3.4.3 Design Traffic Loads

New structures carrying general road traffic are to be designed to accommodate requirements of SM1600 loading to support increased freight productivity. Existing structures carrying NEL or modified on structure by NEL are to be designed to accommodate the full SM1600 load if built after 2003 and 75% of SM1600 loading otherwise (i.e. built prior to 2003).

## 3.5 Infrastructure Integrity & Operations

Guiding documents on the implementation of asset management to be considered in the development of the design include:

- ISO 55001 Asset Management Standards (2014) and the International Infrastructure Management Manual (IPWEA, 2015)
- Victorian Department of Treasury and Finance's (DTFs) Asset Management Accountability Framework (2016)
- Austroads' Guides to Asset Management and to Smart Motorways

- ISO 13923 General principles on the design of structures for durability, and ISO 15686 Buildings and constructed assets - Service life planning.

## 3.6 Landscape and Urban Design

The Landscape and Urban Design (**LUD**) is to be based on the NEL Urban Design Strategy, which will be prepared in collaboration with the Office of the Victorian Government Architect (**OVGA**), to promote best practice in urban design and to optimise project outcomes.

Consideration of the VicRoads Movement and Place Framework will also be key element.

# 4 Base Case Overview

The Base Case links the M80 at the Greensborough Bypass with the Eastern Freeway at Bulleen Road. It also provides for the modernisation of the Eastern Freeway, extending nominally from Chandler Highway in the west to Springvale Road in the east.

Table 4 describes the design elements forming the Base Case for NEL and the following sections of this report elaborate on the Concept Design outcomes that have been achieved by the respective disciplines for this design. This is reflective of the Concept Design only and should not be considered to be the final scope for the Project.

Table 4 Base case design summary

| Alignment | Design Element |
|---|---|
| M80 Interchange to Watsonia Station | • Eastbound on the M80, east of the Plenty Road entry ramp, four traffic lanes will be provided for traffic heading east on the Greensborough Bypass or southbound on NEL. A two-lane exit will be provided for traffic travelling to Diamond Creek exiting via Greensborough Bypass.<br>• Three lanes will continue southwards, with one providing an exit to Grimshaw Street, before being joined by two lanes from Greensborough Bypass to form a four lane carriageway that continues past Grimshaw Street. One lane is dropped south of Grimshaw Street, with three lanes continuing southbound on NEL.<br>• The westbound connection to M80 comprises two lanes from NEL northbound and two lanes from Greensborough Bypass. Grade separated ramps at the Greensborough Bypass interchange and a Collector-Distributor (**C-D**) carriageway between M80 and Grimshaw Street with up to three traffic lanes complete all the connections between Grimshaw Street, Greensborough Bypass, and Plenty Road.<br>• Full freeway connections will be provided to and from Grimshaw Street, with Grimshaw Street elevated over the lowered NEL alignment. |
| Watsonia Station to Lower Plenty Road | • South of Grimshaw Street, the three lane NEL carriageways will continue southwards, passing over the existing Hurstbridge Rail Line before dropping into an open cut which continues to Lower Plenty Road.<br>• All existing access in the Watsonia Station area will be retained in a modified form. Local access provisions alongside NEL are also provided to maintain connectivity in the local area.<br>• A number of new bridges, including four “land bridges”, are provided across the open cut / trough section to maintain connectivity across NEL. |
| Lower Plenty Road to Manningham Road | • Full freeway connections will be provided to and from Lower Plenty Road / Greensborough Road, south of which the NEL will enter a bored tunnel. The bored tunnel will extend to Bridge Street.<br>• The bored tunnel is to progress under the residential areas south of Lower Plenty Road before curving under the Banyule Flats area and passing under the Yarra River.<br>• Full freeway connections will be provided to and from Banksia Street / Manningham Road in an interchange with ramps graded to match the tunnel and constraints of the local area. |
| Manningham Road to Eastern Freeway Interchange | • South of Manningham Road, NEL will continue underground beneath and just east of Bulleen Road southwards until curving westwards and surfacing to the west of Bulleen Road near the Veneto Club. It will then rise onto viaduct, splitting to provide three lane connections to the east on the Eastern Freeway and two lane connections to the west.<br>• The existing connectivity between Bulleen Road, Thompsons Road, and the Eastern Freeway will be retained. Access improvements will also be provided along Bulleen Road. |

| Alignment | Design Element |
|---|---|
| Eastern Freeway Upgrade (from Chandler Highway to Springvale Road) | • The Eastern Freeway will be widened with all existing connectivity typically retained. Five lanes will be provided between Chandler Highway and Burke Road, with a residual median of sufficient width to accommodate public transport upgrades. East of Burke Road, four barrier-separated carriageways will be provided. The innermost two carriageways will each be three-lane express carriageways eastbound and westbound. The outermost two carriageways will provide the connections for the NEL and the connections to Bulleen Road, Doncaster Road and Elgar Road. The eastbound connection will have four traffic lanes from Bulleen Road before reducing to three lanes after Elgar Road whilst the westbound connection will have three lanes from Tram Road before increasing to four lanes after Doncaster Road.<br>• In the easterly direction east of Tram Road, a grade-separated connection will be provided from the express lanes to the Middleborough Road exit. The express lanes will end just past Middleborough Road, and five traffic lanes will be provided to Springvale Road. A dedicated two lane trap exit will be provided to Springvale Road. No modifications are proposed to the Eastern Freeway east of Springvale Road.<br>• In the westerly direction, four traffic lanes will be provided from Springvale Road, increasing to five at Blackburn Road and six at Middleborough Road before splitting into the express lanes and collector-distributor carriageways as described above. |
| Doncaster Busway | • The Doncaster Busway will provide dedicated lanes along the Eastern Freeway to the Doncaster Park and Ride. The busway will commence at Hoddle Street with dedicated bus lanes within the existing shoulders of the Eastern Freeway (in both directions) until west of Chandler Highway and then via dedicated lanes on the north side of the Eastern Freeway to Doncaster Road with provision for a new Park and Ride facility on the corner of Bulleen Road and Thompsons Road. |

# 5 Geotechnical

## 5.1 Overview

Extensive geotechnical investigations have been completed in key areas along the alignment. Methodologies used include borehole drilling and sampling through the soil and rock layers, Cone Penetrometer Testing (**CPT**) through soil layers and geophysical seismic refraction surveys. In-situ testing has been completed including Standard Penetrometer Testing (**SPT**), water pressure (Lugeon) testing to assess the permeability of the rock, and downhole televiewer surveys to assess the rock structure. Where possible, groundwater wells and vibrating wire piezometers have been installed to allow longer term monitoring for groundwater levels.

## 5.2 Corridor Geology

The main geological units encountered along the alignments are:

- Silurian age (approximately 420 to 440 million years old) siltstone and sandstones of the Anderson Creek and Melbourne Formations
- Neogene (Pliocene or Miocene) age (approximately 2.6 to 10 million years old) alluvium or colluvium comprising clay, silt, sand and gravel type soils
- Quaternary (Holocene and Pleistocene) age (approximately 0 to 2.6 million years old) alluvium comprising clay, silt, sand and gravel type soils.

The Silurian age rocks form the bedrock of the area and are generally close to the surface either side of the Yarra River valley. These rocks have been subjected to faulting and folding and subsequent uplift, weathering and erosion. When close to the present day surface, the rock is generally more weathered, with weathering decreasing with depth.

A relatively small deposit of Miocene-Pliocene alluvial sediments has been encountered in the hillside to the north of Bolin Bolin and to the west of Bulleen Road during the investigations, and this has been confirmed from review of historical borehole logs. The sediment comprises sand and clays which are elevated above the current floodplain. This could represent a paleo-channel or historical landslide deposit. The presence of a paleo-channel on the valley side could also explain the locally deeper Silurian rock weathering profile in the vicinity, which has been seen elsewhere such as during the construction of the Bell-Banksia Street cutting adjacent to the Austin Hospital. Remnant deposits of Neogene deposits are found elsewhere across the area. These sediments could be considered analogous to the Red Bluff Sandstone, also known as the Brighton Group.

A relatively thick layer of Quaternary or Neogene (previously referred to as Tertiary) alluvial, swamp and lake sediments overlie the Silurian bedrock within the valley of the Yarra River. The thick layer of sediments is thought to be due in part to the formation of a large lake in the Yarra River valley when lava flows coming from the north dammed the valley further downstream approximately 1 million years ago. Investigations have also identified that these sediments are up to 24 m thick, although they could be deeper in other areas.

The Yarra River valley deposits are complex, with terraces cut into the bedrock at different levels and the whole system formed over an extended period by meandering rivers with associated billabongs, flood deposits and sand bars. The river has eroded into the rock, possibly along planes of weakness such as fault zones encountered at several locations during the geotechnical investigations. The top of rock beneath the valley is thought to be broad and relatively flat, with the original river erosion down cutting into the slightly weathered or unweathered siltstone prior to commencing deposition of the sediments.

## 5.3 Key Challenges

The geotechnical investigations have been focused on assessing hazards and providing geotechnical data for design purposes. A detailed 3D geological model has been developed as work has progressed to inform the design process and as a visualisation tool for project stakeholders. The model is developed iteratively as new data is obtained with the revised model also serving as the basis for determining the locations of subsequent investigations to resolve identified hazards and uncertainties in the model.

The main geotechnical and geological hazards identified to date include:

- Poor ground conditions due to faulting in the Silurian bedrock leading to connectivity with the overlying soils and river, high groundwater inflows and difficult conditions for tunnelling and open excavation
- The presence of high persistence, low strength fractures in the Silurian rock in the vicinity of open excavations with adverse effects on the stability of such excavations
- The potential for deeper incised channels in the rock beneath the valley, leading to reduced rock cover to tunnels and potential construction difficulties
- The high variability of the alluvial sediments including compressible soil and the presence of obstructions in the form of buried logs and boulders leading to potential construction difficulties for tunnelling or other subsurface structures
- Dewatering of high permeability soils within the Yarra River valley due to seepage into excavations during construction leading to vertical compaction of the floodplain soils, lowering of water levels in the surrounding area and drawdown of water levels in Bolin Bolin
- The presence of a possible ancient landslide or soil filled channel incised into the rock to the north of Bolin Bolin and located immediately to the west of the proposed alignment. This introduces the potential for construction activities (such as tunnelling or the construction of tunnel portals) to destabilise or reactivate a landslide or intersect soil type materials in a mined tunnel, which may require more complex ground treatments to mitigate.

## 5.4 Additional Requirements

Geotechnical and geophysical field surveys of the project area have been undertaken during the Concept Design with the data collated used to assist design development and refinement. The next phase of geotechnical field investigations will be required to provide more detailed data of ground conditions to assist development of the Reference Design.

# 6 Roads and Civils

## 6.1 M80 Interchange to Watsonia Station

### 6.1.1 Overview

The limit of works at the northern end is the Plenty Road overpass on the M80 and the Plenty River Bridge on the Greensborough Bypass. Between the M80 and Watsonia railway station, NEL will be a surface road within the existing M80 and Greensborough Bypass road corridors as shown in Figure 5 and Figure 6. A new free flow interchange will replace the existing intersection where the M80 terminates at the Greensborough Bypass. An interchange at Grimshaw Street will provide full connectivity with via a new interchange. To facilitate this, a new bridge will carry Grimshaw Street over NEL. NEL will be lowered under Grimshaw Street and will rise to then passing over the existing Hurstbridge train line at grade (rail under) along the existing Greensborough Highway alignment before entering open cut to go under the access to Watsonia railway station.

Figure 5 NEL Overview: M80 to Grimshaw Street

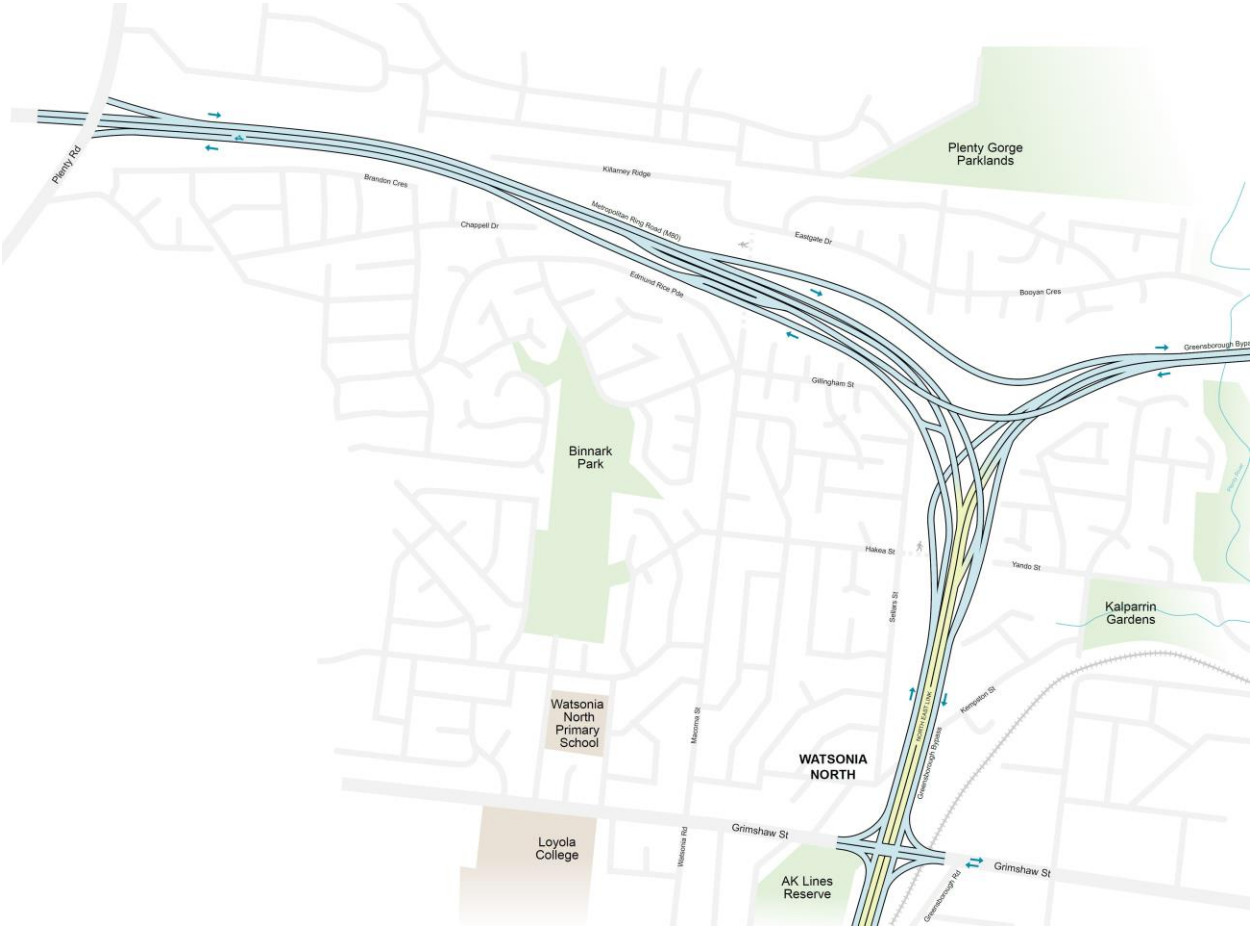


Figure 6 NEL Overview: Grimshaw Street to Watsonia railway station


## Strategic Connections and Functionality

NEL ties in with M80 at Plenty Road. East of Plenty Road, NEL will be an eight lane freeway (compared with the current four lanes), supported by a three-lane westbound Collector-Distributor (**C-D**) road on the south side of the M80, facilitating access to Plenty Road for traffic from the Greensborough Bypass, Grimshaw Street and NEL.

The existing Greensborough Bypass and M80 intersection will be upgraded. The new interchange will provide free flow connectivity from an upgraded M80 to the west, a three lane Greensborough Bypass to the east up to Plenty River (presently two lanes) and four lanes on NEL to the south (presently three lanes southbound and two lanes northbound as the Greensborough Highway). At Grimshaw Street, a C-D will accept northbound traffic for NEL and Plenty Road, continuing on the south/western side of NEL (currently M80) to Plenty Road. This C-D road also accepts Greensborough Highway traffic bound for Plenty Road thus maintaining separation from NEL through traffic. NEL traffic from Grimshaw Street will be metered as it comes onto NEL from the C-D just prior to Plenty Road.

South from Grimshaw Street NEL reduces to six lanes along the existing Greensborough Road alignment before entering an open cut / trough just north of Watsonia Station.

### Provisions for Local Access

Local access north of Grimshaw Street will be maintained. Improvements driven by the free flow junction at the M80, the C-D arrangements and the provision of a service roads, are expected to improve conditions in the area.

The Grimshaw Street/Greensborough Road intersection will be reconfigured and grade-separated to account for the heavy north-south movements generated by the NEL. The existing Greensborough Road service road will be replaced with a pair of new service roads on each side of the NEL to reinstate the existing local connections currently provided by the Greensborough Bypass between Grimshaw Street and Watsonia Road. Access to Watsonia railway station is maintained but under a different arrangement.

A new bridge over Watsonia railway station along the transmission line easement to provide equivalent (or better) access to that which currently exists at Elder Street will be investigated.

The junction between the existing Greensborough Highway and Watsonia Road will be reconfigured to receive the Greensborough Road service road traffic from the east side with an overpass over NEL, which will be in open cut at this location. Access to Watsonia Station carpark will be provided from this junction with the Watsonia Station carpark reconfigured to suit NEL and provide for new local connections along the NEL alignment.

The existing pedestrian bridge over Greensborough Bypass in the vicinity of Nell Street will be replaced at a suitable location to be determined.

## 6.1.2 Key Challenges

The key engineering challenges arise from the need to fit a freeway standard road in a relatively narrow right of way in a built up urban area. Some examples include:

- Accommodating the grading constraints associated with the existing Hurstbridge Rail Line and minimising impact to the Watsonia railway station car park.
- Retention of existing local access between Watsonia Road and Grimshaw Street, including intersecting roads such as Elder Street, as well as maintaining / providing for local access generally in consultation with the community and stakeholder needs.
- Provision of a suitable grading for the ramp terminal intersection on the new Grimshaw Street overpass. Traffic signal phasing aspects for this intersection will also need special consideration.

- Retention of existing pedestrian facilities, including the existing pedestrian bridge over Greensborough Bypass in the vicinity of Nell Street and pedestrian access to Watsonia Railway Station. The Yando Street underpass including the pedestrian connection and the associated risks (for example flooding and Crime Prevention Through Environmental Design (**CPTED**) requirements).
- Constructability and ability to minimise traffic impacts given that significant lengths are to be built within the existing M80 and Greensborough Bypass road corridors.
- Close proximity of interchanges and the ability to minimise potential weaving issues, hence the application of the C-D arrangements between Grimshaw Street, Greensborough Bypass and Plenty Road.
- Amenity and visual impact with a number of elevated structures in a built up urban area.

### 6.1.3 Additional Requirements

#### Noise Attenuation

Throughout the Project, existing noise walls are to remain unless physically impacted by the works, with the exception of existing timber walls which will be expected to be replaced within the limits of the NEL. Impacted noise walls are assumed to be replaced with an approved product of equal or greater height and similar performance and aesthetic of those they replace. Approved products will not include timber or rotationally moulded plastic materials.

New walls will be provided where necessary, including along elevated sections of road. In some cases a combination of containment barrier, noise wall and security fencing will be provided to fully comply with several criteria including safety, privacy and noise.

At the Concept Design stage, no measurements of existing noise have been undertaken for the purposes of determining the ambient noise levels in the Project Area. Accordingly, it has not been possible to model predicted noise levels as a result of the Project (nor have the final noise attenuation requirements been determined given that they will be subject to the EES process), and as such it has not been possible to design the required noise attenuation treatments that may be required. A preliminary review of the design has however been undertaken to determine the indicative noise attenuation requirements necessary to inform the preparation of the Business Case.

For the section from M80 to Watsonia Station the likely areas of noise attenuation to be implemented are shown in Table 5.

Table 5 Noise walls M80 Interchange to Watsonia Station

| Title | Existing | Replacement |
|---|---|---|
| North side of M80 between Plenty Road and Greensborough Bypass | Protected by noise wall for majority of length except small section adjacent to Plenty Road Interchange at commercial/industrial land | No treatment to existing gaps. Existing residential section to be replaced. Approx. 350 m at 4 m high |
| South side of M80 between Plenty Road and Greensborough Bypass | Protected by combination of noise mounds and noise wall | With the majority of the widening on the south side, the mound and any existing noise walls are lost. Replace with new noise walls for full length (approx. 5 m high) |
| New flyover ramps & viaduct sections, and Viaducts along NEL | Nil | Approx. 2 m noise wall above any parapet and/or containment barrier will be provided |

| Title | Existing | Replacement |
|---|---|---|
| Greensborough Bypass both sides to Civic Drive / Diamond Creek Road | Noise walls protect both sides, with a gap just east of the Plenty River. | Replace with new walls and fill gap, approx. 3 m high. |
| Outside of the C-D and Express Lanes southbound to Grimshaw Street | Nil | New noise walls to be provided, approx. 5 m high. |

## 6.2 Watsonia Station to Lower Plenty Road

### 6.2.1 Overview

From Watsonia Station to Lower Plenty Road, NEL is located in the area of the existing Greensborough Road reserve, before the alignment moves east and parallel to Greensborough Road in the area currently occupied by the Simpson Barracks as shown in Figure 7.

The grading of the NEL drops deeper into an open cut formation through this area to allow it to enter a tunnel south of Lower Plenty Road. Greensborough Road and all local access to the south of Watsonia Road (including across the NEL alignment) will be retained. Full connectivity is also provided between Lower Plenty Road/Greensborough Road and NEL.

At Lower Plenty Road NEL enters into a twin tunnel section and continues south.

#### Strategic Connections and Functionality

The proposed alignment would require acquisition of private land between Lenola Street and Yallambie Road before progressing south within government land at Simpson Barracks and then within Borlase Reserve to Lower Plenty Road.

Full entry and exit connectivity will be provided at Lower Plenty Road and Greensborough Road with the ramps split due to space and grading constraints. The northbound entry and southbound exit ramps tie in with Lower Plenty Road adjacent to Greensborough Road, with the northbound exit and southbound entry ramps joining Greensborough Road at a new signalised intersection south of Blamey Drive, opposite Strathallan Road.

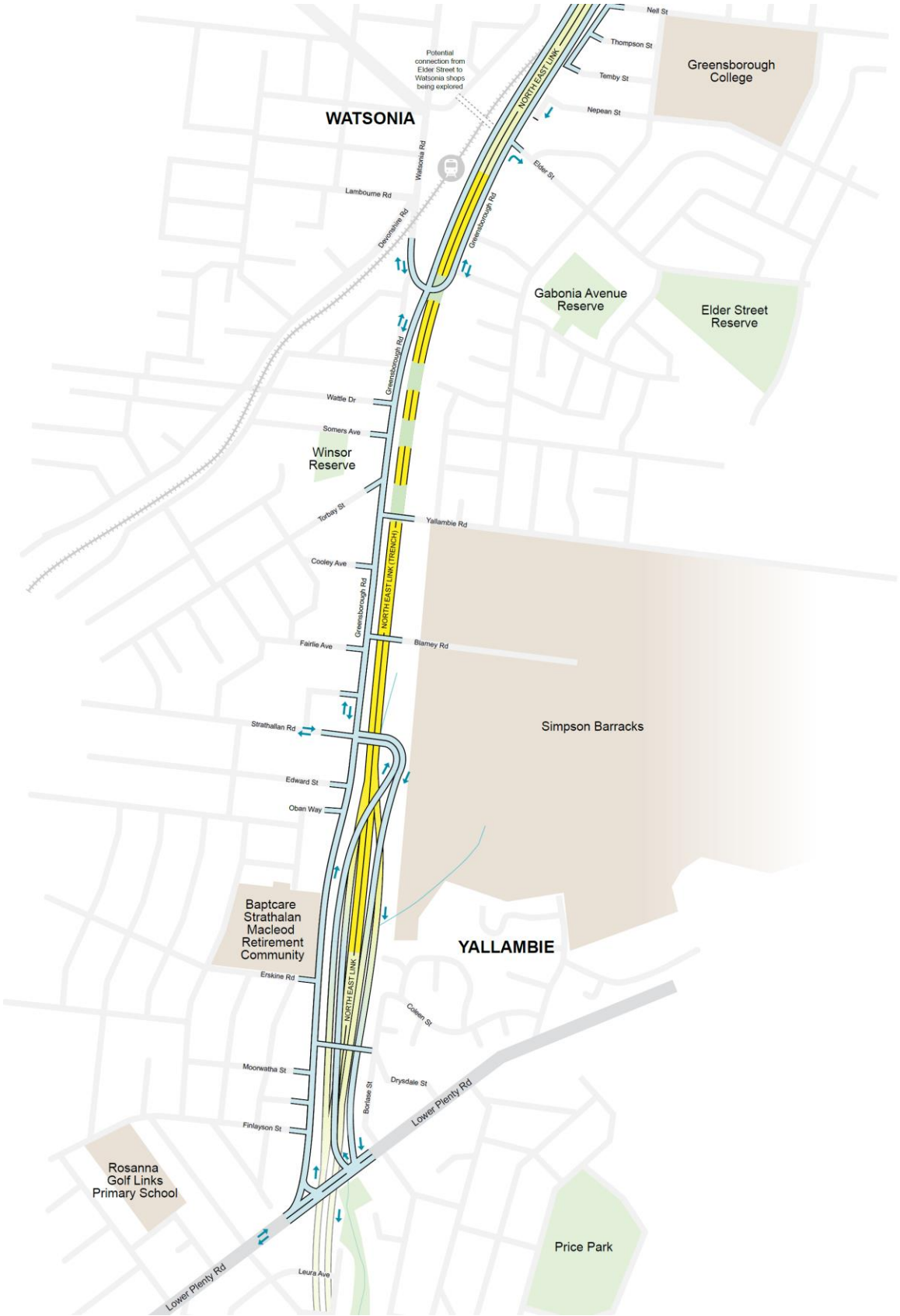
The present configuration of Greensborough Road will be modified at the northern end to tie-in with Watsonia Road. The section between Watsonia Road and Lower Plenty Road will also be retained as two lanes in each direction.

#### Provisions for Local Access

All existing connectivity provided by Greensborough Road will be maintained in its present position. Greensborough Road connections on the east with Yallambie Road, Blamey Road (Simpson Barracks) and Drysdale Street will be achieved with new bridge structures over the NEL (which will be in a deep trough / trench at this point).

A number of landscaped bridges (**landbridges**) will also be provided in this area to provide enhanced connectivity.

Figure 7 NEL Overview: Watsonia railway station to Lower Plenty Road



### 6.2.2 Key Challenges

The key engineering challenges are associated with the existing topography, including the provision of grades acceptable for a freeway, the required cover at Lower Plenty Road suitable for a tunnel, and minimising the impact on existing properties to accommodate these elements.

NEL enters open cut north of Watsonia Station and remains so to the tunnel portal north of Lower Plenty Road. The depth ranges from approximately 8-15 m and the cutting is located directly to the east of the existing Greensborough Road, which will be retained.

At Lower Plenty Road, NEL enters a tunnel section requiring the NEL road surface level at Lower Plenty Road to be approximately 28 m below the existing surface. This leads to long interchange ramps being required to achieve acceptable grades. In this area, the Banyule Drain and Banyule Creek join and continue south as the Banyule Creek, and will need to be modified to accommodate the NEL works.

Other challenges associated at this location include:

- For a 900 m length of the alignment south of Watsonia Station, the trough is very deep (10–15 m or more) and may require the vertical walls to be “propped”
- Poor geotechnical conditions exist with a number of fault lines south of Lower Plenty Road and within the alignment of the tunnel. There is also potential that this may necessitate ground improvement works to minimise impacts on properties
- Hydrology issues will likely result in a need to realign a portion of the Banyule Creek north of Lower Plenty Road. There will also likely be a need for bunding or flood walls (max. height in the order of 1–2 m) in the vicinity of the tunnel portal
- The Lower Plenty Road intersection arrangement results in some complex geometry and a partially underground interchange. This will need to be further investigated in future design stages
- Location of the ventilation station at the tunnel portal has been given careful consideration (and will continue to be as the design is further developed) to minimise impacts on the community and perceived issues with this type of infrastructure
- At the Lower Plenty Road interchange, the southbound entry ramp grade, alignment and entry within a tunnel present a significant challenge to provide an appropriate configuration for ramp metering and storage of traffic at the ramp meter.

### 6.2.3 Additional Requirements

#### Noise Attenuation

Noise attenuation requirements for this section will be similar to those discussed in Section 6.1.3. Aspects and likely implementation are shown in Table 6 below.

Table 6 Noise walls Watsonia Station to Lower Plenty Road

| Title | Existing | Replacement |
|---|---|---|
| South of Watsonia Station | Intermittent timber noise walls near transmission line easement | NEL alignment enters cut heading south, limiting the benefit of providing additional noise walls.<br>Replacement of any existing timber noise walls with combination of containment barrier and approx. 2 m noise wall (as and where required). |

| Title | Existing | Replacement |
|---|---|---|
| West side of NEL alignment from Watsonia Station to Lower Plenty Road | New | Approx. 2 m high noise wall provided above containment barrier |
| East side of NEL alignment from Watsonia Station to Yallambie Road | New | Approx. 1 m high noise wall provided along east side of the alignment, above the containment barrier. |
| East side of NEL alignment from Yallambie Road to Lower Plenty Road | New | Containment barrier as and when necessary to be topped with security fencing only.<br>Towards southern end the containment barrier will also serve the purpose of a flood wall.<br>In the vicinity of residential properties, an approx. 3 m high combined noise wall and containment barrier is to be provided on the outside of the southbound exit ramp to Lower Plenty Road. |
| Southerly oriented ramps from Lower Plenty Road | New | Approx. 3 m high combined noise wall and containment barrier is to be provided until ramp cut and cover section is created. |

## 6.3 Lower Plenty Road to Manningham Road

### 6.3.1 Overview

From the tunnel portal at Lower Plenty Road, the tunnels curve eastwards to pass under the Banyule Flats before realigning for connection with the Manningham Road Interchange as shown in Figure 8. The tunnels end at Bridge Street just north of Banksia Street/Manningham Road and continue in a C&CT. Full connectivity is provided to the NEL at this interchange with the southbound exit ramp connecting with Bulleen Road, and all other entry and exit ramps interfacing with Manningham Road.

#### Strategic Connections and Functionality

The Manningham Road Interchange has full connectivity to the local road network via new junctions at Manningham Road and Bulleen Road. The northbound exit and the southbound entry connect with Manningham Road from the south. The northbound entry ramp also connects with Manningham Road, however a loop is provided initially in open cut then trough / dive structure to the tunnel portal to the north. The southbound exit ties in with Bulleen Road.

#### Provisions for Local Access

Existing local access is retained, except Bridge Street where the westbound traffic lanes would be removed. A number of acquisitions of industrial zoned properties located between Manningham Road, Bulleen Road and the Yarra River would be required so as to create the necessary Project Area (including temporary works and permanent infrastructure).

Controls have also been applied so as not to impact on the grading of Golden Way and the large number of access points off this local road.

Figure 8 NEL Overview: Lower Plenty Road to Manningham Road

### 6.3.2 Key Challenges

Similar to the northern portal, the key engineering challenges are associated with grades suitable for an interchange connecting a tunnel to existing surface roads.

Undulating topography in the area and the gradeline required for a bored tunnel north of Bridge Street, combined with the existing constraints of Manningham Road presents challenging conditions to provide an interchange with the existing routes. The NEL tunnel approach from the north is further constrained by the Yarra River crossing, with the tunnel portal significantly influenced by the flooding characteristics of the area.

Furthermore, siting of the necessary ramps and ventilation structure, while maintaining the existing Manningham Road alignment and providing connections in each direction is complex. The combination of bored tunnelling, Cut & Cover Tunnel and Mined Tunnel construction techniques also adds considerable complexity to the constructability.

Other key engineering challenges include:

- Geotechnical conditions remain a significant challenge with the variable conditions and potential for poorer quality materials in the Banyule Flats area likely to determine the tunnelling solution adopted.
- The achievement of desirable grading for the operation for trucks has been a key issue and will need to be continually optimised. Further investigations are also required to confirm the minimum depth / cover below the Yarra River crossing.
- The location of the tunnel portals and the associated, supporting infrastructure will need to be carefully considered during further design development. The Metropolitan Fire Brigade (MFB) will also need to be further engaged.
- At the Manningham Road interchange, the northbound entry ramp alignment and entry within a tunnel present a significant challenge to provide an appropriate configuration for ramp metering and storage of traffic at the ramp meter.
- Provision of appropriate flood protection from flood levels in the adjacent Yarra River. This aspect will need further consideration in subsequent design stages.
- The space required for the interchange ramps is considerable and will permanently displace the existing industrial area. Consideration will need to be given to the use of remnant land in this area including provision for facilities such as a tunnel control centre, other NEL related infrastructure, and possible urban design opportunities.

### 6.3.3 Additional Requirements

#### Noise Attenuation

This section is in twin tunnels and will not require noise treatments.

## 6.4 Manningham Road to Eastern Freeway Interchange

### 6.4.1 Overview

From Manningham Road, the NEL continues south towards the Eastern Freeway in tunnels under residential properties and the Trinity Grammar Sporting Complex before crossing to the west side of Bulleen Road and emerging from tunnel at the portals south of the Veneto Club. After exiting the tunnel portals, the NEL climbs onto viaducts which provide ramp connections to the Eastern Freeway as shown in Figure 9.

Bulleen Road is re-graded on its current alignment between the Eastern Freeway and the Trinity Grammar Sporting Complex entrance. Bulleen Road passes over the east facing ramp connections to Eastern Freeway and is raised above existing levels in the vicinity of the Veneto Club to pass over the NEL carriageways and city-bound exit ramp which are rising to the tunnel portal at this point. Access roads and modifications to existing access points are required to restore access to adjoining properties.

#### Strategic Connections and Functionality

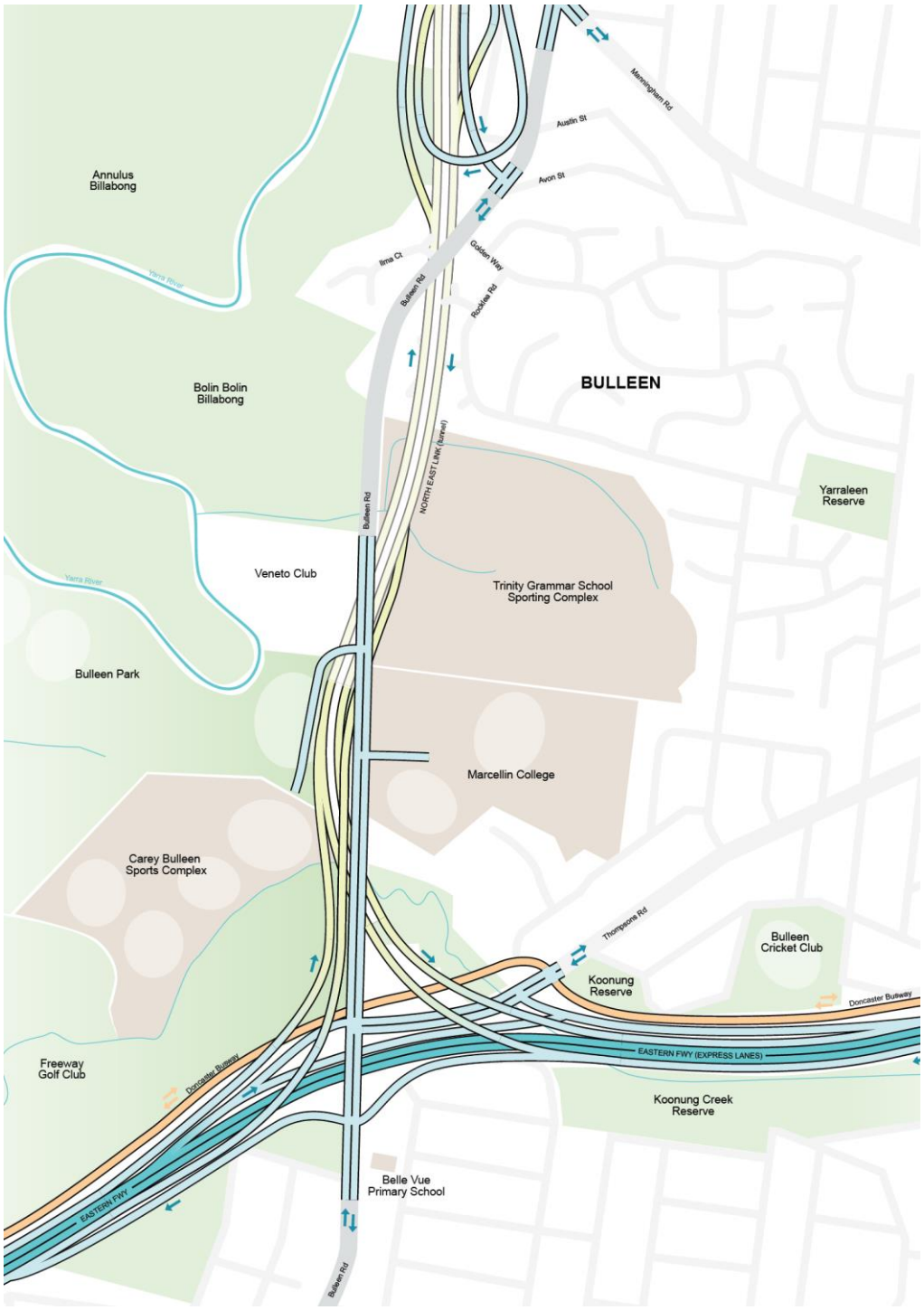
The NEL interchange with Eastern Freeway provides full connectivity between the NEL and Eastern Freeway carriageways.

The existing Eastern Freeway interchange with Bulleen and Thompsons Roads will retain the same functionality as which currently exists.

#### Provisions for Local Access

All local access between Manningham Road and Eastern Freeway is maintained. The re-grading of Bulleen Road required to accommodate the NEL ramp connections to Eastern Freeway requires modifications to existing access arrangements. This includes access roads to traffic signal controlled intersections.

Figure 9 NEL Overview: Manningham Road to Eastern Freeway Interchange



### 6.4.2 Key Challenges

The key engineering challenges are associated with minimising the impacts to residential property, the highly sensitive Bolin Bolin, the Veneto Club, and the school and sporting facilities on either side of the alignment. Aspects which are also influential in this location include the geotechnical conditions, floodplain interactions, existing major utility services and the provision of road elements consistent with freeway standards.

Some specific challenges at this location also include:

- Complex road geometry and limited space combined with added complexity associated with design optimisation to minimise any property impacts.
- The complex underground interchange at Manningham Road presents a number of challenges in relation to buildability, the capacity to cross ramps, and size of the “box” for the tunnel portal and ramp connections.
- The location of the portals south of Manningham Road situates these within the Yarra River floodplain, which presents some significant issues. Depending on the level of flood immunity to be achieved there is the potential for flood walls to a height of up to 10 m. This may be in combination with a number of active and passive provisions.
- Urban design and visual impact/amenity are likely to be key issues given the elevated ramp connections at the Eastern Freeway and the potential for relatively high flood walls in the vicinity of the tunnel portals.
- Proximity to the highly sensitive environmental areas such as the Yarra River and Bolin Bolin Billabong.

### 6.4.3 Additional Requirements

The proposed location for tunnel ventilation and fire deluge facilities is directly above the end of the C&CTs approximately 350 m south of Manningham Road. This location has been selected as it maximises the separation to sensitive receptors. The Freeway Control Centre (FCC) has been tentatively located within the industrial land to be acquired.

The concept design has sought to minimise both temporary and permanent impacts on:

- The sporting facilities abutting Bulleen Road, the Veneto Club, and existing major utility services, in particular the main sewer and gas lines along Bulleen Road
- The Freeway Golf Course, the lower reaches of Koonung Creek, and the local connections to and from Bulleen Road.

These matters will need to be further investigated as the design progresses.

#### Noise Attenuation

Noise attenuation characteristics and requirements for this section will be similar to those discussed in Section 6.1.3. Indicative implementation details for this section are in Table 7.

Table 7 Noise walls Manningham Road to Eastern Freeway Interchange

| Title | Existing | Replacement |
|---|---|---|
| Eastern Freeway Interchange Ramps | New | Ramps on viaduct will be provided with approx. 2-3 m high noise above containment barriers on both sides of the ramps. Different requirements for each ramp may apply given ramps are at different levels with different exposure to residential areas on either side of the Eastern Freeway. |

### Community Interests

The extent of land acquisition, potential impacts on environmentally sensitive areas, and visual amenity associated with the NEL ramp connections to Eastern Freeway will be of key importance to the community. These issues have been addressed in the design by minimising acquisition requirements, treating both Bolin Bolin Billabong and the areas north of Bridge Street as no go zones, and optimising the design to significantly reduce the footprint of the project. The design also considers constructability and aims to allow the interchange to be constructed without significant disruption to Eastern Freeway.

## 6.5 Eastern Freeway Upgrade

### 6.5.1 Overview

The Eastern Freeway will be upgraded nominally between Chandler Highway and Springvale Road, although works will continue west to Hoddle Street to provide for a Managed Motorway for the full length of the Eastern Freeway and to extend the provisions being made for the Doncaster Busway in the Project (see Section 14.2 for details).

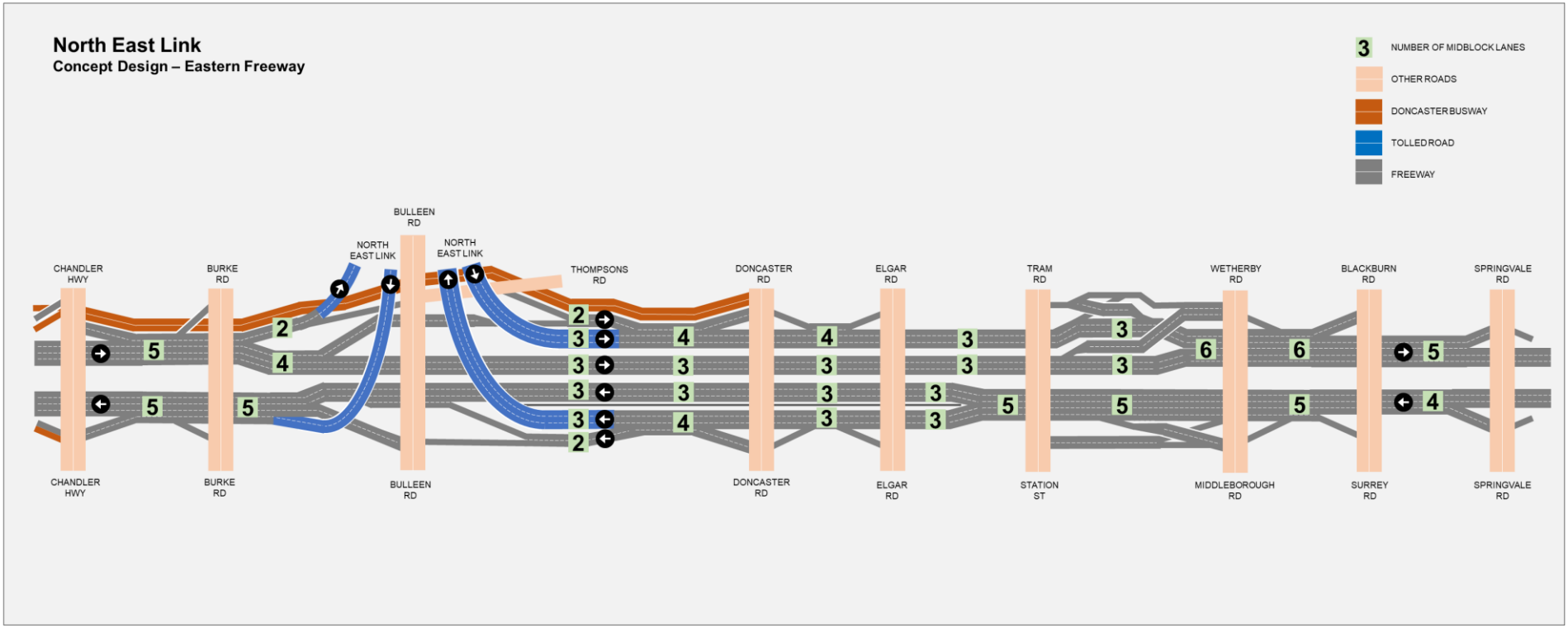
Between Chandler Highway and Burke Road the number of through lanes in each direction will be increased to five. East of Burke Road, in preparation for the interchange with the NEL at Bulleen Road, the eastbound carriageway will bifurcate, with three lanes of Eastern Freeway through traffic being isolated from the various interchanges until Middleborough Road via an Express and C-D arrangement. The westbound carriageway from Tram Road through to Burke Road also applies a similar arrangement.

An interchange connecting NEL to the Eastern Freeway will be provided at Bulleen Road, while maintaining existing functionality of the Bulleen and Thompsons Road interchange. Traffic will be free flowing between the NEL and east facing connections to the Eastern Freeway, while west facing ramps between NEL and Eastern Freeway will be metered.

Between Bulleen and Tram Roads, traffic to or from NEL, Bulleen, Doncaster or Elgar Roads will occupy the outside 3 or 4 lanes in each direction in a C-D. The inside three lanes in each direction will be the Eastern Freeway “express” traffic between Middleborough Road and Burke Road. Express traffic can access the interchanges at Chandler Highway and Middleborough Road, but will not be able to access any of the other interchanges between them. Existing functionality for the freeway is retained east of Middleborough Road.

Figure 10 details the schematic for the Eastern Freeway Upgrade concept design.

Figure 10 Eastern Freeway Concept Design schematic



### Strategic Connections and Functionality

The modernised Eastern Freeway will provide the necessary capacity improvements and segregation of traffic to facilitate a full connection with NEL. A key feature of the upgrade is that Eastern Freeway traffic not originating from or destined for NEL, Bulleen, Doncaster and Elgar Roads will be separated from traffic at those interchanges. This will be achieved by the construction of express lanes in the central segment of the alignment with three lanes in each direction separated from adjacent lanes by traffic barriers. The necessary connectivity to the arterial roads that cross the Eastern Freeway in this area is achieved via the outer C-D carriageways with three to four lanes in each direction.

The existing functionality of the Eastern Freeway and cross roads will be maintained, and the freeway will be upgraded to Managed Motorway (**MM**) standard with ramp metering and associated ramp storage being provided.

### Provisions for Local Access

No local access is provided to/from the existing Eastern Freeway currently. All functionality of the existing interchanges is retained hence there should be no direct impact on any local access.

The existing SUPs along Koonung Creek (and the north side Eastern Freeway, east of Bulleen Road) will be maintained but may need to be realigned to accommodate the works. A number of the SUP bridges crossing the freeway will also likely need to be replaced (as is discussion in Section 7.5).

## 6.5.2 Key Challenges

The key engineering challenges associated with the Eastern Freeway Upgrade are minimising the impacts brought about by the widening works to provide the required number of traffic lanes consistent with freeway standards. Some specific items include:

- **Existing bridge structures**. The existing bridges consist of bridges over the freeway at each arterial road interchange, over-bridges at Belford Road and at the Freeway Public Golf Course, SUP overpass bridges at Kenneth Street, Heyington Avenue, Eram Road, Leeds Street, Busana Way, and a SUP underpass east of Burke Road. The design requires replacement of the Doncaster Road overpass and replacement of several SUP bridges but endeavours to retain all of the other existing bridges. This will need to be further verified in future design stages including determining exactly what works need to be undertaken at each of the bridges to be retained.
- **Constructability**. Consideration needs to be given to how the widening of the freeway, which is substantial in some areas, can be undertaken safely and with the least possible impact on the operation of the freeway (and the travelling public).
- **Ramp metering**. Incorporation of the required storage lengths for metering of entry ramps, particularly given the large storage areas likely to be required, could be an issue. Balancing functionality and connectivity with optimising performance (such as minimising weaving) must also be carefully considered.
- **Existing Koonung Creek**. The freeway is located along the Koonung Creek valley, and the creek is adjacent to it from Springvale Road to Bulleen Road. Numerous culvert crossings of the freeway also feed into Koonung Creek. The design would require significant widening of the existing structures and realignment of portions of the creek. Sections of the existing creek may also need to be covered and there would be some loss of open space as well as impacts on existing creek structures.

### 6.5.3 Additional Requirements

The Eastern Freeway Upgrade works will give consideration to:

- Challenges meeting WSRD requirements given the large increases in pavement area with limited available width remaining in the road reservation to accommodate the required treatment area.
- Significant retaining walls that exist along the existing freeway, which may require modification or reconstruction to accommodate the widening works.
- There are extensive lengths of noise walls along the alignment. Between Doncaster Road and Springvale Road in particular, these are of showcase quality. The widening works will require some reconstruction of the existing noise walls.
- Constructability under traffic will be a key issue and will likely result in extensive traffic management requirements.

#### Noise Attenuation

Noise attenuation characteristics and requirements for the Eastern Freeway upgrade will be similar to those discussed in Section 6.1.3, and will be subject to further investigation and review. Aspects and likely implementation for this section are shown in Table 8.

Table 8 Noise walls Eastern Freeway Upgrade

| Title | Existing | Replacement |
|---|---|---|
| Chandler Highway to NEL / Bulleen Road | Existing noise walls unaffected | Not Applicable. Existing noise walls are currently expected to be unaffected. |
| NEL / Bulleen Road to Doncaster Road | Both sides of the Eastern Freeway | Replacement of existing walls physically impacted or undermined. This is in addition to any new noise walls on the ramp connections for the interchange. Gaps in existing noise walls will be addressed with approx. 4-6 m high noise walls such as along south side of the Freeway, along parts of the Koonung Creek Reserve. |
| Doncaster Road to Middleborough Road – Both Sides | Various | Existing walls will be replaced to the extent that they are physically impacted, nominally with approx. 6 m high noise walls. Existing gaps in noise walls will be addressed, such as on the south side adjacent to sports field west of Elgar Road. |
| Middleborough Road to Springvale Road | Existing noise walls unaffected | Existing walls are unlikely to be affected but will be replaced if impacted by the works. |

# 7 Structures

This section provides an overview of the structures proposed in each of the geographical areas discussed in the Roads and Civils Section. Elements discussed include bridges, cut and cover structures/tunnels, major retaining walls and major drainage structures. It also includes relevant details of the C&CT structures.

Other structures including gantries, sign and lighting, noise walls, roadside barriers and road furniture will be developed further during Reference Design. Driven and Mined Tunnels are discussed in Section 8.

## 7.1 M80 Interchange to Grimshaw Street

### 7.1.1 Overview

The existing intersection of the Greensborough Bypass and the M80 is proposed to be upgraded to a free flow junction. To achieve this, grade separation of a number of ramps is required to be on structures. This includes:

- Westbound Ramp from Greensborough Bypass to M80 – a new structure that is approximately 525 m long with approximately 175 m long Reinforced Soil Structure (**RSS**) at the west end. The ramp crosses over five other ramps with a number of highly skewed crossings in a tight corridor which leads to spans in excess of 70 m
- NEL/Grimshaw Street northbound to M80 westbound – this passes over the exit ramp from the northbound Grimshaw Street to the eastbound Greensborough Bypass on a high skew. Over the majority of its length it will be at-grade or on fill except where it crosses over the exit ramp to the eastbound Greensborough Bypass, and a plank bridge or short underpass with integral abutments is proposed
- M80 eastbound to NEL southbound main carriageway – this connection passes over the exit ramp from the northbound Grimshaw Street and both carriageways of the Greensborough Bypass. The bridge is on a high skew resulting in a main span in the order of 70 m with the total structure length of approximately 380 m.

Two pedestrian crossings are impacted including the Yando/Hakea Street Underpass and the existing pedestrian bridge over M80 at Macorna Street. The underpass comprises precast reinforced concrete crown units and is proposed to be extended to accommodate the widened road corridor. The existing pedestrian bridge will need to be replaced. The new Macorna Street pedestrian bridge is likely to span approximately 80 m to clear all carriageways and is expected to incorporate Disability Discrimination Act (**DDA**) compliant ramps on both sides of the M80.

In addition, assessment of the existing twin bridges over Plenty River (no work currently envisaged) and structural widening to the existing twin bridges over Kempston Street will be required. Grimshaw Street is proposed to be raised over NEL with a new elevated ramp connections from NEL and C-D ramps. The existing Grimshaw Street bridge over Hurstbridge Rail is also to be demolished and replaced as part of the works.

Various structural forms are applied to the structures including plank and Tee-Roff structures for the less prominent and shorter ramp over ramp crossings and two large steel box girder curved ramp structures for the longer structures. Predominantly carriageways have sufficient space within the interchange for battered embankments and cuts though some sections of walled embankment are required where carriageways on differing grade are close together.

### 7.1.2 Key Challenges

The key engineering challenges associated with the structural design here include:

- The existing pedestrian underpass at Yando Street is 88 m long and is subject to flooding in rainfall events that exceed the capacity of the adjacent longitudinal drain. Extension to 130 m long is required and CPTED requirements will need to be addressed including considering opportunities such as natural light in medians, wider cross sections within the extension elements, lighting, and improved passive surveillance near the entrances.
- The two long ramp structures require careful urban design consideration to avoid potentially visual obtrusive elements in relatively close proximity to residential properties. Twin continuous steel structures are included in the concept to present a consistent slender form, with barrier and noise wall details still to be explored.
- Assessment and strengthening of the existing Kempston Street Bridges will be a key consideration. Retention of and minimum disruption to these structures is both a key benefit for minimising impacts on the community and a challenge to the design development.
- Staging of the reconstruction of the Grimshaw Street Bridge over the railway line and the new overpass over NEL will be particularly important. The potential for staged and/or off line construction will need to be considered during design development.

### 7.1.3 Additional Requirements

In addition to the various bridge structures within this section of the works, a number of other key elements of the work will need to be further progressed during the Reference Design. In particular, the need for a number of retained structures within both the deep cuts (e.g. soil nail walls) and walled fill embankments (e.g. RSS walls) around the M80 interchange will need to be further developed as will the extent of and details for the new and modified noise walls at this location.

## 7.2 Grimshaw Street to Watsonia Station

### 7.2.1 Overview

The various elevated roads and ramps at the Grimshaw Street interchange are key to achieving free flow of traffic on NEL while maintaining all local connections. The structures adopted to achieve this include a series of RSS wall embankments and short Tee Roff bridges which support raised ramps either side of NEL. A braid ramp connection also occurs between walled ramps on the west side of NEL via short underpass structure.

The walled embankments are typically narrow and flanked by either ‘Medium’ or ‘Regular’ containment traffic barriers, depending on wall height (typically 4–10 m). Optimising barrier footings and bridge approach structures is likely result in the use of structural concrete pavements similar to that used on bridge decks.

Also in this section is a significant interaction with / modification to the existing Hurstbridge rail underpass. The structure crosses under the existing Greensborough Highway on a tight skew resulting in an underpass of 144.6 m length. Road corridor widening to accommodate NEL and the associated entry and exit roads and local access requires augmentation of the structure approximately doubling the underpass in length. The proposed extension includes both full and partial enclosure depending on what is above. Subject to further development and review during the Reference Design a southwards extension of structure over the rail between the existing underpass and Watsonia Station provides possible augmentation of the Watsonia Station car park.

The existing pedestrian bridge over Greensborough Highway in the vicinity of Nell Street is directly impacted and is to be replaced. Complementing this will be reinstating the existing Elder Street connectivity, with a bridge over NEL proposed nearby within the transmission line easement to restore Nell and Elder St connectivity. Introduction of an overpass on Elder Street itself is not practical as it would sever access to and require acquisition of a number of residential properties. The proposed elevated structure will pass over NEL, the Watsonia Station car park, and the station platforms before matching back into grade at the existing Watsonia Road roundabout and connecting into the local road network on the east side of NEL.

The total length of Elder Street replacement structure is expected to be approximately 300 m with lengths of RSS walls at each end. The bridge width will be sufficient to incorporate one lane in each direction, a footpath and a SUP, barriers and safety/privacy screens in sections. In order to clear span NEL and the rail cutting spans of approximately 50 m are required and a continuous steel trough is proposed.

### 7.2.2 Key Challenges

The key engineering challenges associated with this section include:

- The proposed concept for lengthening the existing 1980's Hurstbridge rail underpass requires consultation and further development during the Reference Design phase. The underpass is potentially lengthened to the point that tunnel attributes such as ventilation, access and egress provisions will be required. Assessment of the condition and capacity of the existing structure is also required
- Determination of a suitable site and form for the replacement structure for the Greensborough Highway pedestrian overpass currently at Nell Street. Interaction of the potential Elder Street overpass with easement constraints, high voltage power lines, the library and residential properties will also need to be carefully considered
- The design and construction of RSS walls alongside an operational railway will also need to be carefully considered. Alignment and interaction with the existing cutting walls to be reviewed and developed during the Reference Design phase
- Further review of the easement constraints (for the new Elder Street and Pedestrian Overpass) including proximity of the high voltage power lines, proximity to the library and residential properties will be required during the Reference Design development.

### 7.2.3 Additional Requirements

Consultation with key stakeholders such as Public Transport Victoria (**PTV**) and Metro Trains Melbourne (**MTM**), and development of concepts for the existing rail underpass will need to be progressed as soon as possible. Further investigation is also required to adequately address cross connectivity for pedestrian and local movements.

## 7.3 Watsonia Station to Lower Plenty Road

### 7.3.1 Overview

The NEL mainline descends into a cutting commencing adjacent to the Watsonia Station car park. The cutting is proposed to be flanked on both sides by drained structural walls along the entire length from Watsonia Station to a point just north of Erskine Street where commencement of the tanked cut and cover tunnel is proposed (refer to Section 7.6 for further details).

Structural walls in the cutting are proposed to stand vertically optimising retention of existing land at grade and supporting the barriers which will separate Greensborough Road and the NEL cutting. It should be noted that the highly weathered Silurian Siltstone in the area exhibits folds and adverse dipping planes, which in the absence of structural walls would affect the spatial viability of batters or tied wall systems greater that 4–6 m high. Cantilever structural walls are also anticipated to be limited to between 8 and 10 m high with higher walls requiring propping.

The depth of cutting varies and three structural forms are proposed to cater for the depth and land use while maintaining a naturally ventilated cutting predominantly open to the atmosphere. The forms will each include a combination of walls or barriers with noise attenuation and safety screens/fencing, and in brief are as follows:

- North of the Watsonia Station and between Blamey Road and the Erskine Street where 2 m to 8 m high cantilever drained contiguous bored piles walls with insitu shotcrete infill and facing panels are proposed.
- Watsonia Station access to Blamey Road where 8 to 14 m high propped and drained contiguous bored piles walls with insitu shotcrete infill and facing panels are required.
- A number of landbridges are proposed and are key focal points to enhance access and local amenity. Each landbridge replaces the prop function between piled walls and is approximately 80 m long separated by sections of open trench flanked by propped piled walls. This arrangement is aimed at maximising natural light and maintaining natural ventilation of the cutting. Four such land bridges are proposed and will be complemented by road bridges to maintain access across NEL.
- Simple integral Tee-Roff bridges will span between the cutting walls to support Blamey Road, the south facing ramp terminals to Greensborough Highway and the northbound NEL exit ramp to Greensborough Highway.
- Further south a cut and cover tunnel portal is proposed just north of Erskine Road. South of this point the mainline alignment deepens rapidly on approach to the bored tunnel portals on the north side of Lower Plenty Road. Tanked cut and cover and open trough ramp structures are anticipated in this area due to the proximity of Banyule Drain and the likely groundwater water table. Tanked structures will likely comprise either diaphragm wall structures (similar to those proposed in the Manningham Road Interchange) or contiguous pile walls with insitu concrete lining.
- Where practical ramp geometry will be such that the depth of excavation terraces in depth minimises the height of retaining walls.
- Ramps connecting to Lower Plenty Road traverse the mainline cut and cover box in walled trough/second level cut and cover structures to assist in minimising the footprint while Drysdale Street is reinstated over the roof of the cut and cover tunnels.
- In closer proximity to the TBM portal sizing of the C&CT structures make allowance for the temporary use as launch/retrieval shafts.

### 7.3.2 Key Challenges

The key engineering challenges associated with the structural design here include:

- F&LS along the cutting. Egress points to the surface, emergency cabinets, fire hydrants, deluge systems and lighting requirements still need to be confirmed in combination with further development of the gradeline and degree of coverage;
- Propped structural walls present urban design and access challenges. Further review of the gradeline, geotechnical conditions and structural options is recommended to reduce the extent and scale of propping;
- The depth from surface to the proposed TBM invert at Lower Plenty Road is approximately 35 m which is approaching the limit for some conventional top down construction techniques.
- Hydrology issues associated with Banyule Drain/Creek will need to be further developed noting that there will likely be a need for localised bunding and/or low level flood walls to prevent water ingress into the tunnel portal; and
- A low point in the NEL alignment occurs within the cutting adjacent to the Watsonia Station (introduced to optimise the design by reducing the depth of cut). Drainage of the low point via directional drilling and gravity draining to discharge will be required.

### 7.3.3 Additional Requirements

Opportunities to further cover the open cut/walled cutting with either additional land bridges or covering the entire section could be explored. The complementary landscaping treatments and augmentation of the SUP network should also be developed further.

Confirmation of geotechnical and groundwater conditions is required to enable further development of structural wall solutions and consideration of suitable zones for drainage and tanked designs. Sizing and design of the sump and pump facility will also be necessary for the area on the north side of Lower Plenty Road.

## 7.4 Manningham Road to Eastern Freeway Interchange

### 7.4.1 Overview

#### Manningham Road Interchange to Ilma Court

The NEL mainline ascends rapidly from the bored tunnels at Bridge Road to a crest located approximately at the mid-point of the interchange to minimise depths of structure and ramp gradients. The alignment then descends to the south to gain sufficient depth for mined tunnelling below residences east/south of Bulleen Road. Throughout the length between the Tunnel Boring Machine (**TBM**) portal and mined tunnels portal the mainline and the majority of the length of each of the ramps are anticipated to be in Tanked C&CTs. The section in close proximity to the TBM portal will be sized to allow for TBM launch/retrieval. Refer to Section 7.6 for more details on the C&CT's.

Within the Manningham Road interchange four entry and exit ramps form a fully functional interchange. The ramps descend from the surface road connection points to the main tunnel and adopt similar structural form and flood protection to the mainline. The extent of cut and cover is maximised to optimise flood protection. Where insufficient cover exists, typically in close proximity to the Bulleen Road/Manningham Road intersection points, flood walls and active flood gates are anticipated.

### Ilma Court to Trinity Grammar

This section is proposed to be constructed via Sequentially Excavated Mined (**SEM**) tunnelling techniques below the residential areas south/east of Bulleen Road. Refer to Section 8 for further details.

### Trinity Grammar to Eastern Freeway Interchange

The northern part of this section between the mined tunnel portals and a point just north of Koonung Creek (near Veneto Club) is proposed to be constructed at depth via C&CT methods. Refer to Section 7.6 for further details.

South of the Veneto Club Bulleen Road is raised onto an elevated structure of approximately 300 m length to pass over the NEL east facing ramps and Koonung Creek. The highly skewed crossing of NEL requires spans in excess of 50 m, Continuous steel trough girders with insitu concrete deck structures are proposed at this stage.

Also, south of the Veneto Club, the NEL alignment of all four ramps rises to pass over Koonung Creek. The extent of cut and cover structure and flood protection walling requires further consideration with potential for the cut and cover section to be maximised and potentially concealed in an earthen embankment to a point nearing Koonung Creek.

The ramp structures passing over Koonung Creek and sections of the Eastern Freeway are proposed to be steel trough girders with insitu concrete deck structure similar to that adopted for adjacent and over the Bulleen Road structure. Steel trough structures are also suited to the long spans, tight skew angles and limited median space available between carriageways of the Eastern Freeway for piers.

The concept design aims to keep the ramp structures and Bulleen Road as low possible at approximately 12–15 m above the existing Bulleen Road level.

## 7.4.2 Key Challenges

The key engineering challenges associated with the structural design here include:

- A range of factors including poor geotechnical conditions, high groundwater levels, significant flooding potential.
- Constructability and complex staging of layered underground ramps within the Manningham Road interchange and the interaction with TBM launch and bored tunnel construction.
- Construction impacts on Bulleen Road given the grade changes, existing services (trunk sewer and gas main), large piers, and superstructure construction above (for the new ramp connections to the Eastern Freeway).
- Land constraints in the Eastern Freeway corridor east of Bulleen Road result in highly skewed crossings and minimal space for pier supports. Long spans (>70 m) steel trough continuous structures on skewed supports are proposed as a result.
- Visual amenity could be a particular concern the height and size of the elevated ramps and flood wall protecting the various tunnel portals.
- Koonung Creek and associated floodway impacts including the proximity to flood walls and the sensitive Bolin Bolin area.
- The new Yarra River Protection Bill (currently being considered by Parliament) and the associated Yarra River Strategic Plan may impose restrictions on structures built in close proximity to the Yarra River. These will require further investigation.

### 7.4.3 Additional Requirements

A number of associated structural elements have not been considered in the Concept Design but will need further investigation in future design stages. In particular, pier protection barriers along the Eastern Freeway, noise mitigation measures and flood wall extents, all of which require careful consideration to minimise the visual impact.

## 7.5 Eastern Freeway Upgrade

### 7.5.1 Overview

The existing freeway passes under all road crossings and most pedestrian crossings and passes over all waterways. Waterway crossings include bridges over Merri Creek and the Yarra River and several arch culvert crossings housing Koonung Creek. As such, there are a number of new or widened bridge structures, several modifications below existing bridges, some bridge replacements, and creek and culvert works. In brief, the proposed structural works as part of the Eastern Freeway Upgrade include:

- **New Doncaster Busway road bridges**. At the Chandler Highway interchange the inbound lane of the Doncaster Busway will require a flyover from the northern side of the alignment over both Eastern Freeway carriageways and the inbound on-ramp before connecting to the shoulder of the Eastern Freeway. There will be no physical widening to the bridges at Yarra River and Merri Creek, however strengthening of the bridge at Yarra River will be required. At the Doncaster Road interchange, the Doncaster Busway will require grade separation.
- **New road bridges**. In addition to the new NEL ramp structures within the new interchange at Bulleen Road, a number of short underpasses and bridges are associated with braided ramps between Tram and Middleborough Roads. The existing bridge at Doncaster Road also needs to be demolished and rebuilt.
- **Pedestrian bridge replacements**. The existing pedestrian bridges at Trennery Crescent, Kenneth Street, Heyington Avenue, and Koonung Creek Trail (west of Springvale Road) are all impacted by the works and have to be replaced.
- **Minor structural modifications to existing bridges**. A number of the existing overpass bridges are able to be retained but will be subject to minor modifications to accommodate NEL. This is likely to include as a minimum modifying existing spill through abutments and pier protection works at Chandler Highway, Bourke Road, Camberwell Golf Course Access, Bulleen Road, Elgar Road, Tram Road, Middleborough Road, and Blackburn Road.
- **Koonung Creek impacts east of Bulleen Road**. The creek is impacted by the proposed widening in several areas, with some key points of interaction including:
  - The existing arch structure housing the underground creek between Thompson and Bulleen Roads is located largely below parkland adjacent to the freeway. While alignments for the proposed widening aim to minimise impacts on the existing structure there are a number of locations where this may not be avoided.
  - The proposed freeway widening to the southern side between Doncaster and Elgar Roads interacts with the existing open Koonung Creek in a constrained environment. Potential treatments require further development, however it is likely that a significant length of open creek would need to be converted into an arched culvert system similar to that existing just to the west (as noted above).

– East of Elgar Road the proposed widening of the freeway and associated works (ramp metering and replacement SUP bridges for example) would also have an impact and require structures to span Koonung Creek.

In addition to the bridge works described above, there will also be significant lighting, gantry, noise wall, and retaining wall works.

### 7.5.2 Key Challenges

The key engineering challenges associated with the structural design here include:

- Complexity in the eastbound braided ramp arrangement west of Middleborough Road will require further consideration as the design progresses to achieve structural design requirements and optimise constructability.
- Extensive noise wall works, both new and replacement, are required. Many existing walls are urban design features and careful strategies for replacement are required.
- Impacts on Koonung Creek including the existing arched structure and coverage of sections of the creek that are currently open (and achieving a balance between hydrology, structure and environmental objectives).
- Confirming the existing condition and works that may be required to existing structures (including major drainage) to satisfy the performance requirements.
- Staging proposals to address the inherent complexity and long duration of constructing the relatively large number of structures in a live freeway environment.

### 7.5.3 Additional Requirements

Further works during development of the Reference Design are required to:

- Confirm the condition, load rating and future proofing requirements for Koonung Creek, including potential hydrology measures.
- Model the design in three dimensions and better understand the potential impacts on existing batters, retaining walls (e.g. undermining) and noise attenuation. This will also need to be accompanied by noise testing, modelling and design to confirm the basis of the structural design of these elements.
- Existing structure inspections and assessment need to be progressed as soon as possible on a risk based approach. Consideration also needs to be given to the availability of existing information and the need for other tests (e.g. durability).

## 7.6 Cut and Cover Structures

### 7.6.1 Overview

For Cut and Cover structures, the Concept Design has resulted in the selection of:

- Drained structures in shallower cut areas with lower groundwater susceptibility, which typically comprise bored reinforced concrete piles with insitu infill and facing, reinforced concrete cantilever walls or soil nail/rock bolt walls.
- Tanked (waterproofed) design solutions for dive/trough structures and C&CT structures in deeper cuts and areas of higher groundwater susceptibility.

Typically tanked structures comprise diaphragm walls and reinforced concrete base slab and roof elements with appropriate waterproofing details.

Flood wall and flood gate protection to dive/trough structures and C&CT structures within the Manningham Road interchange and in the region of the portals south of the Veneto club will be required. Flood gates and/or flood walls extend above the existing ground levels of ramps and entrances to the main tunnel in order to prevent water entering the main tunnel drainage system.

### Lower Plenty Road (Northern Tunnel Portal)

The transition from open trough to a C&CT is proposed just north of Erskine Street. South of this point the alignment rapidly deepens on approach to the bored tunnel portals located on the north side of Lower Plenty Road.

Tanked cut and cover and open trough ramp structures are anticipated in this area due to the proximity of Banyule Drain the groundwater water. Tanked structures will likely comprise either diaphragm wall structures (similar to those proposed in the Manningham Road Interchange) or contiguous pile walls with insitu concrete lining.

In closer proximity to the TBM portals the C&CT structures will be constructed wider and temporarily deeper than otherwise required for the permanent configuration to make allowance for the temporary use as a TBM retrieval shaft.

### Manningham Road (Southern Tunnel Portal)

The mainline C&CT section at Manningham Road is nominally 700 m long and C&CT ramp sections within the interchange total approximately 1000 m. Throughout the Manningham Road to Ilma Court and Trinity Grammar to Koonung Creek areas, deep alluvial material overly weathered and fractured siltstone and high groundwater levels exist. Flooding potential to levels well above the existing ground level also apply. The high groundwater levels coupled with the permeable ground conditions have led to the adoption of tanked C&CT structures for the deeper sections and tanked open trough structures for shallower areas.

The tanked structures are anticipated to comprise diaphragm wall structures constructed with hydromill processes to address the siltstone or contiguous pile walls with insitu concrete lining. Wall socketing into rock and tension piles will be required to resist potential flotation. Construction stage groundwater inflow and groundwater draw down will be studied further during the future design phases and appropriate mitigation measure will be implemented.

## 7.6.2 Key Challenges

The key engineering challenges associated with the structural design here include:

- Construction complexity of the Lower Plenty Road portal area and “Manningham Road Box” given their significant depth and tiered construction to facilitate the multiple road crossings and ramps. The Lower Plenty Road portals are in a constrained environment and has the added complexity of Banyule Drain/Creek while the “Manningham Road Box” will encounter poor ground conditions and high ground water levels. All will need to be considered further as the design progresses.

- Flood protection levels and mitigation measures, particularly in the portal areas are a key issue. Measures are likely to include passive provisions including earth mounding and flood walls coupled with active flood gates to protect against less frequent higher flood events. Opportunities for improved passive protection through raised road alignments and raised closed structures potentially concealed in earthen embankments or raised ground levels will be explored during design development.
- Deep alluvial material overlie weathered, fractured siltstone and high groundwater levels exist resulting in the requirement for deep foundations and the need to design underground structures to resist flotation and as tanked / watertight elements.

### 7.6.3 Additional Requirements

Detailed hydro-geological properties and modelling is required to understand the extent of groundwater drawdown around the Manningham Road Box during construction and the scope of any remediation measures that may be required to limit these effects to acceptable levels.

Preliminary geotechnical information indicate the presence of Potential Acid Sulphate Soils (**PASS**) and the possibility of Acid Sulphate Soils (**ASS**) in the Yarra delta areas between Manningham Road and the Eastern Freeway and could impact structure design. Further studies and testing of soils and groundwater is required to further confirm this (and its extents).

The area south of Manningham Road and along the alignment extending to the Eastern Freeway (with the exception of higher rock in the region of Ilma Court) lie in the Yarra flood plain. It is understood that variable depth of soft ground and alluvial materials overlie faulted Siluriun bedrock, and the groundwater level approaches existing ground level in areas. However, further investigations are required to understand these conditions better.

# 8 Tunnels

This section provides a high level overview of the twin tunnels (e.g. Mined and TBM), proposed between Lower Plenty Road and the Trinity College Sports Complex in Bulleen at a conceptual level. C&CT structures are discussed in Section 7.

## 8.1 Overview

The proposed NEL roadway will be tunnelled beneath the Yarra River with a northern portal at Lower Plenty Road in Yallambie and a southern portal at Manningham Road in Bulleen, and between Ilma Court and the Trinity College Sports Complex in Bulleen. This solution has been adopted in order to minimise impacts on the environmentally sensitive Yarra River Valley and Banyule Flats, residential premises in Bulleen, and avoid long term impacts to the sports fields on the east side of Bulleen Road.

Between Lower Plenty Road and Manningham Road the tunnels are anticipated to be excavated through variably weathered siltstone and sandstone, with groundwater pressures up to 4.5 bar and exposure to alluvial sediments in some locations beneath the valley. As a consequence, TBMs with the ability to provide a positive face pressure and deal with variable materials and the presence of fault lines are expected to be used to excavate the tunnels. Each TBM will install a water-tight precast segmental lining as the TBM advances.

Between Ilma Court and the Trinity College Sports Complex in Bulleen the tunnels are again anticipated to be excavated through variably weathered siltstone and sandstone. The tunnel excavation support is to be carried out by conventional methods, installing a temporary support system directly behind the excavation face and pre-support if required. Following excavation, the construction sequence will install a water tight structural lining.

All the tunnels are proposed to be of MM standard and will be provided with:

- Internal ventilation and vitiated air disbursement facilities as well as F&LS provisions including cross passages every 120 m
- Lighting, communication, drainage and water treatment facilities.

### 8.1.1 Alignment and Space Proofing

The nominal length of each driven tunnel is 3.1 km, with a further 350 m of mined tunnel. Cut and cover structures are provided at either end of the tunnels and between mined and driven tunnels. The total length of each tunnel including a combination of Bored, Mined and Cut & Cover techniques is approximately 5 km.

Each tunnel internal profile has been developed to accommodate the traffic envelope and provision for ventilation, F&LS, emergency egress and MM equipment in accordance with published guidelines and standards. This results in a driven tunnel with an internal circular profile of 13.9 m diameter and a mined tunnel with a ‘frog mouth’ excavation shape of similar diameter.

Indicative cross sections of the tunnels are shown in Figure 11 and Figure 12 with the horizontal alignment of the base case tunnels shown in Figure 13. Each of the tunnels has been sized to allow for three 3500 mm wide traffic lanes. Additional provisions have also been made for vehicle roll, and near and off side shoulders.

For the driven tunnel, preliminary design calculations, fire resistance and durability considerations and benchmarking against previous tunnelling projects, it is anticipated that the permanent segmental concrete lining will be of the order of 600 mm in thickness. In conjunction with a 100 mm allowance for construction tolerances and a 200 mm annular gap for TBM steering, tail shield thickness and annulus grouting, this results in a 15.7 m diameter TBM cut profile with a 194 m2 face area. Further analysis will be undertaken at Reference Design to confirm these assumptions.

For the mined tunnel, based on similar preliminary design calculations for fire resistance and durability considerations, and benchmarking against previous tunnelling projects, it is anticipated that the permanent lining will be of the order of 650 mm in thickness.

Provision has been made for lighting, cable trays, signage and a fixed firefighting sprinkler system, above the traffic envelope. The space below the road deck space is typically used for drainage and water treatment, electrical power supply, electrical equipment (such as transformers) and an underdeck maintenance roadway.

Figure 11 Cross section of TBM driven tunnel

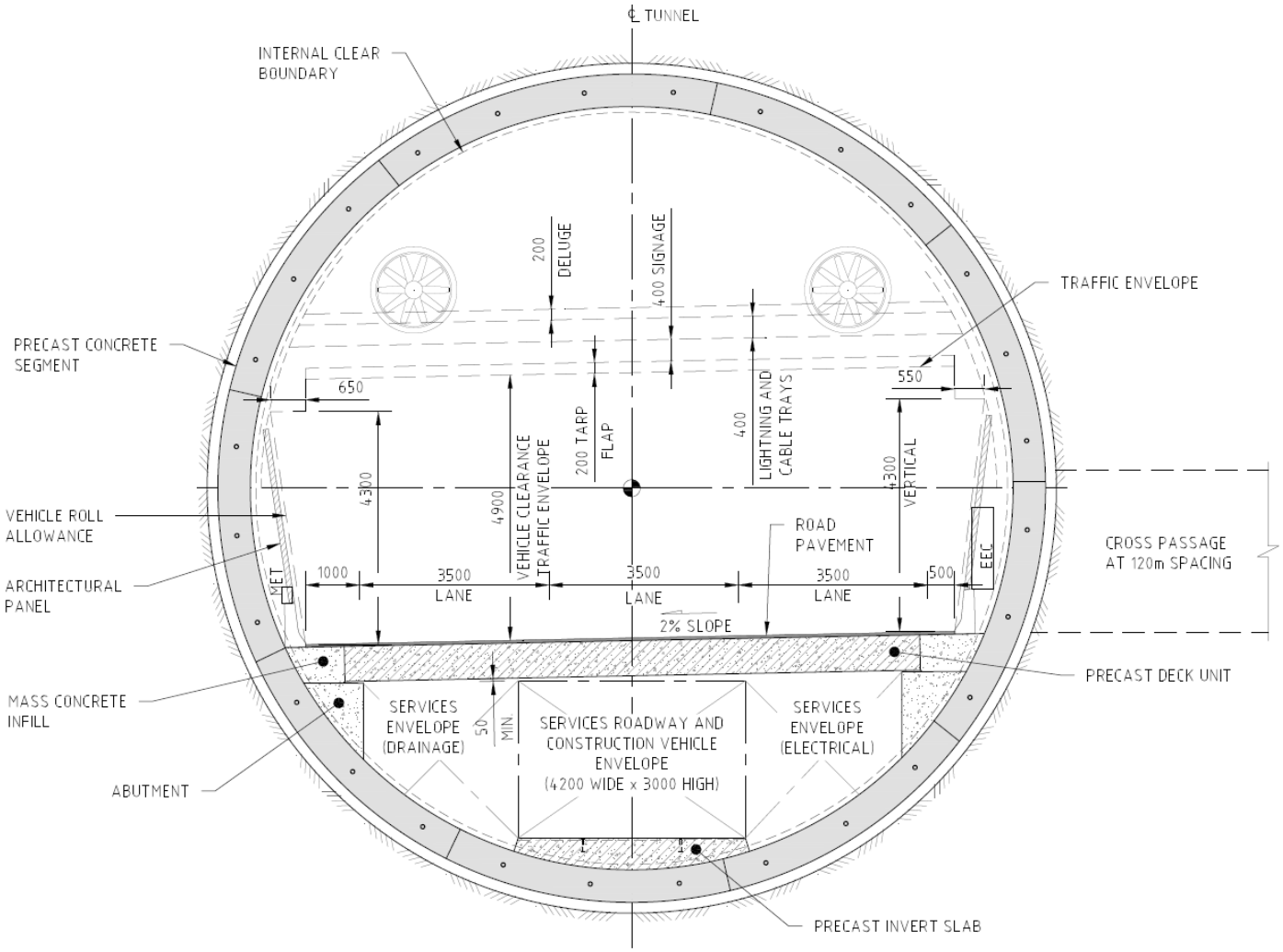


Figure 12 Cross section of mined tunnel

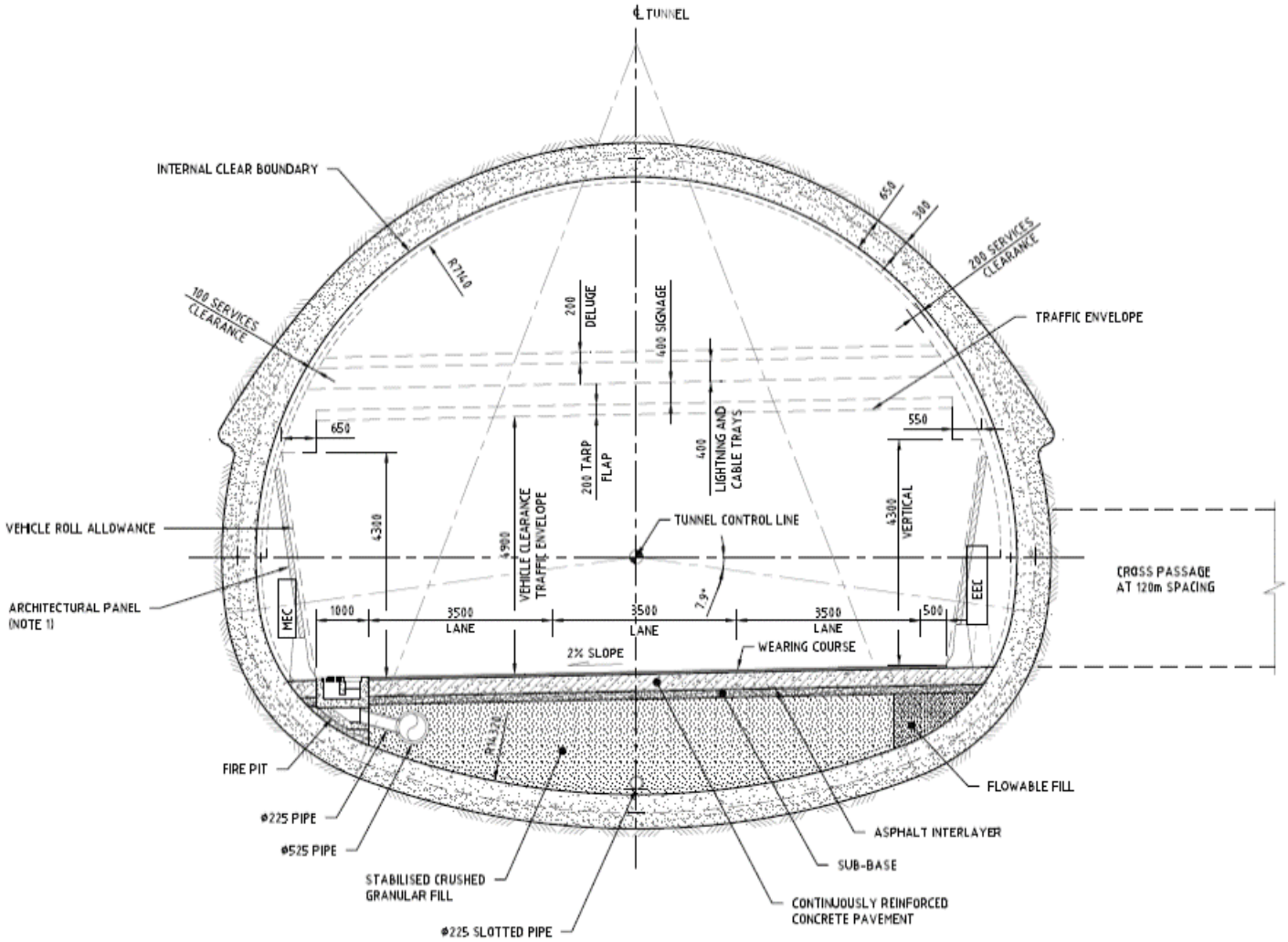
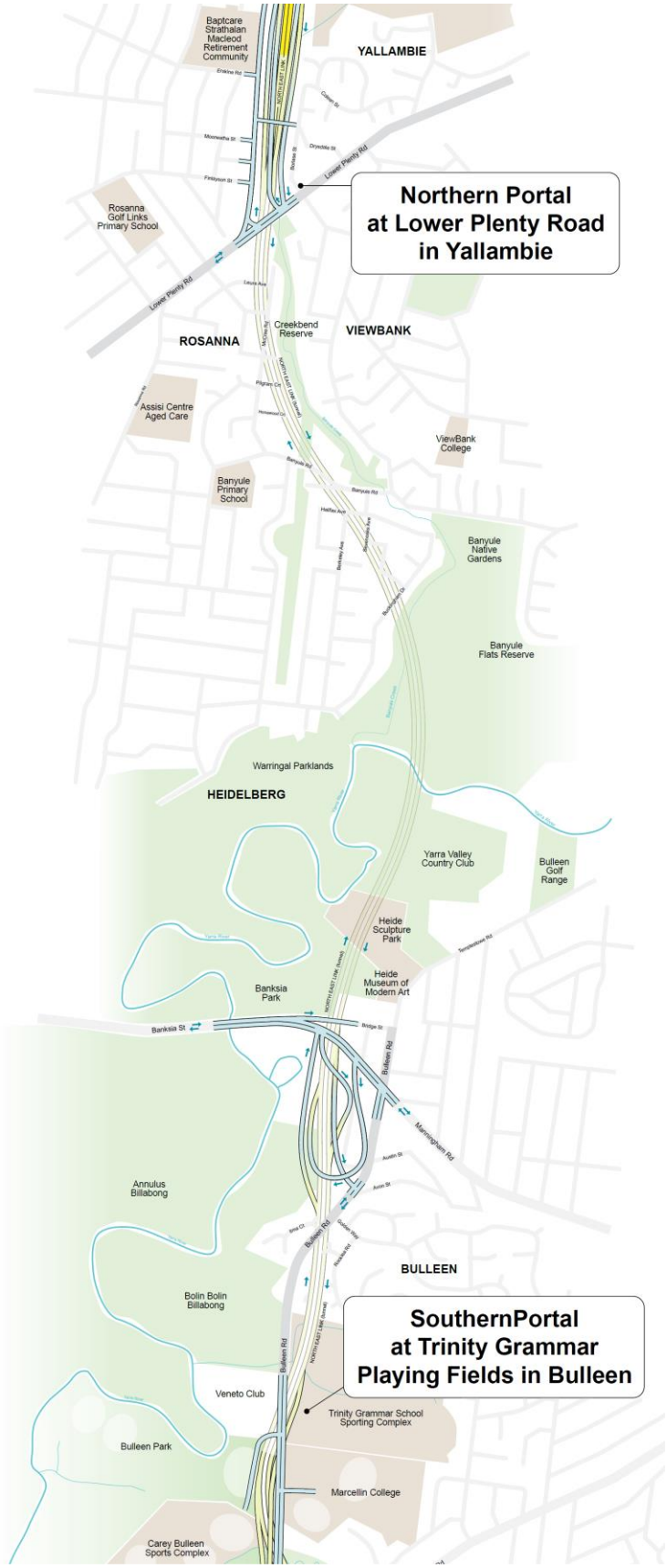


Figure 13 Base Case – Plan view of proposed Tunnel Alignment



### 8.1.2 Ventilation

The tunnels will be provided with ventilation systems and air discharge facilities. The ventilation system will comprise “smoke ducts” and longitudinal jet fans, with a discharge structure located close to each exit portal.

The northern ventilation station, is proposed to be located approximately 500 m north of Lower Plenty Road, directly above the covered roadway. The southern ventilation station is proposed to be located above the roadway on the east side of Bulleen Road.

### 8.1.3 Emergency Systems

The tunnels will be provisioned with F&LS systems. Should an incident in a tunnel occur, the fixed firefighting system will operate and users will use cross passages, spaced at 120 m, to escape from the incident tunnel. Smoke will be removed from the tunnel through an overhead duct.

The cross passages have been dimensioned to include a minimum egress envelope of 1.5 m wide by 2.1 m high; with additional space for lighting and other emergency services. The preliminary tunnel design assumes that an underdeck space will be available for mechanical and electrical equipment, no equipment will be placed in the cross passage. The cross passages will be designed to be “substantially dry”. Construction is anticipated to be undertaken using open face techniques in competent or ground which has been “improved” (for example by grouting) to ensure a safe excavation.

### 8.1.4 Tunnel Drainage

Although the tunnel lining will be designed to be essentially water-tight, drainage and pumping will still be required to account for stormwater water ingress at the tunnel portals, cleaning/maintenance, fire suppression systems and accidental spills. As the tunnel alignment passes beneath the Yarra Valley, there is a low point in the alignment. A second low point will also be located in the C&CT structure beneath the Trinity grammar playing fields. Water derived from sources such as rainfall, wash down, accidental spill, and firefighting will naturally accumulate at the low point sumps. For this reason a preliminary low point sump design has been developed with internal dimensions 15 m high by 10 m long located between the mainline tunnels. A 300 mm internal diameter rising main will be used to pump out the sump when required. As the tunnels and cross passages will be design as “tanked” (i.e. substantially dry) structures, it is envisaged that the low point sump will remain essentially empty most of the time. The low point sump will be constructed using open face mining techniques in competent ground or ground which has been “improved” to ensure a safe excavation.

### 8.1.5 Settlement, Noise & Vibration

Tunnelling can cause ground displacements (“settlement”) with associated ground slopes and strains that have a risk of damage to existing structures and utilities. The damage risk classification suggested by Burland (1995), Mair et al (1996) and Rankin (1998) has been used to undertake a preliminary assessment for the base case alignment. Analysis indicates that the risk of damage is generally “negligible to slight”, however in a few specific locations this risk category may rise to “slight to moderate” depending on the actual ground conditions encountered. Further geotechnical investigations, detailed analysis of settlement effects and design of Instrumentation and Monitoring (**I&M**) arrays will be undertaken at Reference Design stage.

During construction works, it is expected that the use of TBM and other mechanical tunnelling methods will generate ground borne vibrations. In severe cases, the impacts of ground vibrations can include damage to buildings and underground services, settlement in loose soils, re-radiated noise in buildings and human discomfort. However, our assessment indicates that ground borne vibrations will be perceptible when mechanised excavation (hydraulic hammers) equipment are used in the near vicinity of some locations and TBMs may be perceptible.

Re-radiated noise is not expected to exceed standard conversation range and is anticipated to generally be no more than ambient levels.

## 8.2 Key Challenges

In developing the concept design for the tunnels, a number of key challenges for tunnelling have been identified and will need to be addressed in developing the Reference Design. Some of the key engineering challenges for the tunnelling works include:

- It is anticipated that the excavation and tunnelling works may lead to measurable vertical ground displacement ("settlement"). Whilst settlement is not considered to have a significant effect on the Yarra Valley, in developed residential areas careful consideration of the effects will be required. In particular, TBM tunnelling through an area of soft ground with low cover beneath the Heidi sculpture park may give rise to noticeable settlement. Whilst such impacts on the gardens should be slight to moderate, sculptures in the area may need to be temporarily relocated.
- Settlement may also affect residential areas between Lower Plenty Road and the Banyule Flats. However, tunnelling there will be within slightly weathered rock with good cover so it is anticipated that for the most part that settlement risks will lie within the "negligible category". Close to the Lower Plenty Road portals, higher movements and risk could arise due to the deep portal excavation so more detailed assessments will be required here. Buried services in these locations are however expected to be more tolerant to settlement but will be considered on a case-by-case basis if they are deemed sensitive to ground movement.
- Settlement may impact residential areas south of Bulleen Road. Ground treatment, pre support and/or SEM techniques will be required to keep settlement to acceptable limits.
- On the southern and northern edges of the Yarra River crossing, the TBMs are anticipated to penetrate through the rock and into the alluvial soils above for short lengths of drive. For a pressurised TBM tunnel, whilst seeking to minimise inward ground movement, careful construction management will be required to avoid "blowout" due to excessive face pressure. This risk is higher for a "slurry" type TBM compared to an "earth pressure balance" TBM.
- The construction of the deep excavation for the Manningham Road interchange is expected to result in groundwater inflows and drawdown of the water table in the adjacent Yarra Valley. Detailed hydro-geological investigations and modelling will be undertaken to address this particular hazard and to develop a remediation strategy in the Reference Design.

A comprehensive instrumentation and monitoring system will be required to monitor surface settlement, changes in groundwater level, ground borne vibrations and re-radiated noise. The instruments will be firstly used to understand existing ambient levels, set project baselines and then ensure that the project does not exceed the limits agreed with by the regulatory authorities. The instruments will be set out in arrays across the tunnel alignments and will be monitored for periods before and after the passage of the construction face.

## 8.3 Additional Requirements

A number of issues for Tunnel arrangements detailed in the Concept Design will need to be further developed as part of future design stages including:

- The extent of flood control measures that need to be incorporated into the design of portals and retained excavations, which are highly dependent on the assessed maximum flood levels. Further hydrological studies will be required to confirm the assumptions and level of flood immunity to be adopted at Reference Design.
- The ground treatment measures required for the construction of cross passages and the low-point sump beneath the Yarra River Valley remain to be determined and are subject to ongoing geotechnical and hydro-geological investigations.
- Detailed hydro-geological properties and modelling is required to understand the extent of groundwater drawdown (and the scope of any remediation measures) around the Manningham Road interchange as noted above.
- The variability in the elevation of bed rock within the Yarra Valley and the character and properties of the alluvial sediments need to be better understood. Significantly, local deepening of bedrock may result in more complex “mixed ground” conditions for tunnelling and this will be investigated in detail during Reference Design.
- More detailed assessment of settlement and vibration effects will be required as the Reference Design is developed and the scope of any remediation measures that may be required to limit these effects to acceptable levels.
- Further design on the proposed location of supporting tunnel infrastructure will need to be further developed in close consultation with key stakeholders during the Reference Design stage.
- Emergency services will also need to be engaged sooner rather than later to ensure the design satisfies identified requirements.

# 9 Pavements

## 9.1 Overview

Limited work has been undertaken as part of the Concept Design to develop the design for pavements as part of the Project as pavement designs in Victoria typically conform to established standards set by VicRoads. Notwithstanding, it is noted that the pavement structure and compositions will be designed and optimised during later design stages in accordance with Austroads Guide to Pavement Technology (**AGPT**) and relevant VicRoads Codes of Practice. Existing pavements within the Project area will be assessed for condition and ideally be proposed for reuse within new permanent works, subject to being of suitable quality and depth. Furthermore it is likely that deep strength or full depth asphalt pavements will be adopted across the Project in order to meet performance and design life requirements.

Areas of existing pavement will be impacted along the M80, Greensborough Bypass/Highway, and Eastern Freeway, which will necessitate a range of treatments from retain, regulate, rehabilitate, and remove & replace. The extents of retained pavement will be dependent on a range of factors such as how closely the existing levels match the new geometry and condition.

Within tunnels, special performance requirements recognising the strategic importance and heightened safety and construction requirements will necessitate the use of specific pavements. Such performance requirements are likely to include but will not limited to adhesion, visibility, spray, noise, fire, loading, maintenance, and whole of life costs. Although subject to further design development, it is likely that within the tunnels a stone mastic asphalt surface will be used.

## 9.2 Key Challenges

Key challenges for the Pavement design are expected to include:

- A considerable areas of existing pavement are likely to be impacted and there is expected to be significant variability in pavement types and existing conditions, which will have impacts on the remaining design life and the rehabilitation treatments that may be required. For example, parts of the M80 are known to be a rigid concrete pavement and near the end of its design life, whilst other locations throughout the Project are flexible, asphalt pavements.
- Interfaces between new and existing pavement could present some issues and will be considered in later design stages with due consideration for structural support, subsurface drainage, pavement marking, etc.
- Future design stages and performance based requirements will need to allow for numerous potential solutions and may result in variability during future procurement.

## 9.3 Additional Requirements

The following items will need to be progressed during development of the Reference Design:

- Confirming and understanding existing pavement conditions
- Consultation with VicRoads and other stakeholders (such as local Councils) on their expectations with respect to the rehabilitation of existing pavements.

# 10 Utility Services

## 10.1 Overview

This section of the report provides a high level overview of the utility services investigation for the Project. The objective of the utility services investigation is to identify the location of services that may be affected by future construction activities and to advise strategies that will be deployed when utility assets are impacted by detailed design. The strategies are as follows:

- **Do Nothing** – Utility is outside works zone and not impacted.
- **Protection** – Utility is within works zone, but can feasibly be protected rather than modifying or relocating.
- **Modification** – Utility is within works zone and directly impacted, likely to require some modification and associated infrastructure (e.g. lowering below road cut).
- **Relocation** – Utility is within works zone and directly impacted, modification not possible and likely to require relocation.
- **Removal** – Utility is within works zone and directly impacted, however could potentially be abandoned due to it being a redundant service, and therefore it can be removed.

A number of existing utility services have been identified as being potentially impacted by the Project, which necessitates the need for protection, modification or relocation. All associated works and proposed treatments are to be fully co-ordinated with the relevant utility asset owner as detailed in Table 9 during development of the Reference Design.

Table 9 Utility asset owners

| Utility | Utility Asset Owners | |
|---|---|---|
| Electrical | AusNet<br>Jemena | CitiPower<br>United Energy |
| Gas | APA | MultiNet |
| Telecommunications | NBN<br>Optus | Telstra<br>Pipe Networks |
| Water | Melbourne Water (**MW**) | Yarra Valley Water |
| Sewer | Yarra Valley Water (**YVW**) | |
| Stormwater Drainage | Melbourne Water (**MW**) | Various Local Councils |
| Rail | VicTrack | Other Rail Operator(s) |

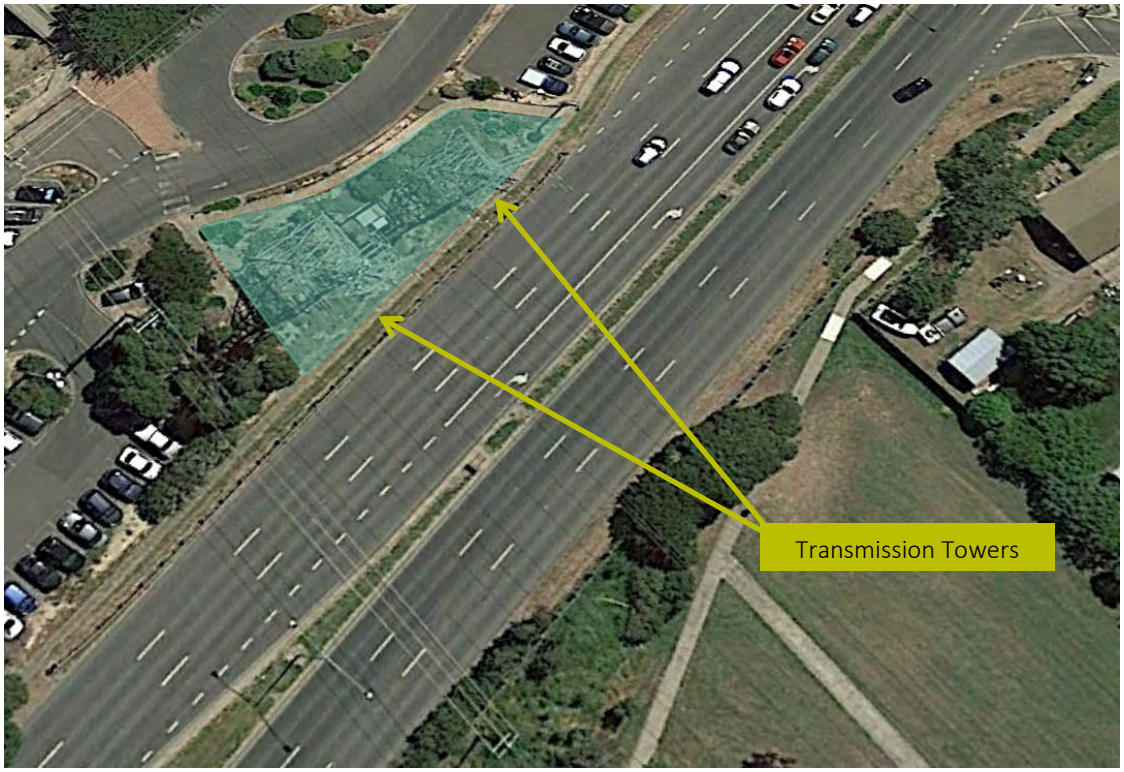
### 10.1.1 Electrical

Overhead power lines, power poles, underground cables and streetlights are all located along the alignment, with road crossings predominately in the intersection areas. The current design indicates most electrical services will require some form of protection, modification or relocation.

The most significant electrical component identified along the alignment is the relocation of two transmission towers and 220 kV overhead transmission lines across Greensborough Road, Watsonia (south of Elder Street) as shown below in Figure 14. The alignment passes through the locality of the existing towers, with the key objective to ensure the two transmission towers are relocated with minimal disruption to services in the local/regional area.

Due to the space constraints on the west side of Greensborough Road, relocating the towers to the east side of Greensborough Road would be most logical, within the existing Electrical Transmission Easement.

Figure 14 Transmission towers adjacent to Greensborough Road




Furthermore, all transmission towers above the proposed tunnel works (i.e. Banksia Park), must be protected for the duration of the works to ensure their structural integrity is not compromised.

Another area of significance is the proposed upgrade to the Eastern Freeway between Chandler Highway and Springvale Road. Although no major transmission lines are affected, a significant amount of works will be required to relocate existing services. These include, but are not limited to, relocate existing central median lighting and all low voltage underground cables adjacent the existing freeway to the outer verge of the upgraded carriageways and associated road widening.

### 10.1.2 Gas

Gas services located within the alignment are primarily adjacent to the existing Greensborough Road and Bulleen Road carriageways, with road crossings predominately at intersections. The current design indicates that most existing gas services will require some form of protection or modification in areas of Open Cut and C&CT, however no significant works are expected.

Although no major modification or relocation to gas services are proposed, two important areas to highlight are the existing 450 mm diameter transmission gas line crossing Greensborough Highway and the 450 mm isolation gas main running longitudinally on Manningham Road and Bulleen Road, as shown below in Figure 15 and Figure 16. As a minimum, protection of these services has been proposed, however further investigation will need to be undertaken during Reference Design, including discussions with the Utility Service Owners, to confirm the feasibility of these treatments.

Figure 15 450mm diameter gas transmission line – crossing Greensborough Road

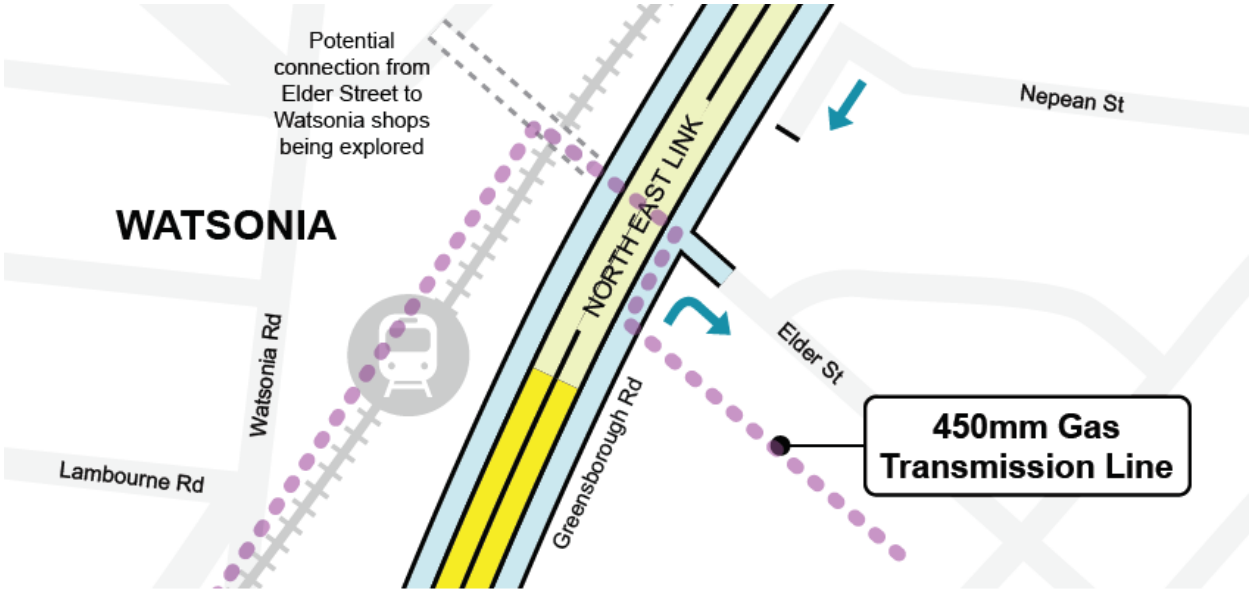
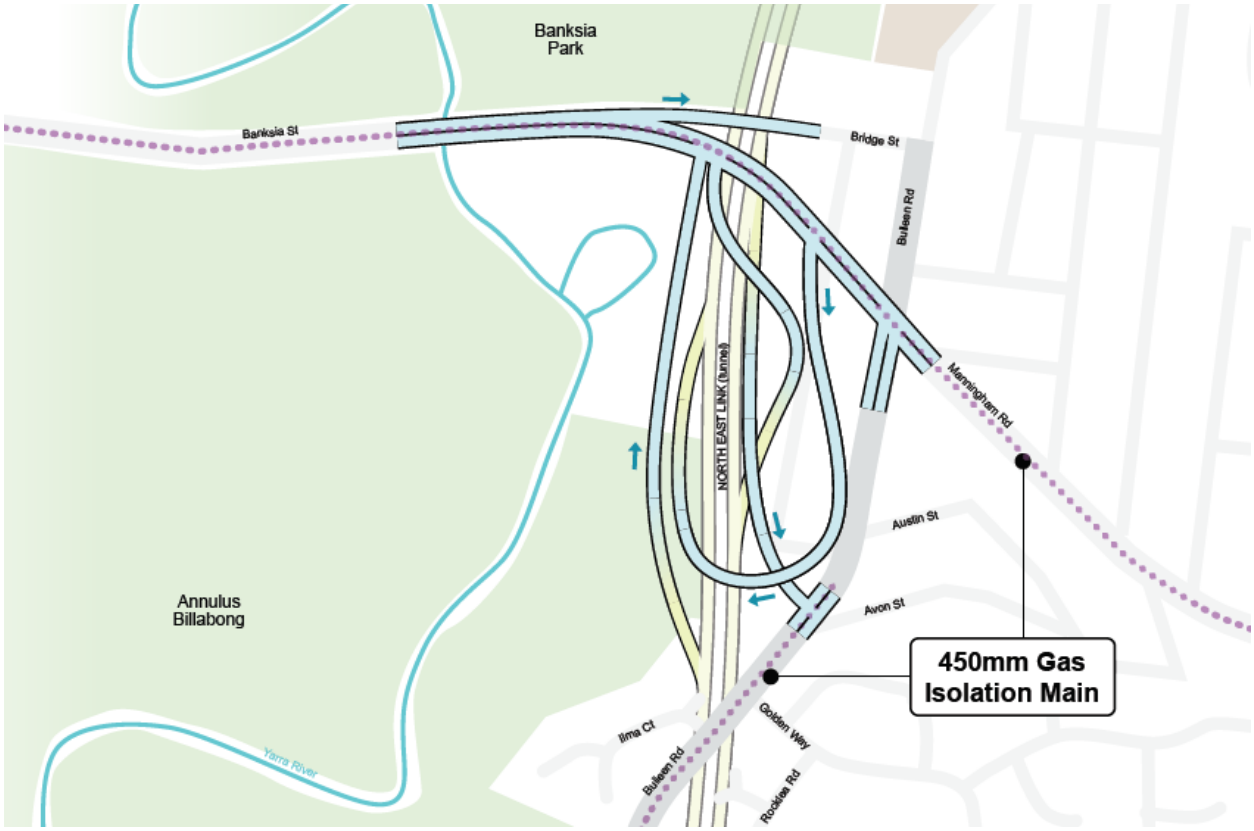


Figure 16 450 mm diameter gas isolation main – Manningham and Bulleen Roads




## 10.1.3 Telecommunications

Telecommunication underground cables are located in most areas along the alignment of the NEL base case, predominately near intersections and along road reserve footpath areas. The current design indicates most telecommunication cables will require some form of protection, modification or relocation, predominantly in areas of Open Cut and proposed structures (i.e. bridges and vent stations), including the proposed road widening on the Eastern Freeway.

The most significant telecommunication works associated are the communication facilities (building and tower) at the current M80 / Greensborough Highway intersection and further south adjacent to Greensborough Road, Watsonia (north of Elder Street) as shown below in Figure 17 and Figure 18. The alignment passes through the location of the existing facilities, thus the key objective would be to relocate the buildings and towers to a nearby land parcel to the satisfaction of the asset owner, with minimal disruption to services in the local/regional area.

Another area of significance to highlight is the proposed upgrade to the Eastern Freeway between Chandler Highway and Springvale Road. Although no communication towers are affected, some works will be required to relocate any ITS cables clear of the works.

Figure 17 Telecommunication Facility – M80 and Greensborough Road intersection


Figure 18 Telecommunication Facility – Greensborough Road, Watsonia

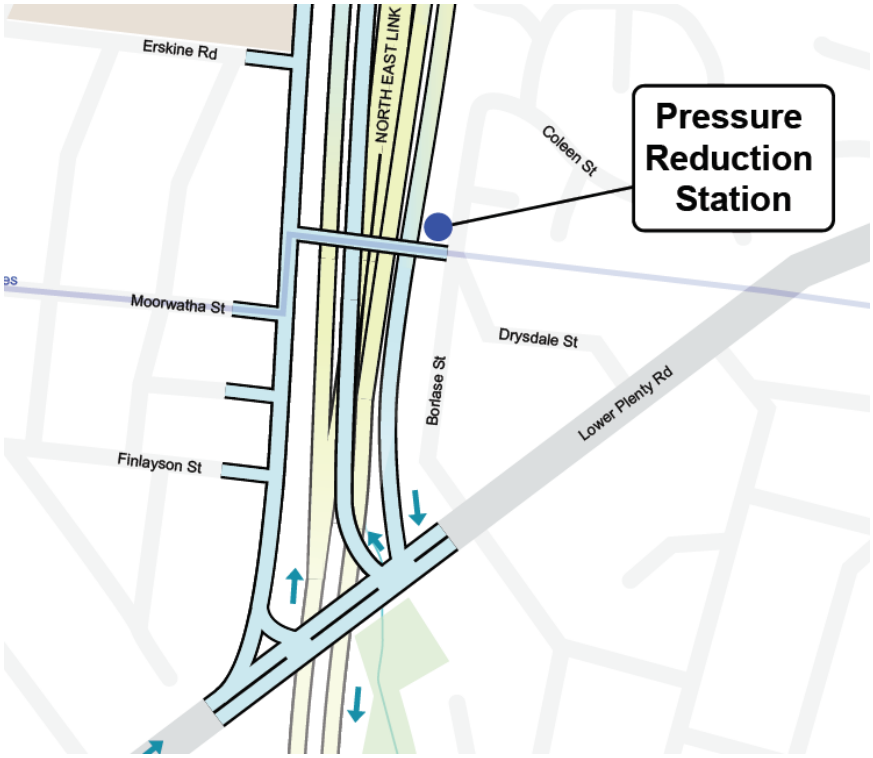

### 10.1.4 Water

There are a number of YVW and MW assets within the NEL alignment, with road crossings predominately at the intersection areas. The current design indicates most water main road crossings range from 150 to 375 mm diameters and a number of them will require some form of protection or modification, particularly in locations of Open Cut or bridge structures.

The most substantial water main works that have been identified are on Drysdale Street in Yallambie which will involve the relocation of a water pressure reducing station that connects 800 mm and 1350 mm diameter water mains, as shown on the schematic diagram in Figure 19. The alignment passes through the existing pressure reducing station and pipe network where substantial Open Cut and C&CT is proposed on the approach to the northern tunnel portal. Therefore, the key objective will be to relocate the facility to a nearby location with minimal disruption to services in the local/regional area. However, locating accessible land in the immediate area may prove challenging.

No major water works have been identified with respect to the Eastern Freeway upgrade, however several road crossings have been identified for protection. Notwithstanding this further investigation will be undertaken during Reference Design to confirm these treatments.

Figure 19 Schematic of existing Watsonia pressure reducing station



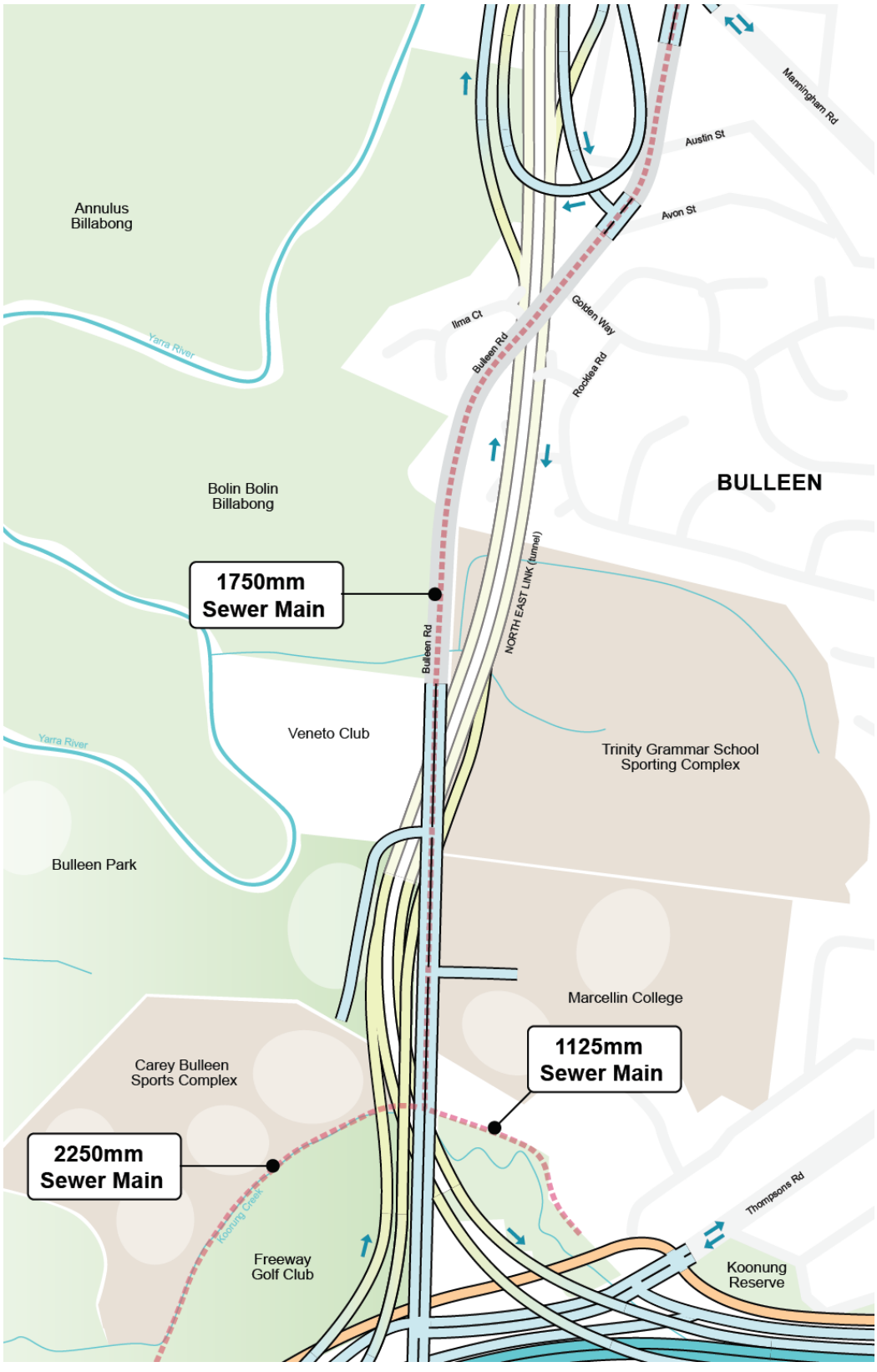

## 10.1.5 Sewer

There are a number of YVW assets within the NEL alignment, with road crossings again predominately in the intersection areas. The current design indicates most gravity sewer main road crossings range from 150 mm to 375 mm in diameter, and a number of them will require some form of protection or modification, particularly in locations of Open Cut or bridge structures.

The most significant sewer main works are along Greensborough Road, north of Watsonia Road intersection (near Drysdale Street) and near the northern tunnel portals, where substantial Open-Cut and C&CT is proposed. Works will incorporate the relocation and regrading of existing 2 x 225 mm and 1 x 300 mm diameter mains, with the possible introduction of pump stations to adequately service upstream connections. Pump station requirements will also need to be confirmed during Reference Design. Consultation with YVW and MW will be progressed at future design stages.

The existing 1750 mm diameter sewer main running longitudinally on Bulleen Road and the 1125 mm and 2250 mm diameter sewer mains crossing the NEL and Eastern Freeway interchange, as shown below in Figure 20 are likely to be the most critical sewer assets potentially impacted. Protection is initially nominated as the recommended treatment; however, this is subject to the design levels of the tunnel, C&CT and viaducts crossing Bulleen Road. Further work would also need to be undertaken during the Reference Design to confirm the potential impacts on these assets as a result of the above mentioned.

Figure 20 Sewer mains longitudinal and traverse to alignment



### 10.1.6 Stormwater Drainage

Information on existing drainage infrastructure has been limited with no service proving being undertaken. Detailed assessment of Council drainage networks will therefore be required during the Reference Design phase to gain a full appreciation of the impact the Project will have with the local stormwater drainage network.

Asset information received to date is limited to drainage infrastructure (VicRoads assets) contained within the road reserve of the Eastern Freeway with most existing 300 and 375 mm diameter stormwater pipe road crossings expected to be retained and extended to the outer verges of the new widened carriageways. However, existing longitudinal stormwater pipes are likely to be under capacity and anticipated to be made redundant. Upgraded drainage infrastructure must be provided to cater for the additional impervious catchment areas associated with the road widening with concentrated flows predicted to double.

A significant number of crossings under the Eastern Freeway have also been identified, ranging in size from 750 mm to 2100 mm in diameter. It is anticipated that widening of the Eastern Freeway will impact these crossings and they will need to be extended.

## 10.2 Key Challenges

There are a number of key challenges associated with the modification and relocation of existing utility services. Specific challenges include but not limited to:

- Latent ground and site conditions and the potential for additional services to be identified or those services already picked up not being in the same location.
- Construction methodology required to minimise impacts on end users of the service and the service itself. Site constraints imposed by the proposed freeway alignment and associated depths in cuttings may also introduce a number of limitations.
- Relocating major utility infrastructure (i.e. sewer pumping stations, water pressure reducing stations, communication facilities, etc.) to nearby vacant/accessible land/easements, and the ability to do so within nominated shut-down periods (and impacts this may have on the Critical Path for the project).
- Physical constraints in congested urban areas with limited areas to relocate assets as well as additional complications in trying to mitigate disruption to operation of existing services
- Lack of information relating to the extent and condition of rail assets in the Project area particularly with respect to the works in close proximity to the Hurstbridge rail line and Watsonia railway station

The timing of Utility Service Authority design and construction procurement associated with major services relocations undertaken as Non-Contestable Works (e.g. such as transmission power and gas pipelines, communications towers, etc.) could also be a key issue. This is particularly the case that in some instances the process can take up to two years from the date of inception.

## 10.3 Additional Requirements

### 10.3.1 General

As part of the Reference Design development, a detailed investigation will be undertaken to determine exact locations of utility services and provide updated recommendations for possible solutions. This is expected to include the following:

- Review information and correspondence already held by the NELA relating to utility services.
- Conducting additional research and 'desktop studies' to further identify and verify the location of services along the project. This may include consultation with utility asset owners, additional Dial Before You Dig (DBYD) searches and other inquiries.
- Conducting physical searches in the field (asset location surveys, potholing, etc.) to positively verify the location of services within or immediately adjacent to the project boundaries.
- Consultation with each of the utility service providers to share knowledge of asset locations and confirm requirements for relocation or protection.

### 10.3.2 Limitations

The assessment of the existing utility services for the Concept Design has been limited to a desktop study only. There has been limited discussion with some Services Authorities in order to obtain an understanding of the likely assets to be encountered during the delivery of the Project. However, there has been no site survey or in-ground services investigation undertaken.

The information used for the Concept Design assessment has been based on information obtained as follows:

- Limited DBYD information along the main NEL corridor and the Eastern Freeway (excluding tunnelled sections)
- Existing VicRoads services record drawings obtained via NELA;
- YVW GIS plans obtained from YVW public access website.

# 11 ITS, Signage and Tolling

## 11.1 Overview

### 11.1.1 ITS

A high level strategy has been prepared documenting the Intelligent Transport Systems (**ITS**) required to ensure NEL can operate as a MM in accordance with VicRoads policy and guidelines. This includes but is not limited to the following:

- ITS cableway, communication backbone, and communication network inclusive of vehicle detection, real-time traffic data, and integration with STREAMS and SCATS;
- Ramp metering including consideration of co-ordinated entry ramp metering, exit ramp management, and freeway to freeway ramp metering;
- A Lane Use Management System (**LUMS**) including Lane Use Signs (**LUS**), Variable Speed Limit Signs (**VSLS**) and Variable Message Signs (**VMS**);
- Incident detection and incident response systems including for example Automatic Incident Detection (**AID**) systems (Loop and CCTV based for tunnel);
- Comprehensive video coverage of all sections of NEL including Closed Circuit Television (**CCTV**) and a video management system in the Freeway Control Centre (**FCC**);
- Dedicated tunnel management system including backup and disaster recovery system, tunnel radio rebroadcast system and PA loudspeakers;
- Tunnel closure devices and systems for emergency and over height vehicle detection situations; and
- Coordinated ITS integration (arterial to motorway / motorway to motorway).

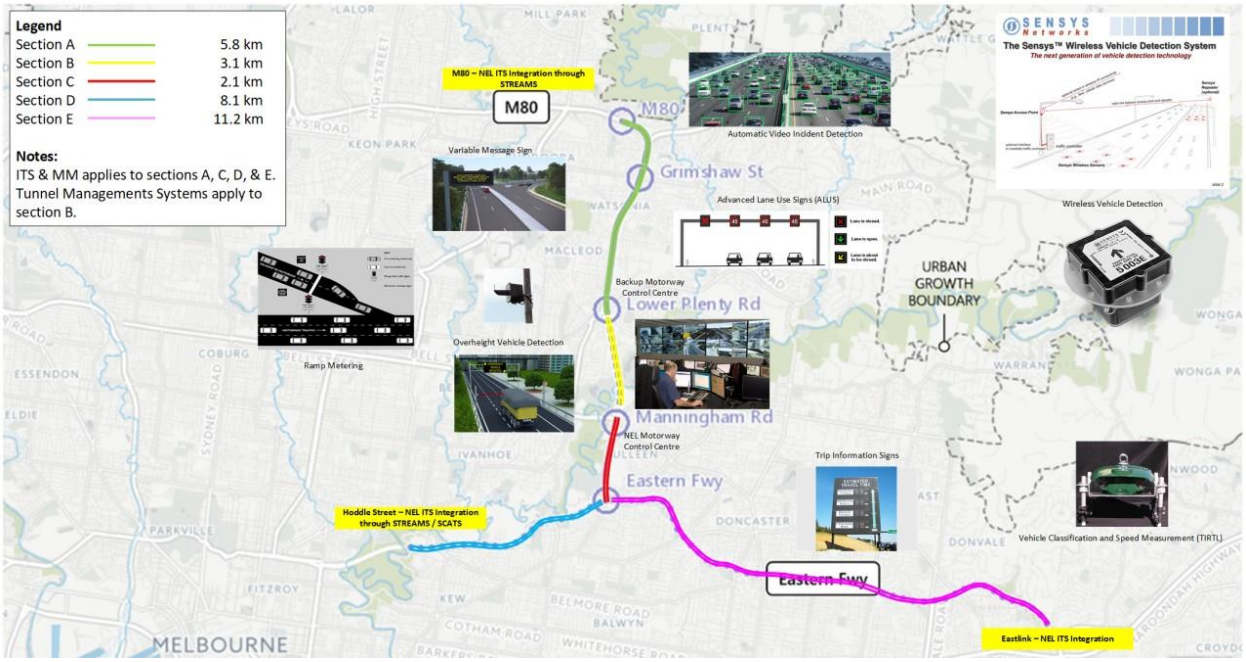
NEL including the tunnel, the section north of the tunnel to the M80 and south of the tunnel to the Eastern Freeway, and the Eastern Freeway itself will all be treated as a MM. The basis of the MM design is to implement ramp metering on all motorway on-ramps and lane use and variable speed control through the installation of LUS at specified intervals along the entire length of the motorway with full Automatic Video Incident Detection (**AVID**)/CCTV coverage.

NEL itself will include a considerable amount of new construction and the current base case entry ramp configurations will require significant optimisation in order to provide the necessary vehicle storage for effective ramp metering. The Eastern Freeway will be widened in places and it is envisaged that a key constraint of this work will be associated with the new or upgraded ramps needed to provide effective ramp storage.

Preliminary diagrams reveal some 28 entry ramps and 27 exit ramps including the ramps at the Hoddle Street end of the Eastern Freeway.

The Reference Design will take all of the ramps into consideration in order to best allow for future ITS connectivity and function, and MM integration with connecting motorways (such as the M80). Some of these ITS concepts are illustrated Figure 21. The diagram shows the different sections of the design including the tunnel and some of the key ITS technology to be applied.

Figure 21 Key NEL Intelligent Transport System Concepts




### 11.1.2 Signage and Tolling

A major directional signage strategy will need to be prepared for the Project and is currently awaiting advice from VicRoads. Complementary to the ITS infrastructure required, will be a requirement to incorporate the necessary infrastructure to operate the proposed tolling scheme. This will need to be further detailed at the Reference Design stage.

## 11.2 Key Challenges

The key engineering challenges associated with this component of the design are:

- Interfaces between NEL, Eastern Freeway, Hoddle Street and East Link will need to be defined through the establishment of a high level ITS Concept of Operations. This Concept of Operations will set the functional and performance requirement associated to the inter-operation between the MM operators and guide the ITS infrastructure and equipment design;
- Subject to the outcomes of the procurement process, the design will need to provide for the interface with at least two adjacent ITS systems. The Operations and Maintenance (O&M) arrangements will in turn need to reflect the same; and
- The tolling operating model (distance / single point tolling) will need to be defined before the supporting roadside tolling infrastructure and equipment can be established.

## 11.3 Additional Requirements

To ensure the ITS design is appropriate for the time horizon of NEL, consideration will need to be given to upcoming VicRoads specification changes that may have a material impact on the ITS design. The following items have been excluded from the ITS strategy within the Concept Design and will need to be further explored during the Reference Design phase:

- Motorist Emergency Telephones (METS) and Speed Cameras (except for in-tunnel);
- Weigh-in-Motion (WIM) and Over-Width Vehicle requirements and Tolling Roadside Equipment and Infrastructure; and
- Tunnel Plant Management Systems and M&E.

# 12 Infrastructure Integrity & Operations

## 12.1 Overview

This section provides an overview of asset management advice on whole-of-life considerations relating to existing and new assets considered in the NEL design development. A review of the Project design elements in this regard is shown in Table 10.

Table 10 Infrastructure design review

| Alignment | Comments |
|---|---|
| M80 Interchange to Watsonia Station | • Design to take into account the need to access the assets, particularly elevated structures, for future inspections and maintenance.<br>• Access requirements for third party assets such as for the Hurstbridge rail line needs to be confirmed (as may have power fixed to NEL structures). |
| Watsonia Station to Lower Plenty Road | • Maintenance of drainage systems for passive elements in drained open cut and groundwater monitoring/recharge/treatment must be addressed.<br>• Low point sumps and pumps requiring clean out, maintenance and power for mechanical/electrical plant.<br>• Durability risk to be assessed (based on soil/groundwater testing) to support materials selection.<br>• "Semi-open" trench structure south of Watsonia station presents whole-of-life challenges (including safety and durability) as difficult to access for maintenance / repairs and exposed to multiple environments. |
| Lower Plenty Road to Manningham Road | • "Marshalling" areas and associated "evacuation" roads are required at specific locations including before tunnel portals.<br>• Flood protection in lower sections need to be designed as potentially critical assets.<br>• Quantity of mechanical/electrical equipment – power, maintenance, replacement.<br>• Future proofing and resilience considerations for tunnels so they cater for changing transport futures and unexpected events.<br>• Tunnels to be designed for optimal balance of durability, inspectability and maintainability |
| Eastern Freeway Interchange | • Viaduct structure for all the ramp connections into the Eastern Freeway – note the introduction of a low point sag into the viaduct is undesirable. |
| Eastern Freeway upgrade | • As part of the proposed changes to the existing Eastern Freeway and structures crossing over it, the responsibility for the O&M of those assets needs to be clarified. For instance additional lanes on the Eastern Freeway may be managed by the NEL O&M contractor while the existing lanes remain managed by VicRoads.<br>• Access requirement for third party assets such as<br>1 Koonung Creek<br>2 Major sewer and gas in Bulleen Road (risk of electrolysis concerns in relation to the gas line)<br>• It is particularly important to understand the current condition and remaining life of existing assets modified for NEL as well as the future interventions planned for them to optimise their management in the future. |

## 12.2 Key Challenges

Challenges facing O&M and Infrastructure Integrity are:

- Understanding the extent and condition of all existing structure impacted by the works;

- Potential durability issues need to be managed through the implementation of a durability management process that aims to support the achievement of the project's lifecycle objectives. In particular, the following should be developed as part of future designs:
  - A preliminary durability management plan that addresses the exposure conditions at the site and any specific key environments affecting material selection, and applicable deterioration mechanisms of materials. This should also include provision of durability processes, service life modelling and applicable corrosion protection methods
  - Undertaking subsequent durability reviews of the reference and detailed designs, including reviewing design drawings/reports against the durability management plan and design life requirements of the brief, while flagging any risks.

Risk associated with change in ownership and management of existing assets modified as part of the Project are being investigated. Information required for existing assets likely to be modified rather than removed or replaced by the NEL project includes:

- Asset Register/GIS Model, Asset Management Plan, and Durability Management Plan
- Condition Assessment Report, Inspection and Maintenance Plan, and access requirements for inspection and maintenance
- As-Built drawings, materials data (construction materials), current age and design life along with details of the Maintenance History, and Asset Owner
- Safe System Asset Framework Strategic Plan, ITS Assets Strategic Plan, and Traffic Operations Plan.

## 12.3 Additional Requirements

### 12.3.1 Emergency Services Accessibility and Over-Height Management

Accessibility to the tunnel portals and the tunnels in the event of an emergency has been considered along with over-height vehicle management. Specifically, the following requirements for emergency services access and staging at each tunnel portal have been considered during development of Concept Design and will be further considered during Reference Design:

- Provide a safe area of assembly for MFB personnel and vehicles with immediate access to the tunnel at the tunnel portals. The assembly area is to be accessible from local roads via at least one entry ramp of the interchange;
- Accommodation for an assumed 8 No. MFB appliances, with consideration of all movements has been provided by a 100 m x 4 m assembly area adjacent to each tunnel portal; and
- A 10.5 m radius turning circle has been allowed for MFB appliance U-turns based on MFB Fire Safety Guideline GL-27. Any median gates will be remotely operated from the FCC.

Over-height vehicle management has also been considered at the tunnel portals in conjunction with emergency services accessibility requirements. Over-height vehicle holding bays have been provided prior to the tunnel portals with a method of turn-back/extraction provided via a dedicated ramp or median gate in the event of an over-height vehicle failing to exit prior to the tunnel.

As both tunnel portals have exits ramps just prior to the tunnel, the road operators' management plan for over-height vehicles will be activated for all over-height vehicles on the tunnel approaches, even when those vehicles are intending to exit prior to the tunnel. The management plan will utilise the freeway management system to reduce speeds, close lanes and direct the over-height vehicle to the exit. Should the vehicle fail to exit the over-height vehicle will be directed to the holding bay where it will be held until such time as the vehicle can be removed safely.

# 13 Surface Water (Hydrology)

## 13.1 Overview

Table 11 below describes the watercourses and catchments impacting on the NEL alignment. Further details on the design elements forming the Base Case are discussed earlier in this report and should be referred to accordingly.

Table 11 Surface water catchments within the Project Area

| Route Section | Watercourses / catchments |
|---|---|
| M80 Interchange to Watsonia Station | Crosses the Yando Main Drain and its overland flow path |
| Watsonia Station to Lower Plenty Road | Crosses Banyule Creek / Banyule Drain |
| Lower Plenty Road to Manningham Road | Passes under the Yarra River at the Banyule Swamp |
| Manningham Road to Eastern Freeway Interchange | Passes through the Yarra River floodplain and will cross Koonung Creek |
| Eastern Freeway Upgrade | Intersects with Koonung Creek in a number of locations |
| Doncaster Busway | Crosses Merri Creek and the Yarra River (existing bridges) |

## 13.2 Key Challenges

### 13.2.1 M80 Interchange to Watsonia Station

The Yando Street pedestrian underpass conveys flood flows travelling overland from the western to the eastern side of Greensborough Bypass. The capacity of this culvert will need to be maintained and it is assumed the underpass will be retained and lengthened to accommodate NEL. Any change to flood impacts in the area will need to be investigated in future designs.

### 13.2.2 Watsonia Station to Lower Plenty Road

The NEL may impact a section of Banyule Creek likely resulting in a need to realign and/or underground (pipe) a portion of the creek. A retarding basin will be required upstream of Lower Plenty Road to ensure flows downstream of the works are the same as in the existing conditions.

This area will likely need bunding or flood walls in the vicinity of the tunnel portal to provide flood protection for the tunnels. Preliminary hydrological and hydraulic investigations have been undertaken of the existing flood conditions to inform the Concept Design. This has included investigation of a number of different flood events with varying frequencies. Figure 22 shows the alignment at Banyule Creek and the preliminary 1% Annual Exceedance Probability (AEP) existing conditions maximum flood depths. Table 12 shows preliminary Banyule Creek peak flood levels for a range of flood events just upstream of Lower Plenty Road.

Figure 22 Banyule Creek 1% AEP existing conditions maximum flood depths


A risk assessment will be undertaken to determine the level of flood protection to be provided to the tunnel portal in the vicinity of Banyule Creek.

Table 12 Preliminary peak flood levels at Lower Plenty Road

| Flood event | Maximum Peak Water Surface Elevation (m AHD) | |
|---|---|---|
| | Existing Conditions | Climate Change Scenario |
| 1% AEP (1 in 100) | 40.3 | 40.8 |
| 0.5% AEP (1 in 200) | 40.7 | 41.4 |
| 0.2% AEP (1 in 500) | 41.3 | 42.0 |
| 0.1% AEP (1 in 1,000) | 41.9 | 42.2 |
| 0.05% AEP (1 in 2,000) | 42.2 | 42.3 |
| Probable Maximum Flood (**PMF**) | 42.9 | 42.9 |

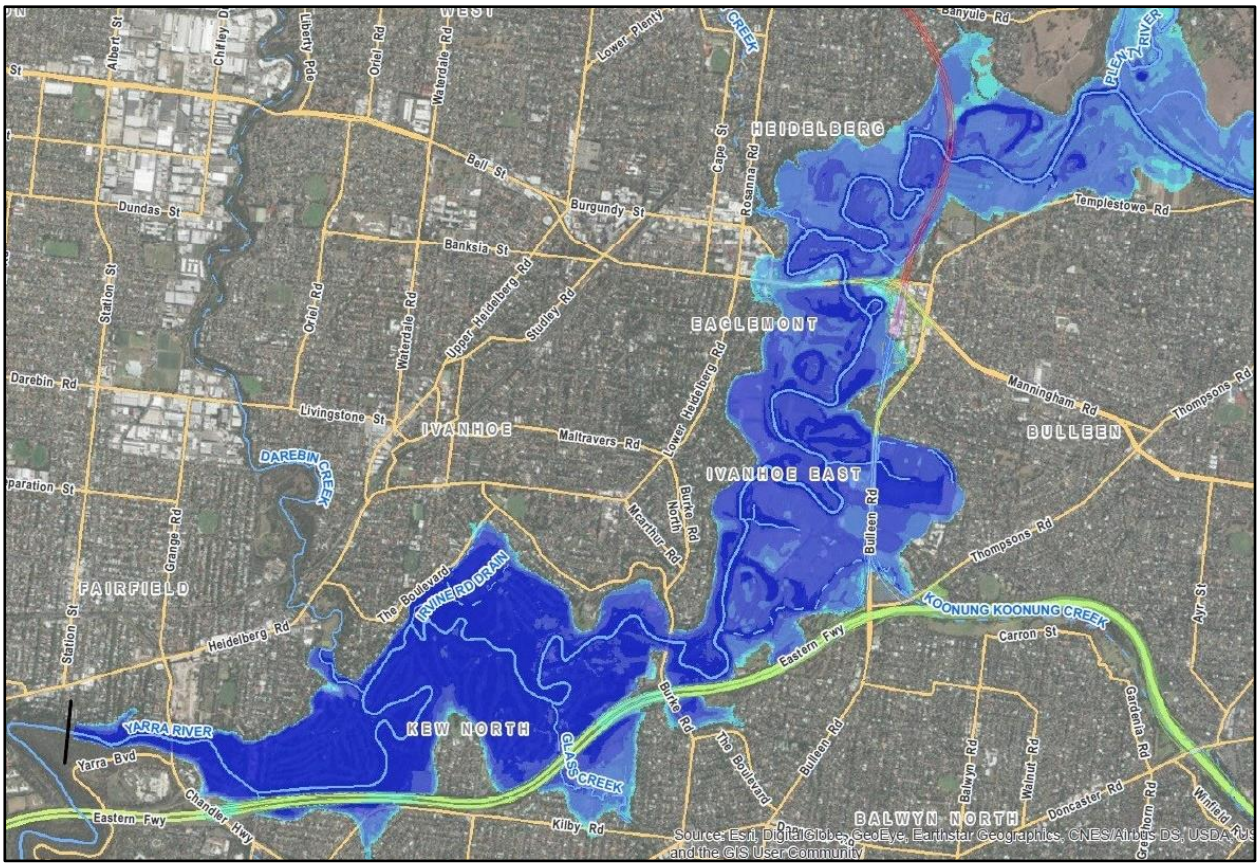
### 13.2.3 Lower Plenty Road to Manningham Road

The design in this area passes underneath the Yarra River and does not directly impact the river. It should be noted that the Yarra River Strategic Plan is currently being developed by Melbourne Water and is envisaged to be a key document to inform subsequent project design stages. The Yarra River Strategic Plan will guided by key elements including (but not limited to) environmental health, amenity, adjacent land use and cultural and heritage values.

### 13.2.4 Manningham Road to Eastern Freeway Interchange

Two portals are proposed in this section; one for the Manningham Road interchange and one for the Eastern Freeway Interchange. The location of the portals south of Manningham Road situates these within the Yarra River floodplain. Preliminary hydrological and hydraulic investigations have been undertaken of the existing flood conditions to inform the design. This has included investigation of a number of different flood events with varying frequencies. Figure 23 shows the NEL alignment through the Yarra River floodplain near Manningham Road and the preliminary 1% AEP existing conditions maximum flood depths.

Figure 23 Yarra River preliminary 1% AEP existing conditions flood depths



Similar to Banyule Creek and the northern tunnel portal, a risk assessment will be undertaken to determine the level of flood protection to be provided to the southern tunnel portals. Given the much higher flood levels and variability between different flood events this will however be a far greater challenge at the southern tunnel portals.

Table 13 shows preliminary Yarra River peak flood levels for a range of flood events near the Manningham Road interchange.

Table 14 shows preliminary Yarra River peak flood levels for a range of flood events near the Eastern Freeway interchange. The variability of flood levels in the Yarra River at these interchanges for different flood events has the potential to require flood walls to be of a significant height ranging between 5 to 20 metres.

The proximity to the Yarra River and the associated potential for environmental impacts is a key issue requiring ongoing review, monitoring and management.

Table 13 Preliminary peak flood levels at the Manningham Road interchange

| Flood Event | Maximum Peak Water Surface Elevation (m AHD) | |
|---|---|---|
| | Existing Conditions | Climate Change Scenario |
| 1% AEP (1 in 100) | 17.7 | 18.8 |
| 0.5% AEP (1 in 200) | 18.6 | 19.9 |
| 0.2% AEP (1 in 500) | 19.8 | 21.2 |
| 0.1% AEP (1 in 1,000) | 20.7 | 22.3 |
| 0.05% AEP (1 in 2,000) | 21.7 | 23.2 |
| PMF | 35.7 | 35.7 |

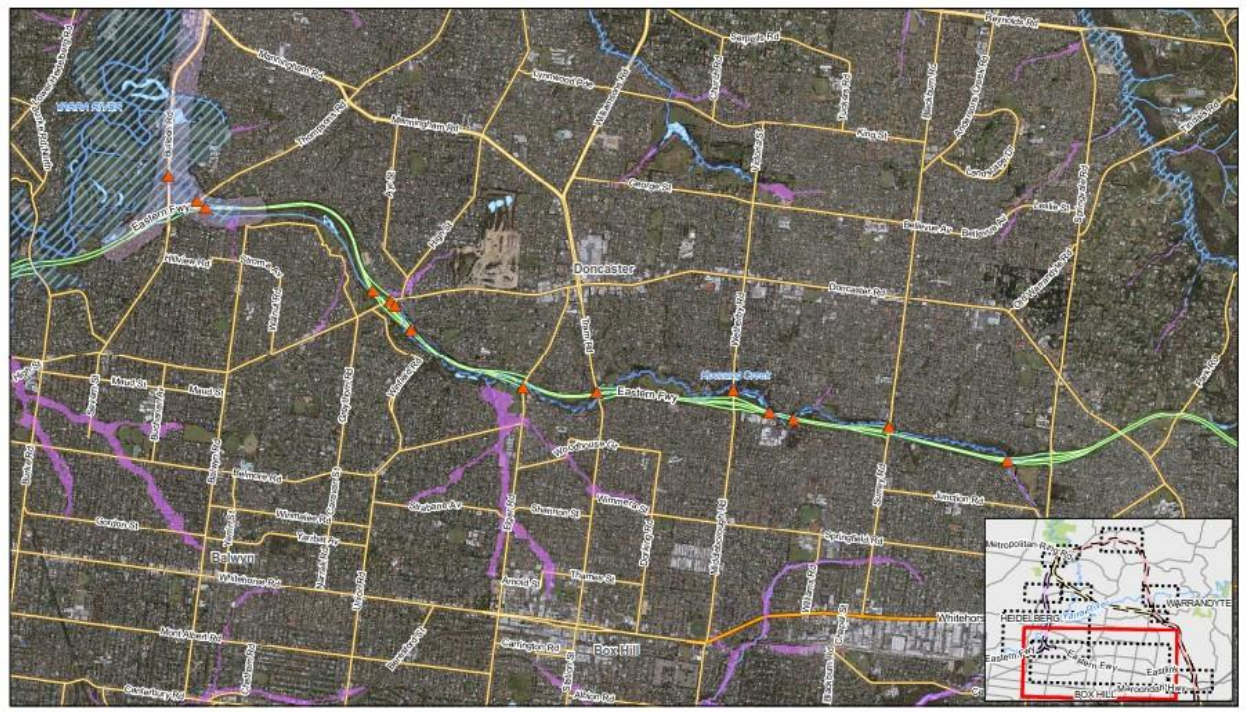
Table 14 Preliminary peak flood levels at the Eastern Freeway interchange

| Flood Event | Maximum Peak Water Surface Elevation (m AHD) | |
|---|---|---|
| | Existing Conditions | Climate Change Scenario |
| 1% AEP (1 in 100) | 17.6 | 18.8 |
| 0.5% AEP (1 in 200) | 18.5 | 19.8 |
| 0.2% AEP (1 in 500) | 19.7 | 21.2 |
| 0.1% AEP (1 in 1,000) | 20.7 | 22.2 |
| 0.05% AEP (1 in 2,000) | 21.7 | 23.2 |
| PMF | 35.6 | 35.6 |

### 13.2.5 Eastern Freeway Upgrade

The NEL will impact a significant section of Koonung Creek and its surrounding area. Widening of the Eastern Freeway is likely to require parts of the creek to be undergrounded (piped) or realigned. The freeway is located along the Koonung Creek valley, and the creek is adjacent to it for the 9 km length from Springvale Road to Bulleen Road with numerous culverts crossings, each of which is a significant structure (see Figure 24). The current design will require significant widening of the existing structures and realignment of portions of the creek. Long lengths of the existing creek will likely also need to be covered and there will be some loss of open space. In addition, there will be considerable impacts on existing creek structures.

Figure 24 Existing culvert locations along Koonung Creek (red triangles)




## 13.3 Additional Requirements

Further investigation of designs and flood levels in various locations is required to ensure the Melbourne Water Floodplain Performance Criteria and water quality objectives are met.

Additional impervious area created by new roads for the NEL will require retention and treatment through WSRD to meet the required objectives. This is anticipated to be a significant challenge given the space requirements for such a large increase in impervious areas. In some areas of the NEL such as along Eastern Freeway Upgrade there could be significant issues in meeting WSRD requirements given the likely short-fall in storage area to accommodate all the additional impervious area (see Section 6.5.3).

During Reference Design implications of the Yarra River Strategic Plan will be further investigated as well as the possible impacts of the Project as a result of key stakeholder requirements.

# 14 Associated Works

## 14.1 Active Transport

### 14.1.1 Overview

A key element of the Base Case is the incorporation of Active Transport. This includes upgrading the wider SUP network to add value to the current walking and cycling paths. An overall SUP network has been prepared, with proposed network elements described below and shown in Figure 25. A number of additional SUP bridges and minor structures will also likely be required, and these will need to be developed further at a later stage of design.

#### On-road cycle paths

The base scope Concept Design includes new on-road cycle paths would improve connectivity to and from key activity centres:

- Greensborough: a cycleway along Yando Street, Hakea Street and Macorna Street to improve connectivity from the north and west
- Watsonia: a cycleway along Nell Street and Nell Street West
- La Trobe University: a cycleway between Waiora Road and Greensborough Road via the local road network
- Heidelberg: a cycleway along Yarra Street connecting to the Main Yarra Trail.

#### North East Link shared use path

New walking and cycling connections would improve east-west connectivity along North East Link, integrating with the new cycle path running parallel to North East Link, including:

- A shared use path at the Yarra Flats between the Main Yarra Trail and Bulleen Road to improve connectivity between Ivanhoe East and the recreational facilities on Bulleen Road
- Completion of the east-west shared use path following the powerline reserve which will run from Plenty Road to the Plenty River via Watsonia.
- New pedestrian crossings across Greensborough Road to provide easier access to the path

#### Eastern freeway cycle path

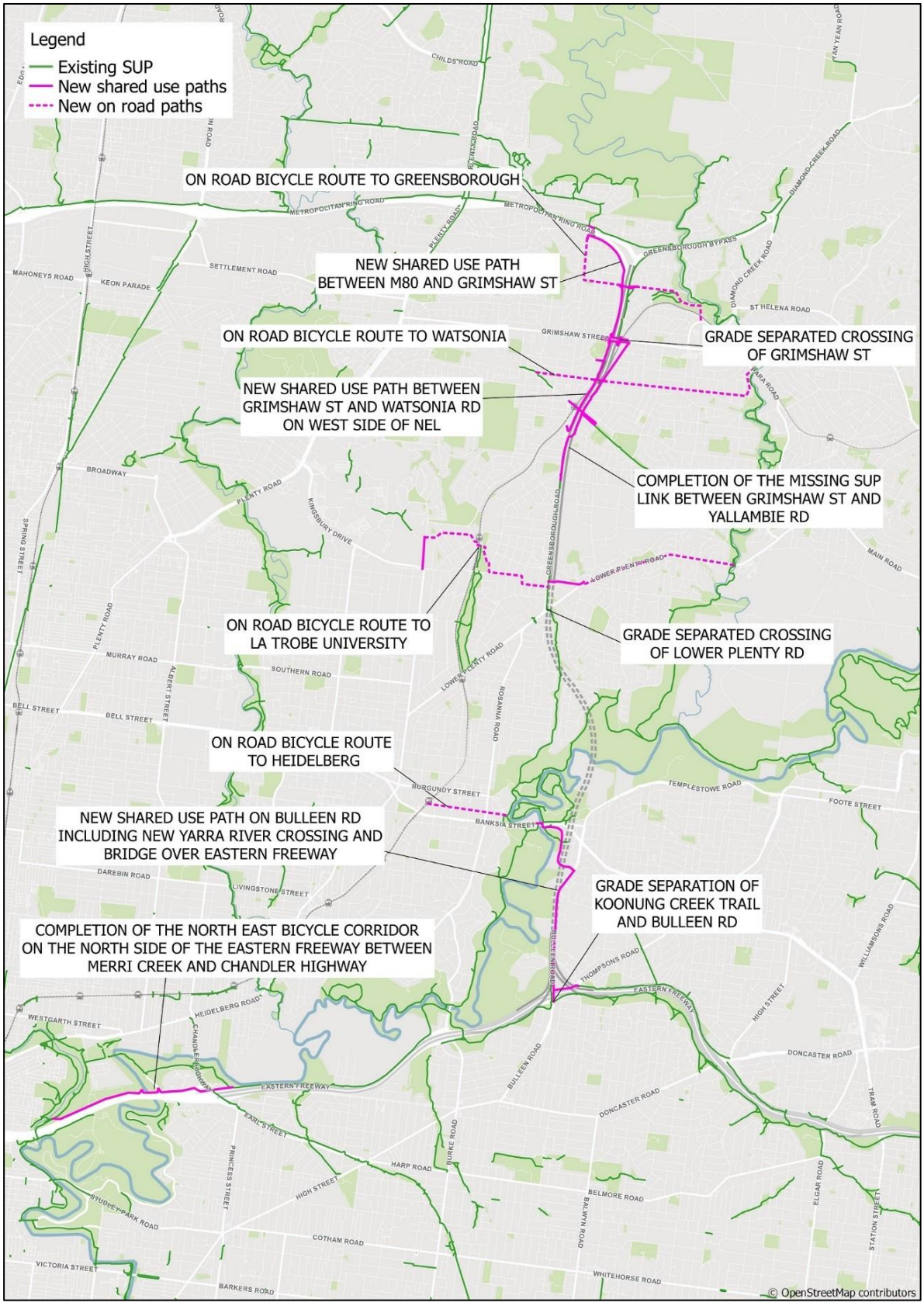
New cycle paths along the Eastern Freeway, including providing a new direct connection at the western end of the freeway, and a grade separated crossing of Bulleen Road would improve easier access and more network connectivity. Identified options include:

- Extension of the cycleway along Bulleen Road south of the Eastern Freeway to complete a missing link in the network
- A new pedestrian crossing along Greensborough Road to reduce severance and provide easier access to the Greensborough Road Path.

#### Bulleen Road cycle path

Extension of the cycleway along Bulleen Road south of the Eastern Freeway to complete a missing link in the network.

Figure 25 North East Link walking and cycling infrastructure



### 14.1.2 Benefits

The construction of the NEL presents the opportunity to improve walking and cycling infrastructure within the north-east. These potential projects can help improve local accessibility, amenity and safety to and from key activity centres in line with Plan Melbourne's objective of achieving 20-minute neighbourhoods.

The potential walking and cycling projects have been developed in consultation with Transport for Victoria (**TfV**) and are based around the following principles:

- Realising the PBN and the SCC by identifying the potential to provide missing links in the networks
- Achieving the objectives of a 20-minute neighbourhood, including:
  - Removing barriers which currently constrain the community's ability to reach everyday services and facilities within a 20-minute walk (reducing severance);
  - Providing safe and connected routes to access key destinations including activity centres, recreational facilities, transport hubs and education facilities; and
  - Improving walking and cycling accessibility to and from activity centres by providing direct, convenient and safe facilities.

### 14.1.3 Key Challenges

The scope of the Active Transport works has been developed based on a review of the overall active transport network and strategies developed by Councils and other stakeholders. The feasibility of completing all of the proposed paths within the available reserves and road reserves will need to be proven during the next stage of design development.

It will also be critical that consultation with key stakeholders be implemented as soon as possible to understand their interests and ensure the Active Transport plans are in line with these wherever possible.

## 14.2 Public Transport

### 14.2.1 Overview

The impacts to existing public transport have been considered throughout the Concept Design with a focus on making provision for Public Transport infrastructure as an integral element to the NEL works. Public transport within the project area is mostly limited to on-road bus services which have been considered during design and functionality retained.

The alignment crosses the Hurstbridge Line and all existing functionality and degree of separation will remain. Provisions are also made for various SmartBus routes (e.g. priority and bus jump provisions at interchanges) and the Doncaster Busway bus service as a key element of the Project. Furthermore, the design has endeavoured to consider future projects relating to public transport to ensure they are not adversely impacted by construction of NEL (e.g. rail connection to Doncaster).

A critical element for the Public Transport provisions is the new connection for Doncaster Busway bus services, which will predominately be provided within the existing shoulders of the Eastern Freeway in both directions from Hoddle Street to C after which it will shift to immediately north of the widened Eastern Freeway carriageways as shown in Figure 26. In this capacity, two 3.7 m wide lanes will be dedicated specifically to buses (and segregated from all other traffic) between Doncaster Park & Ride and Hoddle Street. Provision will be made for future bus station and Park & Ride facility on the corner of Bulleen Road and Thompsons Road.

Access across the NEL alignment and into the Watsonia Station precinct will be maintained, and enhanced where possible. Future design stages will look to build on this to provide for intermodal opportunities and connectivity between transport modes.

### 14.2.2 Benefits

The key benefits of the Public Transport provisions included in the design to date include:

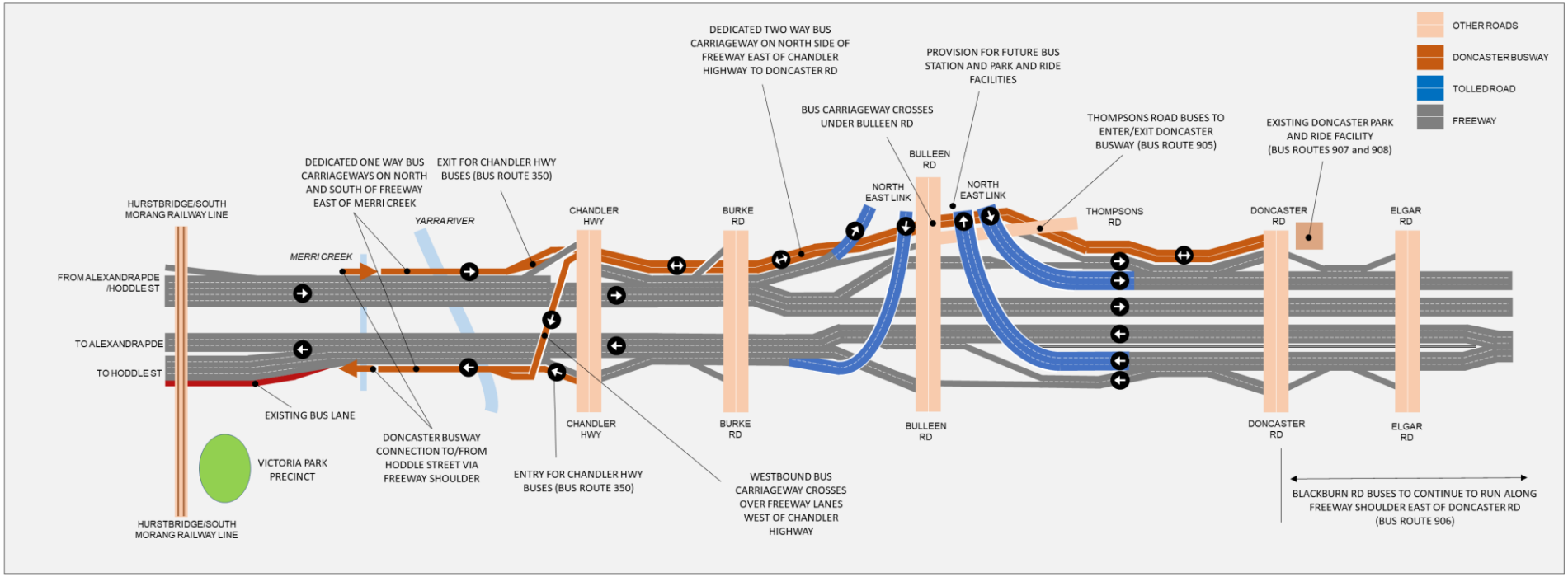
- A focus on complementing the road based solution to provide both added value to the Project and to leverage off benefits between transport modes
- Improved connectivity to public transport and greater flexibility to shift between modes of transport. Combined with the greatly improved, direct connection to/from the City, this is likely to also result in improved patronage on public transport
- Provision for future value capture opportunities and associated works (e.g. the potential to add value to the Doncaster Park & Ride as part of the new Doncaster Busway connection).

### 14.2.3 Key Challenges

The key challenges likely to apply the proposed Public Transport provisions, with a specific focus on the new Doncaster Busway connection, include:

- Constructability of the works with added complexity introduced at the Eastern Freeway and NEL interchange and a number of additional structures required for the busway
- The possibility to increase the likelihood of having greater impacts to the environment inclusive of additional works above the Yarra River and Merri Creek (modifications to the existing freeway bridges)
- Ensuring what works are provided do not precluding any other future possibilities.

Figure 26 Doncaster Busway schematic



# 15 Safety

## 15.1 Safe Systems Framework

The design of NEL will adopt the Safe Systems design approach, however as part of the Concept Design only a strategic review of what this means for NEL has been undertaken. A key next step then will be as part of commencing the Reference Design stage that the requirements of Safe Systems be confirmed and a detailed review of the Concept Design be undertaken to confirm what elements of this approach are to be incorporated into NEL.

The Safe Systems approach involves a holistic view of the road transport system and the interaction among roads and roadsides, travel speeds, vehicles and road users (drivers, motorcyclists, passengers, pedestrians, cyclists and heavy vehicle drivers). It recognises that people will always make mistakes and may have road crashes, but the system should be forgiving and those crashes should not result in death or serious injury.

The Safe Systems design approach will also align with Victoria's Road Safety and Action Plan – Towards Zero 2016 – 2020 campaign, which is a vision for a future free of deaths and serious injuries on our roads. VicRoads will therefore be a key stakeholder in this and will be actively consulted in the development of the Reference Design.

## 15.2 Safety in Design

As part of the Safe Systems design approach, Safer Roads is one key principle in promoting a Towards Zero approach to road safety. The evaluation of whether the Safer Roads principle is incorporated as part of the NEL is achieved via the Safety in Design (**SiD**) process.

SiD is a process that allows for the early identification of health and safety risks that arise during the design development for the whole of the life cycle of a product or project, evaluating health and safety risks that arise during the pre-construction, construction, operation, maintenance and decommissioning phases. SiD is therefore a key risk management process which forms part of the overall Design Management Plan. It is also a critical element in being able to demonstrate that the designer(s) have complied with their OHS obligations.

At present, VicRoads has not formally published Specifications or Guidelines detailing the requirements and criteria for Safe Systems, although a preliminary framework is in development by AustRoads and available for assessment.

On the basis of the current Safe Systems Assessment Framework by AustRoads, the SiD process will incorporate the Safe Systems Matrix to develop a risk register to eliminate or reduce potential health and safety risk. The Safe Systems Matrix operates on the basis of evaluating the existing condition/current road design, producing a scoring system for each risk category or item and applying a hierarchy of available treatment methods to reduce the risk score. The revised design is evaluated against the design to evaluate the extent of adoption of Safe Systems principles.

Incorporating this Safe Systems Matrix as part of the SiD process via a risk register will therefore align the development of the NEL with Safe Systems principles. Additional SiD considerations will be required and incorporated into the SiD process with respect to the design of the structural assets, tunnels, drainage, utilities, ITS, environmental impacts, urban design and any other disciplines or products involved in the Project.

The SiD process will incorporate various forms of review and evaluation including SiD workshops, risk registers and an integral part of the Design Review process.

Further development for appropriate SiD requirements, risk categories/items and treatment options for the NEL will require ongoing discussion with VicRoads and other key stakeholders.

## 15.3 Road Safety Audit

A Road Safety Audit has not been undertaken for the project to date but will be undertaken on the Concept Design before it progresses to the Reference Design stage.