MAJOR ROAD PROJECTS AUTHORITY

MORDIALLOC BYPASS

SURFACE WATER IMPACT ASSESSMENT

OCTOBER 2018

Report Number: 2135645A-SE-26-WAT-REP-0005 REV1

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Mordialloc Bypass
Surface Water Impact Assessment

Major Road Projects Authority

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1	12/10/2018	Final

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ABBREVIATIONS

AEP	Annual Exceedance Probability
ANZECC guidelines	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
BOM	Bureau of Meteorology
BPEMG	Best Practice Environmental Management Guidelines
CEMP	Construction Environmental Management Plan
CMA	Catchment Management Authority
DS	Drainage Scheme
EPA	Environment Protection Authority
EY	Exceedances per Year
FO	Floodway Overlay
GIS	Geographic Information Systems
IFD	Intensity Frequency Duration (design rainfall data)
LSIO	Land Subject to Inundation Overlay
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
MRPA	Major Road Projects Authority
NWQMS	National Water Quality Management Strategy
RFO	Rural Floodway Overlay
SBO	Special Building Overlay
SEPP	State Environment Protection Policy
TSS	Total suspended solids
TP	Total Phosphorus
TN	Total Nitrogen
VPP	Victorian Planning Provisions
WSRD	Water Sensitive Road Design

EXECUTIVE SUMMARY

The Mordialloc Bypass (the project) is a proposed new freeway connecting the Mornington Peninsula Freeway, Aspendale Gardens in the south, to the Dingley Bypass, Dingley Village in the North to become a vital link in the southern movement corridor. The corridor also provides road users with access to residential zones, recreation areas and employment and activity centres within the City of Kingston and adjacent municipalities, including the National Employment Cluster in the City of Monash.

The proposed project was referred to the Minister for Planning who decided an Environment Effects Statement (EES) was required. This report addresses the Scoping Requirements of the EES in relation to potential impacts to surface water resulting from construction and operational activity as a result of the construction of the bypass.

SURFACE WATER CONTEXT

A surface water impact assessment has been undertaken for the proposed Bypass. The proposed road alignment crosses Smythes Drain open channel, Dingley Drain open channel, Gartsides South Drainage Scheme open channel, Gartsides Drainage Scheme underground drainage, Braeside West Drainage Scheme open channel, Old Dandenong Road Drain waterway and Gartsides North Drainage Scheme underground drainage. Stormwater runoff from the proposed road will enter the downstream drainage system or main waterway through discharge points (Outfalls) at impacted sub-catchments. The open land flood flow paths of these drains will also interact with the Bypass as the Bypass will block some of the overland flow paths. In addition, the proposed road runs though the western part of Mordialloc Creek Wetlands (Waterways wetlands) and the stormwater runoff from the road discharges to Woodlands Industrial Estate Wetlands and Edithvale Wetlands, which is a declared Ramsar site downstream of the project area. All stormwater runoff from the project will eventually drain to Edithvale Wetlands or Port Phillip Bay.

The objective of this assessment is to ensure flooding and water quality impacts are managed so that surrounding water sensitive receptors, flood levels and drainage infrastructures are not adversely impacted.

Stormwater interaction with groundwater and potential impacts to the Edithvale-Seaford Wetlands are also discussed in:

1. EES Technical Report Groundwater Impact Assessment
2. EES Technical Report Flora and Fauna Impact Assessment
3. EES Technical Report Contaminated Land Management Impact Assessment.

METHOD

OPERATION PHASE

A desktop assessment of existing water quality and flow regime of the catchments and wetlands was undertaken by reviewing existing publicly available water quality data and using a water quality model (MUSIC) to estimate flow and pollutants loadings entering the Edithvale Wetland, Woodlands Industrial Estate Wetlands and Waterways Wetland. The MUSIC model was then modified to reflect the land uses under proposed Bypass conditions and the loadings entering the wetlands and the overall catchments are compared to evaluate the impacts.

A separate water balance model was developed for the Edithvale Wetland using SOURCES model suite, which was originally developed for the Edithvale and Bonbeach Level Crossing Removal Project. This model incorporated the impacts of the project from both the surface water and groundwater aspects.

Hydrologic (RORB) and hydraulic modelling (TUFLOW 2-dimensional flood modelling) was undertaken for the project area and its contributing catchment to assess the flooding impacts. The purpose of flood modelling is to enable a detailed analysis of flood impacts and the subsequent investigation of mitigation options. A study area was split into two modelling areas. The 'North' TUFLOW model covers the section of the Mordialloc Bypass between Dingley Bypass and

Mordialloc Creek and the 'South' TUFLOW model covers the section of the Mordialloc Bypass between Mordialloc Creek and Thames Promenade. A range of design flood events have been assessed under the baseline and with proposed project scenarios for the 20%, 5% and 1% Annual Exceedance Probability (AEP) and climate change events. Impacts were assessed by comparing the change in flood level, flood depth, flood extent and flood hazard (product of velocity and depth).

CONSTRUCTION PHASE

The surface water impact assessment for construction phase does not seek to specify particular solutions to manage stormwater, but identifies whether standard engineering principles can be applied to mitigate any adverse impact. Stormwater management options should be developed with the City of Kingston and Melbourne Water during the detailed design process.

KEY FINDINGS

KEY FINDINGS FOR OPERATION PHASE:

WATER QUALITY AND FLOW REGIME

The water quality and flow regime impacts of the Bypass are summarised as below:

- The overall change in pollutant loading entering the Mordialloc Creek catchment under the proposed project conditions meet the required water quality targets a whole so that no further mitigation measures are required.
- For Waterways Wetlands, Woodlands Industrial Estate Wetlands and Edithvale Wetland (water sensitive receptors), there is increases in loading on the three wetlands when compared to existing conditions. Additional treatment, in addition to the grassed swales, is recommended to further reduce the pollutant loadings on these wetlands. Bio-retention systems are recommended (see Table ES.1).
- An oil and fuel risk assessment found that spills occurring on the Bypass near Outfall H pose a moderate risk to Woodlands Industrial Estate Wetlands. Spills occurring on the Bypass near outfalls discharging to Woodlands Industrial Estate Wetland (Outfall F), Waterways Wetlands (Outfalls I & J), and to Edithvale Wetlands (Outfall M) pose a high spill impact risk to the downstream wetlands. Extended and widened swales is recommended for moderate risk outfalls and 20,000 Litre spill containment is recommended for high risk outfalls (see Table ES.1 for details).
- The project is anticipated to have minimal impact on the flow regime of the waterways and wetlands systems hence the industry and agriculture water users, and aquatic flora and fauna. No mitigation measures are considered necessary for the minimal flow increases caused by the project.

FLOODING

The changes in flooding conditions caused by the Bypass mostly meet the performance criteria. There are a number of localised areas with flood impacts. However, as summarised in Section 7.1.3, these are generally limited to within the project area or waterways so that flood risk and hazard is low. At Braeside Park, the flood impact is more widespread, but the flood impact assessment shows that the impacted areas are mainly within parkland, channel banks and road reserves and there is no adverse impact to private property or safety risks to users.

KEY FINDINGS FOR CONSTRUCTION PHASE

WATER QUALITY AND FLOW REGIME

Erosion of disturbed areas within construction sites has the potential to contribute large sediment loads to downstream areas. Sediment laden runoff from disturbed areas, stockpiles, storage areas and haulage routes may increase turbidity of receiving water bodies resulting in reduced water quality. There is also potential for runoff to contain pollutants including contaminated sediments, oils and/or chemicals.

During construction, it may be necessary to dispose of runoff from excavated areas after rainfall events using temporary pumping. Surface water pumped from construction areas may be high in sediment, turbidity and other pollutants. Without water quality control measures pumped discharge may adversely impact nearby waterway networks.

Water supplies may be needed during construction for controlling dust and other purposes. Depending on the quantities required and the source of the water, this may have potential impacts on users of the water resource and aquatic fauna and flora.

FLOODING

Aspects of the construction process have the potential to temporarily worsen flooding due to the presence of temporary works (such as access tracks, piling platforms, stockpiles, etc.) in the floodplain causing reductions in flood conveyance or floodplain storage. Temporary diversion of overland flow and restriction of flow paths also has the potential to worsen flooding.

Wherever possible construction works required for the project should occur outside the extent of the 1% AEP floodplain, to reduce the risk of increased inundation of properties. However, due to the location of the project and the extensive nature of the 1% AEP floodplain, the construction elements will occur within the extent of the 1% AEP floodplain. More detailed assessment is required before the construction works commence.

ENVIRONMENTAL PERFORMANCE REQUIREMENTS

Table ES.1 lists the environmental performance requirements recommended for the Mordialloc Bypass project.

Table ES.1 Recommended environmental performance requirements

EPR NUMBER	ENVIRONMENTAL PERFORMANCE REQUIREMENT (EPR)	PROJECT PHASE
W1	**Water body health** During design and operation, impacts on surface water quality and flow must be minimised through adoption of measures to avoid an increase in discharge of pollutant loading (to higher than existing conditions levels) on beneficial uses due to the construction of the project in accordance with CSIRO *Best Practice Environmental Management Guidelines for Urban Stormwater (1999*) and Water Sensitive Road Design (WSRD). In addition, the project must incorporate spill containment at the outfalls which pose a high risk to sensitive receptors, including Braeside Park Wetlands, Waterways Wetlands, Woodlands Wetlands and Edithvale Wetlands. The design of surface water control measures for the project as a whole must comply with the VicRoads *Integrated Water Management Guidelines (2013)* and CSIRO *Best Practice Environmental Management Guidelines for Urban Stormwater (1999).*	Design and Operation
W2	**Flood impacts** Changes to flood behaviour resulting from the project must meet the requirements of Melbourne Water's guideline "*Melbourne Water standards for infrastructure in flood prone areas*". Design-specific maintenance requirements relating to floodwater, and that do not form part of standard VicRoads maintenance requirements, must be included in the Water Management and Monitoring Plan (EPR W5).	Design and Operation

EPR NUMBER	ENVIRONMENTAL PERFORMANCE REQUIREMENT (EPR)	PROJECT PHASE
W3	**Surface water management (construction)** — Protect local waterways by applying best practice sedimentation and pollution control measures in accordance with EPA Victoria publication 480 *Environmental Guidelines for Major Construction Sites* and EPA publication 275 *Construction techniques for sediment pollution control* through the Construction Environmental Management Plan(s) and other plans. Implement a water collection and treatment system to ensure that stormwater discharges comply with the *State Environment Protection Policy (Waters of Victoria) 2004* and Melbourne Water performance criteria. Such plans and systems should be prepared in consultation with relevant authorities before the commencement of works.	Construction
W4	**Flood protection (construction)** During construction, the requirements of the "*Melbourne Water standards for infrastructure in flood prone areas*" must be complied with. Measures must be implemented to the satisfaction of Melbourne Water and in consultation with any other relevant drainage authority, to ensure that temporary construction activities do not increase flood risks (including flood levels, flows and velocities) to the surrounding areas. A flood management plan must be developed in consultation with and not objected by Melbourne Water for any temporary works.	Construction

W5	**Water Management and Monitoring Plan**
	A Water Management and Monitoring Plan (WMMP) must be prepared in consultation with EPA Victoria and relevant water authorities, and be implemented prior to construction, during construction and for five years following opening the project to the public. The WMMP must incorporate both surface and groundwater monitoring.
	Incorporating the baseline data collected to date, the WMMP must include:
	— Detail of the monitoring parameters, including the frequency and location of surface water monitoring points and groundwater monitoring bores
	— Specific trigger levels (water quality in surface water bodies and groundwater bores) and details of contingency plans in the case trigger levels are exceeded
	— Detailed reporting requirements
	— Roles and responsibilities, not limited to:
	  — The owner of monitoring network assets
	  — The manager of monitoring network assets and results
	  — The party (or parties) undertaking monitoring (prior to construction, during construction and for five years following opening).
		All

W6	**Surface water management (Design and operation)** The volume, peak flow and quality of surface water discharges during operation must be designed to have no adverse impact to the drainage network capacities in consultation with Melbourne Water, Kingston City Council and Greater Dandenong City Council, as appropriate.	Design and Operation

1 INTRODUCTION

1.1 PROJECT DESCRIPTION

The Mordialloc Bypass project (the project) is the proposed construction of a new freeway connecting the Dingley Bypass with the Mornington Peninsula Freeway; and is predominately to be constructed within an existing road reservation. The project passes between the western boundary of Braeside Park and the eastern boundary of the Woodlands Estate (constructed) wetlands, traverses constructed wetlands at Waterways and approaches to within one kilometre of the Ramsar-listed Edithvale-Seaford Wetlands. The northern and southern ends of the project pass through or border the South East Green Wedge. (Figure 1.1).

The project corridor is approximately 9.7 kilometres in length, comprising two, two-lane 7.5 kilometre long carriageways (with a path for walking and cycling) along the greenfield alignment, and 2.2 kilometres of roadworks required to integrate the project with the Mornington Peninsula Freeway. It is expected that each carriageway will provide for two 3.5 metre wide lanes, with a 3.0 metre wide outside shoulder and 1.0 metre wide inside shoulder. The Mordialloc Bypass will also provide connections from the freeway onto the Dingley Bypass, Centre Dandenong Road, Lower Dandenong Road, Governor Road, Springvale Road and new north facing ramps at Thames Promenade. There will also be an overpass at Old Dandenong Road. Mordialloc Creek and the associated Waterways Wetlands will be spanned by twin 400 metre long bridges.

The proposed alignment allows for a future upgrade of the project to a six-lane freeway standard road within the construction footprint.

The proposed alignment is generally located within the existing road reservation, most of which is already covered by Public Acquisition Overlay, and some of which is already in VicRoads' ownership.

The proposed project consists of:

- Four-lane freeway standard cross-section (two lanes in each direction), divided by a centre median
- 100 km/hr posted speed limit
- Full diamond interchanges at Springvale Road, Governor Road and Lower Dandenong Road whereby Mordialloc Bypass is elevated over the arterial roadway with northbound and southbound entry and exit ramps providing access for all directions of travel
- Half single point urban interchange at Centre Dandenong Road whereby Mordialloc Bypass is elevated over Centre Dandenong Road and southbound entry and northbound exit ramps provide accessibility to and from the south
- Addition of northbound entry and southbound exit ramps at the existing Mornington Peninsula Freeway interchange at Thames Promenade to provide access to and from Mordialloc Bypass. The existing interchange provides ramps to and from Mornington Peninsula Freeway to the south only. The proposed entry and exit ramps will create a full diamond interchange at Thames Promenade
- An at-grade T-signalised intersection at Dingley Bypass
- Elevation of the bypass over Old Dandenong Road and Bowen Parkway to maintain existing connectivity on these routes
- Shared use path running north-south along the length of the Mordialloc Bypass and connecting existing paths along the north side of Dingley Bypass and the south side of Springvale Road adjacent to Chelsea Heights Hotel
- Bus queue jump lanes provided in intersection configurations at the proposed Springvale Road and Centre Dandenong Road interchanges.

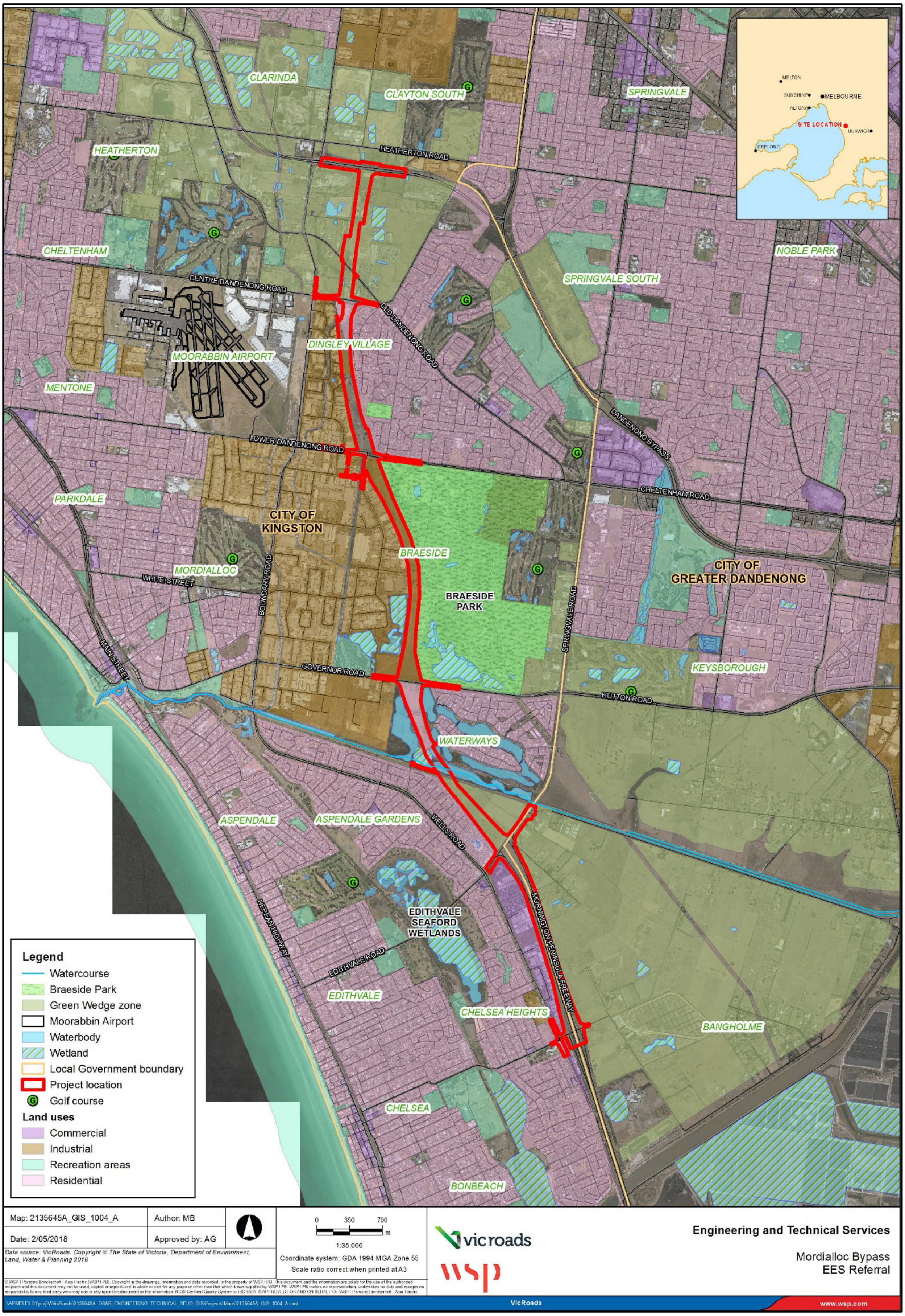

Figure 1.1 Project overview map

1.2 PROJECT AREA

The proposed project area is located within the Dandenong major catchment area and interacts with the Mordialloc Creek waterway system. The Dandenong catchment supports multiple and varied uses and values, including flood mitigation, significant plant and animal species, and amenity. While there has been extensive modification to rivers and creeks for flood protection within the Dandenong catchment, a large number of ecologically and culturally significant wetlands occur throughout the catchment. The Lower Dandenong Creek, Patterson River and Mordialloc Creek were all created to drain the once extensive Carrum Carrum Swamp that existed prior to European settlement. Dandenong Creek flows into Mordialloc Creek and the Patterson River via diversion structures upstream of Perry Road in Dandenong South.

The proposed road alignment crosses Smythes Drain open channel, Dingley Drain open channel, Gartsides South Drainage Scheme open channel, Gartsides Drainage Scheme underground drainage, Braeside West Drainage Scheme open channel, Old Dandenong Road Drain waterway and Gartsides North Drainage Scheme underground drainage. Stormwater runoff from the proposed road will enter the downstream drainage system or main waterway through discharge points (Outfalls) at impacted sub-catchments.

In addition, the proposed road runs though the western part of Mordialloc Creek Wetlands (Waterways wetlands) and the stormwater runoff from the road discharges to Woodlands Industrial Estate wetlands and Edithvale Wetlands, which is a declared Ramsar site downstream of the project area. All stormwater runoff will eventually end up in Edithvale Wetlands or Port Phillip Bay. A detailed description of the surface water environment of the project areas can be found in Sections 5.1 and 5.2.

2 EES OBJECTIVES AND REQUIREMENTS

The EES scoping requirements for water, catchment values and hydrology are provided below. It should be noted that this report only addresses requirements related to surface water aspect. Groundwater aspect has been addressed in the Groundwater impact Assessment report (WSP2018b).

2.1 EVALUATION OBJECTIVE

To minimise adverse effects on groundwater, surface water and floodplain environments and minimise effects on water quality and beneficial uses, including the ecological character of the Edithvale-Seaford Wetlands Ramsar site.

2.2 KEY ISSUES

- *The potential for adverse effects on the functions, values and beneficial uses of surface water environments (including Braeside West and Mordialloc Creek Wetlands, Waterways wetlands, Woodland Industrial Estate wetlands, and associated Mordialloc Creek drainage system) due to the project's activities, interception or diversion of flows or changed water quality or flow regimes during construction and operation.*
- *The potential for adverse effects on the functions, values and beneficial uses of groundwater due to the project's activities, in particular on groundwater dependent ecosystems (GDEs) and the ecological character of the Edithvale-Seaford Wetlands due to changes in groundwater levels, behaviour or quality.*
- *The potential for adverse effects on nearby and downstream water environments (including the Mordialloc Creek catchment and Edithvale-Seaford Wetlands) due to changed flow regimes, floodplain storage, run-off rates, water quality changes, or other waterway conditions during construction and operation.*
- *The potential for adverse effects on biodiversity values of the Edithvale-Seaford Wetlands Ramsar site including, but not limited to:*
  - *Australasian Bittern; and*
  - *Sharp-tailed Sandpiper.*

2.3 PRIORITIES FOR CHARACTERISING THE EXISTING ENVIRONMENT

- *Characterise relevant surface water, catchments and floodplain environments, including in terms of the existing drainage functions and behaviour.*
- *Characterise the relevant groundwater environments, including the protected beneficial uses and values, existing drainage functions and behaviours, including with regard to the nearby wetlands such as the Edithvale-Seaford Wetlands Ramsar site and identifying any GDEs that might be affected by the project.*
- *Characterise the interaction between surface water and groundwater within the project site and the broader area.*
- *Characterise the physical and chemical properties of the project area groundwater, including the potential pre-existing contamination.*
- *Identify and characterise the nature and status of any nearby projects which may affect the relevant groundwater environments.*
- *Detail and evaluate the groundwater modelling techniques utilised.*

2.4 DESIGN AND MITIGATION MEASURES

- *Identify and evaluate aspects of project works, and proposed design refinement options or measures, which could avoid or minimise significant effects on water environments, including the Edithvale-Seaford Wetlands Ramsar site and Braeside West, Waterways wetlands and Mordialloc Creek Wetlands.*
- *Describe further potential and proposed design options and measures which could avoid or minimise significant effects on beneficial uses of surface water, groundwater and downstream water environments during the project construction and operation.*
- *Identify methods to manage and, if required dispose of groundwater, including contaminated groundwater during construction.*

2.5 ASSESSMENT OF LIKELY EFFECTS

- *Characterise the local and regional groundwater systems in order to predict short and long-term effects of the project on groundwater flow regime during construction and operation, including interactions between surface water and groundwater, and having regard to potential impacts of other relevant infrastructure projects.*
- *Identify and evaluate effects of the project and relevant alternatives on groundwater and adjacent surface water and floodplain environments in the vicinity of the project works and the Edithvale-Seaford Wetlands, including:*
  - *The likely extent, magnitude and duration (short and long term) of changes to groundwater level or flow paths during construction and operation, considering appropriate climate change scenarios*
  - *Changes to groundwater and surface water quality at all project phases, including from drawdown and rebound of groundwater levels, present contaminants, saline water intrusion into aquifers, sedimentation and downstream effects on ecological values (e.g. groundwater dependent ecosystems, EPBC Act listed communities and the Edithvale-Seaford Wetlands Ramsar site)*
  - *Changes to availability of groundwater for beneficial uses near the project*
  - *Changes to groundwater quality and flow construction, and compression of soil with the potential for reduced porosity and permeability, due to project works such as construction and placement of embankments, pilings and other structures in the project area; and*
  - *Risks associated with potential acid forming materials (e.g. soil) which may be disturbed or exposed by the project activities.*

2.6 APPROACH TO MANAGE PERFORMANCE

- *Describe any further methods that are proposed to manage risks of effects on groundwater and surface water environments and catchment values, as well as water quality, including as part of the EMF (see section 5 of the Scoping Requirements Document).*
- *Describe any further methods that are proposed to manage risks of effects as a result of nearby projects impacting on water inflow to water environments and catchment values, as well as water quality.*
- *Describe and evaluate the approach to monitoring and the proposed contingency measures to be implemented in the event of adverse residual effects on water environments including water quality and catchment values requiring further management.*
- *Describe and evaluate the approach to monitoring and the proposed ongoing management measures to be implemented to avoid adverse residual effects on the Edithvale-Seaford Wetland Ramsar site.*

3 LEGISLATION AND POLICY

This section summarises the current legislative requirements and guidelines relevant to surface water considerations for the project.

3.1 COMMONWEALTH

3.1.1 *NATIONAL WATER QUALITY MANAGAMENT STRATEGY*

The National Water Quality Management Strategy (NWQMS) is a joint approach by the Australian and New Zealand governments to improving water quality in waterways. The objective of the NWQMS is to achieve sustainable use of water resources, by protecting and enhancing their quality, while maintaining economic and social development.

The NWQMS provides a framework for the development and implementation of management plans for catchment, aquifer, coastal waters and other water bodies, by community and government. The NWQMS includes a number of guidelines covering water quality benchmarks, groundwater management, diffuse and point sources, sewerage systems, effluent management, and water recycling. Guidelines relevant to the project include:

- Australian and New Zealand guidelines for fresh and marine water quality (ANZECC guidelines); and
- Australian guidelines for water quality monitoring and reporting.

3.2 STATE

3.2.1 *ENVIRONMENT PROTECTION ACT 1970*

The Environment Protection Act 1970 aims to prevent pollution and environmental damage by setting environmental quality objectives and establishing programs to meet them. The Act establishes the powers, duties and functions of the Environment Protection Authority (EPA). These include the administration of the Act and any regulations and orders made pursuant to it, recommending State environment protection policies (SEPPs), issuing works approvals, licences, permits, pollution abatement notices and implementing National Environment Protection Measures.

3.2.2 *STATE ENVIRONMENT PROTECTION POLICY (WATERS OF VICTORIA)*

The SEPP (Waters of Victoria) sets the framework for the protection of the uses and values of Victoria's surface water environments. The policy sets out uses and values of water environments that communities want to protect (known as beneficial uses), establishes objectives and indicators which describe the environmental quality required to protect beneficial uses (known as environmental quality objectives), and provides guidance to authorities, agencies, businesses and communities to protect and rehabilitate environmental water to levels to meet the environmental objectives (known as the attainment program).

The beneficial uses and water quality objectives relevant to this project are discussed further in detailed in Section 3.4.1.

Groundwaters are excluded from the SEPP (Waters of Victoria) as they are covered by the SEPP (Groundwaters of Victoria).

3.2.3 *PROPOSED STATE ENVIRONMENT PROTECTION POLICY (WATERS)*

A new SEPP is proposed to replace the existing SEPP (Waters of Victoria) and SEPP (Groundwaters of Victoria). The draft SEPP is completed and currently at public consultation stage. It is expected to be enacted sometime in 2018.

The key changes in the SEPP is the combination of surface waters and groundwaters SEPP into a single SEPP. There is a new "urban" segment proposed in the SEPP together with the corresponding water quality objectives. Details of the proposed water quality objectives are discussed in Section 3.4.1.

3.2.4 PLANNING AND ENVIRONMENT ACT 1987

The Planning and Environment Act establishes a framework for planning the use, development and protection of land in Victoria. Victorian Planning Provisions (VPPs) are set out in the Act to assist in proving a consistent and coordinated framework for planning schemes. Parts of the VPPs relevant to surface water in the project area are summarised in Section 3.2.5. The project area is within the Planning Scheme for City of Kingston.

3.2.5 VICTORIAN PLANNING PROVISIONS

3.2.5.1 STATE PLANNING POLICY FRAMEWORK

The State and Local Planning Policy Frameworks contain the long-term directions and outcomes sought by the scheme. The requirements relevant to surface water on the projects are:

- Clause 12.05 – Environmental and Landscape Values – Rivers
  - Consideration of Healthy Waterways Strategy 2013, Melbourne Water.
- Clause 13.01 – Environmental Risks - Climate change impacts
  - Plan for possible sea level rise of 0.8 metres by 2100.
- Clause 13.02 – Environmental Risks – Floodplains
  - Identify land affected by flooding (1 in 100 year flood event)
  - Avoid intensifying the impacts of flooding through inappropriately located uses and developments
  - Consideration of:
    - SEPP (Waters of Victoria)
    - Any surface water policy, practice or strategy adopted by the responsible floodplain management authority
    - Any best practice environmental management guidelines for stormwater adopted by the EPA; and
    - Victoria Floodplain Management Strategy (Department of Natural Resources and Environment, 1998).
- Clause 14.02 – Natural Resource Management – Water
  - Consider impacts of catchment management on downstream water quality and water environments
  - Retain natural drainage corridors with vegetated buffer zones of at least 30 m
  - Undertake measures to minimise the quantity and retard flow from developed areas
  - Encourage measures to filter sediment and wastes from stormwater prior to its discharge into waterways
  - Ensure land use and development minimise nutrient contributions to waterways
  - Use appropriate measures to restrict sediment discharges from construction sites
  - Coordinate with activities of catchment management authorities
  - Ensure activities potentially discharging contaminated runoff or wastes to waterways are sited and managed to minimise such discharges and protect the quality of water environments
  - Consideration of:
    - SEPP (Waters of Victoria)
    - Plans, works programs and strategies approved by Catchment Management Authorities (CMAs)
    - Technical Guidelines for Waterway Management (Department of Sustainability and Environment, 2007)
    - Construction Techniques for Sediment Pollution Control (EPA, 1991); and
    - Environmental Guidelines for Major Construction Sites (EPA, 1996).

- Clause 19.03-2 – Infrastructure - Development Infrastructure – Water Supply Sewerage and Drainage
  - Ensure water quality in water supply catchments is protected from possible contamination
  - Plan urban stormwater drainage systems to:
    - Coordinate with adjacent municipalities and take into account the catchment context
    - Include measures to reduce peak flows and assist screening, filtering and treatment of stormwater, to enhance flood protection and minimise impacts on water quality in receiving waters
    - Prevent, where practicable, the intrusion of litter.
  - Encourage the re-use of urban run-off and run-off from irrigated farmland where appropriate
  - Consideration of:
    - State Environment Protection Policy (Waters of Victoria)
    - Any relevant Environment Protection Authority guidelines
    - Litter Prevention and Control Strategy for the Greater Melbourne Area (Waste Management Council, 1995)
    - Urban Stormwater Best Practice Environmental Management Guidelines (Victorian Stormwater Committee, 1999 as amended)
    - Guidelines for Environmental Management: Code of Practice – Onsite Wastewater Management (Publication 891.4, Environment Protection Authority, 2016)
    - Guidelines for planning permit applications in open, potable water supply catchment areas (Department of Sustainability and Environment, 2012).
- Clause 19.03-3 – Infrastructure – Development Infrastructure – Stormwater
  - Consider integrated planning of stormwater quality through a mix of on-site measures and developer contributions
  - Mitigate stormwater pollution from construction sites
  - Ensure stormwater and groundwater runoff do not have a detrimental effect on wetlands and estuaries
  - Incorporate water-sensitive urban design techniques into developments to:
    - Protect and enhance natural water systems
    - Integrate stormwater treatment into the landscape
    - Protect quality of water
    - Reduce run-off and peak flows
    - Minimise drainage and infrastructure costs
  - Consideration of:
    - Urban Stormwater Best Practice Environmental Management Guidelines (CSIRO, 1999).

3.2.5.2 OVERLAYS

The type and purpose of overlays relevant to surface water on the projects are:

- Clause 44.01 – Erosion Management Overlay (EMO)
  - To protect areas prone to erosion, landslip or other land degradation processes, by minimising land disturbance and inappropriate development.
- Clause 44.03 – Floodway Overlay (FO or RFO)
  - To identify waterways, major footpaths, drainage depressions and high hazard areas which have the greatest risk and frequency of being affected by flooding
  - To ensure that development maintains the free passage and temporary storage of floodwater, minimises flood damage and is compatible with flood hazard, local drainage conditions and the minimisation of soil erosion, sedimentation and silting
  - To protect water quality and waterways as natural resources in accordance with the provisions of relevant SEPPs; and
  - To ensure development maintains or improves river and wetland health, waterway protection and flood plain health.
- Clause 44.04 – Land Subject to Inundation Overlay (LSIO)
  - To identify land in a flood storage or flood fringe area affected by the 1 in 100 year flood or any other area determined by the floodplain management authority
  - To ensure that development maintains the free passage and temporary storage of floodwater, minimises flood damage and is compatible with flood hazard, local drainage conditions and will not cause any significant rise in flood level or flow velocity
  - To protect water quality in accordance with the provisions of relevant SEPPs; and
  - To ensure development maintains or improves river and wetland health, waterway protection and flood plain health.
- Clause 44.05 – Special Building Overlay (SBO)
  - To identify land in urban areas liable to inundation by overland flows from the urban drainage system as determined by, or in consultation with, the floodplain management authority
  - To ensure that development maintains the free passage and temporary storage of floodwater, minimises flood damage and is compatible with flood hazard, local drainage conditions and will not cause any significant rise in flood level or flow velocity
  - To protect water quality in accordance with the provisions of relevant SEPPs.

A permit is required to construct or carry out works in the above overlays. An application must be referred to the relevant floodplain management authority.

3.2.6 WATER ACT 1989

The Water Act 1989 provides the legal framework for water management and use across Victoria, including the issuing and allocation of water entitlements and the provision of water services by state-owned water corporations and catchment management authorities.

Under the Act, the designated waterways, regional drainage and floodplain management authority for the Port Phillip and Westernport catchment region is Melbourne Water Corporation (Melbourne Water).

The Act states that Melbourne Water have the power to make By-laws, which include:

- By-law No. 1: Water Supply Protection, 2008; and
- By-law No. 2: Waterways, Land and Works Protection and Management, 2009.

Under the Act, a permit from the relevant waterway authority is required for works within or in proximity of designated waterways.

3.2.7 MELBOURNE WATER CORPORATION BY-LAW NO.2: WATERWAYS, LAND AND WORKS PROTECTION AND MANAGEMENT (2009)

The objectives of Melbourne Water By-Law No. 2, made under the Water Act 1989, are:

- The management, protection and use of lands, waterways and works under the management and control of Melbourne Water
- Preventing or minimising interference with or obstruction of the flow of water
- Preventing or minimising the silting up of a designated waterway or designated land or works or any injury to or pollution of it or them, including prohibiting the deposit of material in or near it or them
- Prohibiting or regulating the removal of any material from land forming part of a designated waterway or designated land or works
- Regulating activities carried out on land forming part of a designated waterway or designated land or works; and
- The general management and control of any designated waterways or designated land or works.

The By-Law prohibits works and certain activities on designated waterways or designated lands or works without a permit issued by Melbourne Water.

3.3 GUIDELINES

3.3.1 PROJECT SPECIFIC GUIDELINES

3.3.1.1 MELBOURNE WATER PERFORMANCE CRITERIA

In accordance with By-Law No.2 of the Water Act 1989, Melbourne Water has provided three documents " *Protection of and Modifications of Melbourne Water Storm Water Main Drains – Performance Criteria for Major Road and Rail Projects, April 2017*" (MWC 2017a), "*Melbourne Water standards for infrastructure projects in flood-prone areas* " (MWC 2018) and "*Mordialloc Bypass Stormwater Quality Performance Criteria*" (MWC 2017b) to outline their requirements regarding flood and water quality impacts of the proposed Bypass on the waterways and floodplain affected. Full details of the requirements are in Appendix D.

3.3.2 CITY OF KINGSTON

The project area is within the Planning Scheme for City of Kingston and, according to Planning and Environment Act 1987, the City of Kingston is responsible for existing stormwater infrastructure along both sides of the road corridor with the exception of those infrastructures owned by Melbourne Water. Permit would be required for any proposed connection to these stormwater assets. The City of Kingston developed an Integrated Water Cycle Strategy in 2012 which set out a process for managing stormwater runoff quantity and quality. The stormwater design for this project needs to be consistent with the objectives of this strategy.

3.3.3 PORT PHILLIP BAY ENVIRONMENTAL MANAGEMENT PLAN

This Plan is required under the State Environment Protection Policy (Waters of Victoria) – Schedule F6 Waters of Port Phillip Bay (1997) to protect the beneficial uses and environmental value of the Bay. Priority Area 3 of the Plan encompass ensuring nutrient and sediment loads do not exceed current levels and pollutant loads are reduced where practicable. However, there is not a quantity target for stormwater reduction.

3.3.4 OTHER RELEVANT GUIDELINES

A number of guidelines are relevant to surface water management for the project, including:

- Australian Rainfall and Runoff 2016
- Australian Rainfall and Runoff 1987
- Austroads Guide to Road Design, 2013
- VicRoads Supplements to AGRD, 2013
- Integrated Water Management Guidelines, VicRoads 2013
- Integrated Water Cycle Strategy. City of Kingston 2012
- Urban Stormwater: Best Practice Environmental Management Guidelines (BPEMG), 1999
- Melbourne Water Guidelines for Development in Flood-prone areas, 2007
- Melbourne Water Flood Mapping Projects Guidelines and Technical Specifications 2012
- Melbourne Water MUSIC Guidelines, 2016
- Civil Design Requirements for Developers, City of Kingston 2016
- Healthy Waterways Strategy, Melbourne Water 2013
- Victoria Floodplain Management Strategy, Department of Natural Resources and Environment, 2016
- Technical Guidelines for Waterway Management, Department of Sustainability and Environment 2007
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, ANZECC 2000
- EPA Publication No. 275. Construction Techniques for Sediment Pollution Control (1991); and
- EPA Publication No. 480. Environmental Guidelines for Major Construction Sites (1996).

3.4 SURFACE WATER ASSESSMENT CRITERIA

3.4.1 OPERATIONAL PHASE

3.4.1.1 WATER QUALITY AND FLOW REGIME

BENEFICIAL USE AND WATER QUALITY

The SEPP (Waters of Victoria) provides a legal framework to protect areas with a use of the environment which is conducive to public benefit, welfare, safety, health or aesthetic enjoyment and which requires protection from the effects of waste discharges. Beneficial uses of water environments include:

- Aquatic plants and animals
- Water suitable for aquaculture and edible seafood
- Water-based recreation
- Water suitable for human consumption
- Cultural and spiritual values
- Water suitable for industry and shipping
- Water suitable for agriculture.

The types and level of protection of beneficial uses depend on the segment of surface water environment to which the project area belongs. The segments, and the SEPP Schedules that apply to them, relevant to the project are:

- Schedule A (Environmental Quality Objectives and Indicators); and
- Schedule F6 (Waters of Port Phillip Bay).

Water quality objectives (WQOs) are defined for different segments to ensure the beneficial uses are adequately protected. The project area (Mordialloc Creek) is within the Cleared Hills and Coastal Plains (lowlands of Yarra, Western Port, Latrobe, Mitchell, Tambo, Snowy, Thomson & Macalister catchments) segment. The water quality objectives for key environmental indicators, as set out in Schedule A of SEPP, are tabulated in Table 3.1. The water quality of the waters in the project area is to be characterised based on these WQOs.

It should be noted that these WQOs are mainly for perennial rivers and streams in non-urban areas (EPA 2003a) and not appropriate for intermittent/episodic streams or for lakes and wetlands (EPA2003b). However, the key beneficial uses in the project area are found in the nearby wetlands especially the Edithvale-Seaford Wetlands Ramsar site, which will receive stormwater runoff from a small portion of the proposed bypass. This means that the WQOs in Table 3.1 are not applicable to these wetlands. EPA (2003b) acknowledged the need of specific WQOs for wetlands but such WQOs are not currently available. EPA (2003b), though, recommended that “considerable effort should be directed towards controlling non-point sources nutrient inputs”. Thus, assessing the change in pollutant loading into wetlands is taken as one of the criteria for assessing impact of the proposed project on affected wetlands (Woodlands Industrial Estate Wetlands, Waterways Wetland and Edithvale Seaford Wetlands).

Table 3.1 Water Quality Objectives for key environmental indicators

TOTAL PHOSPHORUS (µg/L)	**TOTAL NITROGEN (µg/L)**	**DISSOLVED OXYGEN % SATURATION**		**TURBIDITY (NTU)**	**ELECTRICAL CONDUCTIVITY (µS/cm)**	**pH (pH UNITS)**		**METALS**
75th percentile	**75th percentile**	**25th percentile**	**maximum**	**75th percentile**	**75th percentile**	**25th percentile**	**75th percentile**	**Max**
Existing SEPP (Waters of Victoria) – Cleared Hills and Coastal Plains (lowlands of Yarra, Western Port, Latrobe, Mitchell, Tambo, Snowy, Thomson & Macalister catchments)								
≤ 45	≤ 600	≥ 85	110	≤ 10	≤ 500	≥ 6.4	≤ 7.7	95% ANZECC trigger values
Proposed SEPP (Waters) – Urban								
≤ 110	≤ 1300	≥ 70	110	≤ 35	≤ 500	≥ 6.4	≤ 7.9	90% ANZECC trigger values

The proposed SEPP (Waters) added a number of new segments including wetlands and urban segments. According to this proposed SEPP, the project area will belong to the new urban segment with a set of revised WQOs. The revised WQOs are also presented in Table 3.1. Since the proposed SEPP is still in draft status, the revised WQOs will not be used to characterise the existing water quality of the streams and waterways in the project area, however, these WQOs are compared as a reference. It should be noted that the proposed WQOs are less onerous than the existing WQOs but possibly more realistic and relevant for urban catchments.

In addition, the definition of the wetlands segment in the proposed SEPP “excludes marine and estuaries wetlands and constructed stormwater wetlands”. Since all the wetlands in the area are either constructed wetlands or estuaries wetlands, WQOs for the wetlands in the proposed SEPP are not applicable to the wetlands in the project area.

PERFORMANCE CRITERIA

Clause 46 of the SEPP classifies runoff from roads as urban stormwater. Therefore, the project must meet the requirements of the SEPP for urban stormwater runoff, which includes the protection of beneficial uses and the demonstration of best practice.

Best practice is defined in the SEPP as “the best combination of techniques, methods, processes or technology used in an industry sector or activity that demonstrably minimises the environmental impact of that industry sector or activity.” This approach requires proposed road projects meet the best practice performance objectives and process outlined in Urban Stormwater: Best Practice Environmental Management Guidelines, Victorian Stormwater Committee (CSIRO 1999) (BPEMG). At a minimum, these are as follows:

- Total suspended solids (TSS) – 80% retention of the typical urban annual load
- Total phosphorus (TP) – 45% retention of the typical urban annual load
- Total nitrogen (TN) – 45% retention of the typical urban annual load
- Litter – 70% retention of the typical urban annual load; and
- Flows – maintain discharges for the 1.5 year Average Recurrence Interval (ARI) at pre-development discharges.

The same criteria are adopted by City of Kingston and VicRoads. Melbourne Water adopts the same criteria except that the last “Flows” criterion is excluded (see “Mordialloc Bypass Stormwater Quality Performance Criteria”).

The impacted areas in this project are along the road corridor which crosses many sub-catchments of Mordialloc Creek. Stormwater runoff will enter the downstream drainage system or main waterway through discharge points (outfalls) at impacted sub-catchments. According to the BPEMG guideline, water sensitive road design (WSRD) is required to remove the pollutant loadings by the percentages listed above. A holistic view has been taken in this assessment that the pollutant loading reduction performance is assessed based on the overall total pollutant removal rate at catchments within the whole road corridor. This means that the reduction target might not be met at individual outfall but the total catchment of the road corridor as a whole will.

For flow impacts, the road corridor sub-catchments draining to the discharge points are relatively small compared to the catchment of the receiving waterway upstream of the discharge points. The impact on total flow downstream of the discharge points is expected to be minimal. However, the impact will become more notable further downstream where flow impacts from the individual discharge points accumulate. Thus, the assessment of flow impacts focuses on change in flow characteristics downstream of the discharge points where the individual impacts combine rather than at each individual discharge point. Rather than assess impacts on a specific flow event, such as the 1.5 year ARI event as specified in the BPEMG, the assessment has considered the impact on the flow duration curve of the receiving catchment, which represents the full range of flow events.

The performance criteria for waterways are presented in Table 3.2.

Table 3.2 Performance criteria for water quality and flow regime impacts

INDICATORS	TARGETED REDUCTION OF TYPICAL URBAN (ROAD) ANNUAL LOAD	ASSESSMENT APPROACH
Total suspended solids (TSS)	80%	Overall reduction
Total phosphorus (TP)	45%	Overall reduction
Total nitrogen (TN)	45%	Overall reduction
Litter (Gross pollutants)	70%	Overall reduction
Flow	Minimal change in flow duration curve	Downstream of confluence of discharge points

To ensure that the water sensitive receptors such as wetlands, which have high beneficial uses, are protected, it is important that there is minimal change in the flow regime and a minimal increase in nutrients entering wetlands. An additional criterion is recommended to assess the impact to wetlands downstream of the proposed road, i.e. Waterways, Woodland Industrial Wetlands and Edithvale Wetlands. This criterion is the assessment of the change in total annual pollutants loading entering the wetlands from the catchment affected by the proposed road.

3.4.1.2 FLOODING

Clause 16 (Schedule F7) of SEPP (Waters of Victoria) requires the floodplains to be managed to protect beneficial uses, and in particular that:

- Land use or works on flood prone areas do not increase the risk during flood events of transportation of materials which would pose a risk to beneficial uses; and
- Waterways and their flood plains retain sufficient flood detention capacity to moderate peak flows to protect the beneficial uses of downstream waterways.

To implement the requirements of the SEPP, Melbourne Water provides more detailed requirements in "*Melbourne Water standards for infrastructure projects in flood-prone areas*", which is provided in Appendix D-2) and requires that all works occurring in the project area meet the following criteria:

- Flood Flow: Works or structures should not affect floodwater flow capacity.
  - This ensures that existing flood levels are not made worse by alterations to the flow characteristics of a floodplain or overland flow path.
- Flood Storage: Works or structures should not reduce floodwater storage capacity.
  - This prevents higher flood levels that may occur if the available storage volume is reduced.
- Freeboard: Works or Structures should not reduce minimum freeboard.
  - This ensures there is no adverse impact on existing property and infrastructure.
- Site Safety Requirements: Works or structures should not create new hazards or increase existing hazard.
  - Development will not be allowed where the depth and flow of floodwaters would create new hazard or increase existing hazards.
- Access Safety Requirements: Access safety requirements should be taken into account.
  - Development cannot be allowed in circumstances where the depth and flow of floodwater affecting access to the property is hazardous.
- Climate Change Requirements: Works or structures must factor in climate change:
  - Sea-level rise – An increase of 0.8 m by the year 2100 is the current standard for sea level rise assessments.
  - Increase in rainfall intensity – Rainfall intensity increase figure must be derived from either the AR&R 2016 Book or the AR&R Data Hub. The adopted figure must reflect the project's asset life and the project's flood protection technical performance requirements.

Melbourne Water also requires the proponent to consider and address where applicable any additional requirements specified in Melbourne Water and industry best practice standards and guidelines, including but not limited to:

- Australian Rainfall & Runoff 2016
- MW's Land Development Manual
- MW's Guidelines for development in flood-prone areas
- MW's Shared user path guidelines.

3.4.2 CONSTRUCTION PHASE

Clause 56 of the SEPP requires construction works be managed to minimise land disturbance, soil erosion and the discharge of sediment and other pollutants to surface waters. The contractor needs to implement effective management practices that are consistent with guidance from the Environment Protection Authority, including that provided in the Environmental Guidelines for Major Construction Sites (EPA 1996), as amended and Construction Techniques for Sediment Pollution Control (EPA 1991), as amended. Where construction activities adjoin or cross surface waters, construction managers need to monitor affected surface waters, to assess if beneficial uses are being protected.

Melbourne Water, in "*Melbourne Water standards for infrastructure projects in flood-prone areas*" (MWC 2018) requires a flood management plan for any temporary works and the impacts need to satisfy the Melbourne Water requirements detailed in Section 3.4.1.2.

The EPA 1996 and EPA 1991 Melbourne Water guideline will also define the performance criteria for construction impact.

4 METHODOLOGY

4.1 KEY ISSUES AND POTENTIAL IMPACTS

This section describes the key construction and operational activities that may impact the quality of receiving waters or increase flooding risk due to the Mordialloc Bypass project.

The key construction activities include:

- Site establishment including clearing of vegetation and establishing compound areas and site facilities
- Earthworks including cut and fill to establish the proposed alignment and design levels for the proposed bypass
- Protection and if necessary, relocation of existing utilities
- Excavations for piling, particularly at the proposed bypass crossing at Mordialloc Creek
- Managing of stockpile material including material excavated from site and transported to site
- Construction of the piling support for the proposed bypass over the existing road at Springvale Road and Governor Road
- Grade separations at Old Dandenong, Centre Dandenong, Governor Road and Lower Dandenong Roads.

It should be noted that there is a potential for acid sulphate soil in the south side of the project area. The assessment of acid sulphate soil impacts and the corresponding mitigation measures required are addressed in the Contaminated Land Management Impact Assessment report (WSP 2018a).

The key operational activities include:

- Increase in impervious area will increase the runoff pollutant loads to the receiving waters
- Increase in impervious area will increase the runoff rate to the receiving waters
- Increase in traffic and potential for fuel and oil spillage as a result of traffic accidents will increase the risk of water sensitive receptors being contaminated by hydrocarbons
- Water bodies identified in SEPP (Waters of Victoria) as with beneficial uses requires protection and are considered as sensitive receptors. Impact to these receptors need to be assessed in accordance with performance criteria set out in Section 3.4. Sensitive nearby receptors to the project include the Edithvale-Seaford Wetlands, Waterways Wetland, Woodlands Industrial Estate Wetlands, Mordialloc Creek and properties and establishments in and adjacent to the existing floodplain of Mordialloc Creek. More discussion of water quality sensitive receptors can be found in Section 5.2.4.

4.1.1 POTENTIAL EFFECTS OF ROAD RUNOFF

Typical pollutants found in road runoff include sediments, hydrocarbons, nutrients and metals. Untreated and undiluted road runoff may result in a deterioration of water quality in the receiving water environment. While some pollutants will be diluted and toxic impacts reduced during high rainfall events, there is a need to treat road runoff prior to discharge into the receiving waters.

The approach used to manage water quality for this project includes incorporating Water Sensitive Road Design (WSRD) elements into the road drainage design, with a particular emphasis on first flush impacts. A key design tool is the use of water quality modelling using the MUSIC software program, which is used to simulate the effectiveness of treatment measures that remove total suspended solids (TSS), total nitrogen (TN), total phosphorous (TP) and litter. Since the majority of heavy metals in road runoff are bound to the sediment, the removal of TSS also gives a good indication of the removal of heavy metals. Further details of the water quality modelling are discussed in Section 4.2.2.1.

4.2 APPROACH TO EXISTING CONDITIONS

To assess the potential impact of the proposed project on the water environment, it is required to first characterise the existing conditions of the water environment and its vulnerability to potential impacts.

Catchments that interact with the project along with key flow paths and the project boundary are shown in Figure 4.1. The existing conditions of these surface waters have been assessed based on a detailed review of background data and previous studies. This review has been supplemented with hydrologic and hydraulic modelling and water quality modelling to provide a detailed quantitative assessment of the existing conditions of the water bodies with beneficial uses/values that could be potentially impacted by the project.

4.2.1 AVAILABLE INFORMATION

The following information relevant to surface water was available for this phase of the assessment:

- Previous studies – reports and models
- Aerial photography
- Topographic data – contours, LiDAR, and feature survey
- Waterway, channel, underground pipe, water body, wetland and other drainage infrastructure GIS data
- As-built drawings
- Drainage Scheme (DS) information
- Planning Scheme Overlays (e.g. LSIO, SBO); and
- Project boundaries.

Surface water overview maps, showing some of the above information, are provided in Appendix A.

Previous studies relevant to the project include:

- Draft Mordialloc Bypass Desktop Hydrology Assessment (GHD, Oct 2016)
- Dingley Bypass Cross-Drainage Hydraulic Assessment, (GHD, Oct 2014)
- Mordialloc Settlement Drain Flood Mapping (GHD, May, 2013)
- Smythes drain/springs drain Bangholme Flooding Investigation Discussion paper (Craigie August 2011); and
- “The waterways” – Mordialloc creek floodplain wetland system, hydrologic, hydraulic, water quality and environmental performance (Neil Craigie et.al January 2000).

A review of these studies in relation to this project is provided in Appendix B.

4.2.2 WATER BODY HEALTH (WATER QUALITY AND FLOW REGIME) ASSESSMENT

4.2.2.1 WATER QUALITY ASSESSMENT

The water quality assessment has been conducted through a combination of desktop data review and MUSIC modelling. The desktop review examined available water quality data and previous study reports to establish the existing conditions of the waterways.

MUSIC modelling was used to establish the existing pollutant loading, contributed by the portion of the catchments affected by the project, on the three key wetlands: Edithvale Wetlands, Woodland Industrial Estate Wetlands and Waterways Wetlands as these are significant environmentally sensitive receptors for which there is limited water quality data available. MUSIC modelling of these wetlands will also enable assessment of the potential change in pollutant loading due to the project through comparison of existing and proposed case models.

For the assessment of water quality on Mordialloc Creek as a whole, impact is assessed based on the ability to achieve pollutant reduction rates as tabulated in Table 3.2 under proposed conditions. Therefore, MUSIC modelling is not used to establish existing pollutant loadings from the road corridor. MUSIC modelling is carried out for each of the road corridor catchments and the total pollutants loading discharge out of the Mordialloc Bypass drainage system as a whole is assessed to ensure the pollutant reduction targets can be achieved for the overall catchment.

4.2.2.2 FLOW REGIME ASSESSMENT

The project will change catchment ground cover characteristics and, possibly, redistribute the flow in waterways downstream of the bypass. It is important to understand the magnitude of such changes on these waterways, especially those waterbodies sensitive to the surface water inflow.

To understand existing flows in the waterways within the vicinity of the project, a review of available stream flow data was conducted. Only one flow gauge was identified within the Mordialloc Creek Catchment, which had an available data record for the period 1975 to 2017. This is located on Dunlops Drain at Citus Street (228358A) (see Figure 4.2). This gauge covers the catchment area of the northern parts of the project. The gauge is considered to provide a suitable record for flow regime analysis to inform the baseline assessment and impact assessment of the project. The flow record at this gauge was used to calibrate the rainfall runoff parameters of the MUSIC model (see Appendix J).

No flow records were available to assess inflow entering key water sensitive receptors such as Edithvale Wetlands (see Figure 4.3) and Woodlands Industrial Estate Wetlands (see Figure 4.2). The water balance model developed for Edithvale Wetlands is also used to assess the holistic hydrological impacts on Edithvale wetlands; accounting for the surface water and groundwater impacts of the project. Details of the modelling and assessment can be found in the Groundwater Impact Assessment Report (WSP 2018b). Flows in other water sensitive receptors have been simulated by rainfall runoff modelling using MUSIC with calibrated rainfall runoff parameters established from the Dunlops Drain calibration as discussed above. The 1952 to 1961 rainfall period is adopted as the simulation period. This period is the period recommended in the Melbourne Water Music Guideline *Input parameters and modelling approaches for MUSIC users in Melbourne Water's service area* (Melbourne Water 2018) for this region. Simulation was also carried out for the 1975 to 2017 period to check the sensitivity of the impact assessment on different rainfall conditions.

It should be noted that a flow regime assessment was not carried out for Waterways Wetlands as the flow impact on this wetland is localised to the Braeside overflow cell and the impacted area (about 10 ha) is minor compared to the overall 2720 ha catchment area for the wetlands. In addition, the bypass will be constructed between the Braeside overflow cell and the Open water cells in the Waterways Wetlands. This is could potentially change the hydraulic conveyance capacity of the weir and channel between the cells. Due to lack of site details at these locations, the change in hydraulic conveyance capacity is not assessed in this report but to be specified as design requirements during detailed design.

The flow regime assessment used flow duration curves that are generated based on the recorded or simulated flows.

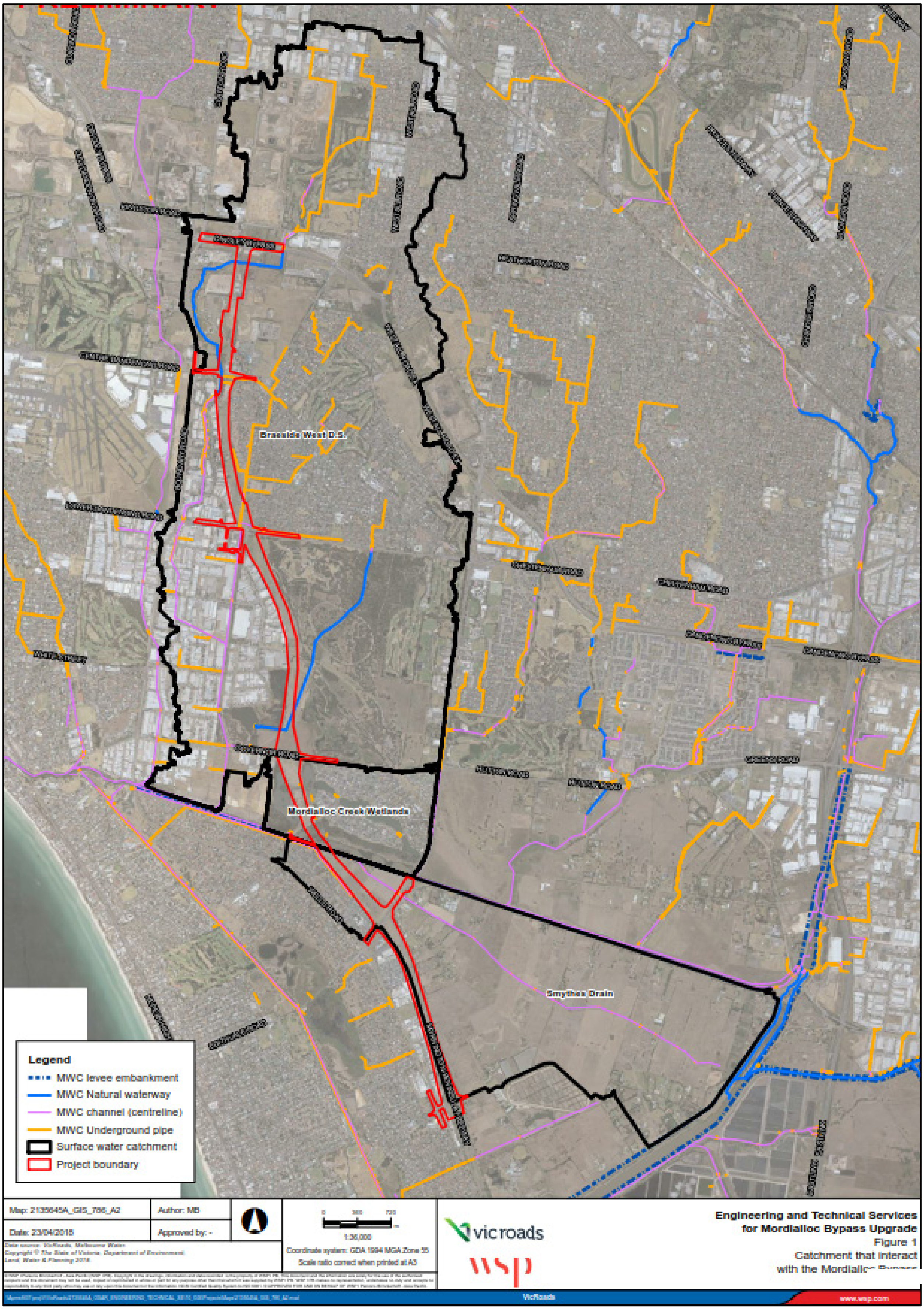

Figure 4.1 Catchments that interact with the Project

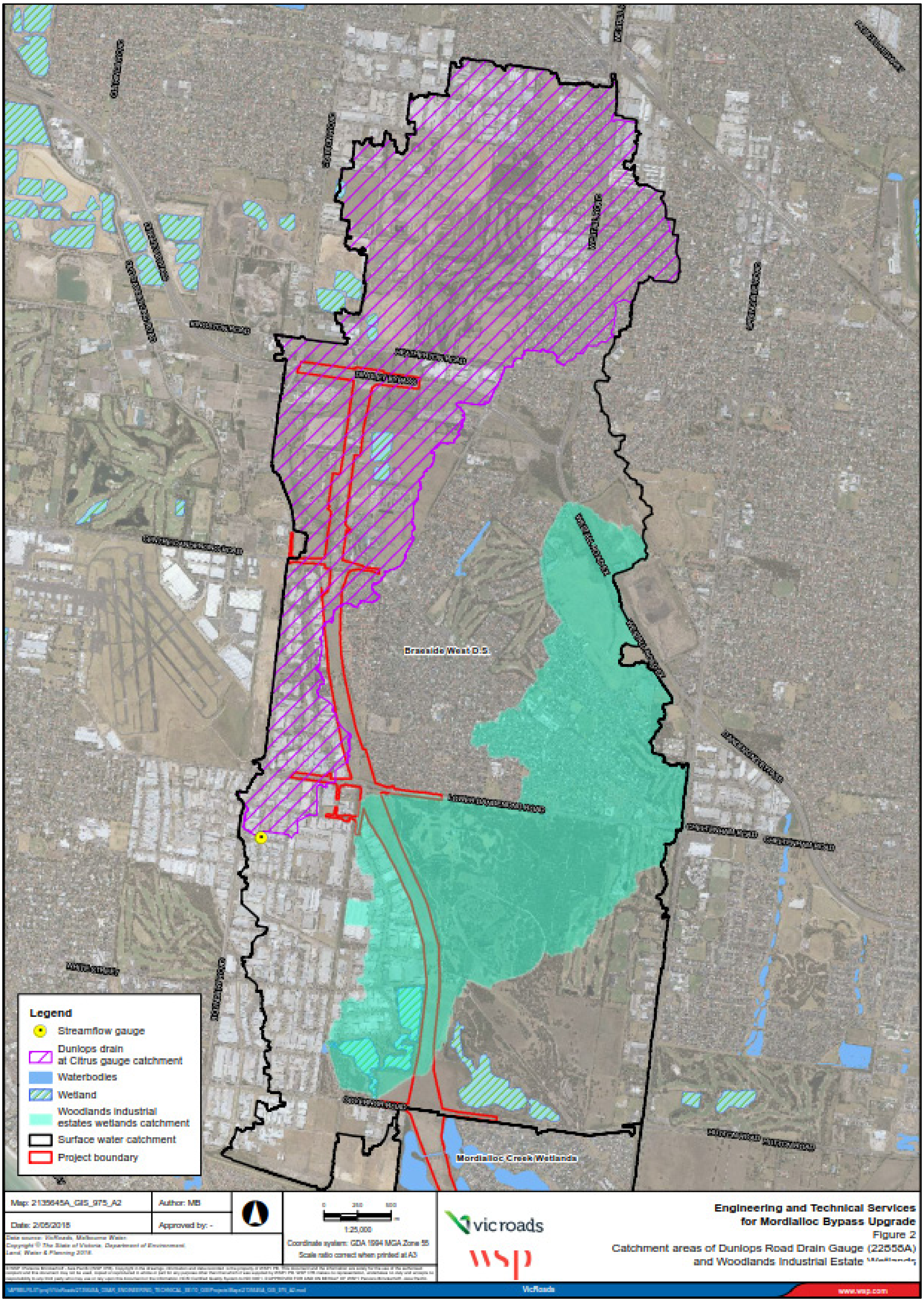

Figure 4.2 Catchment areas of Dunlops Rd Drain Gauge (228358A) and Woodlands Industrial Estate Wetlands

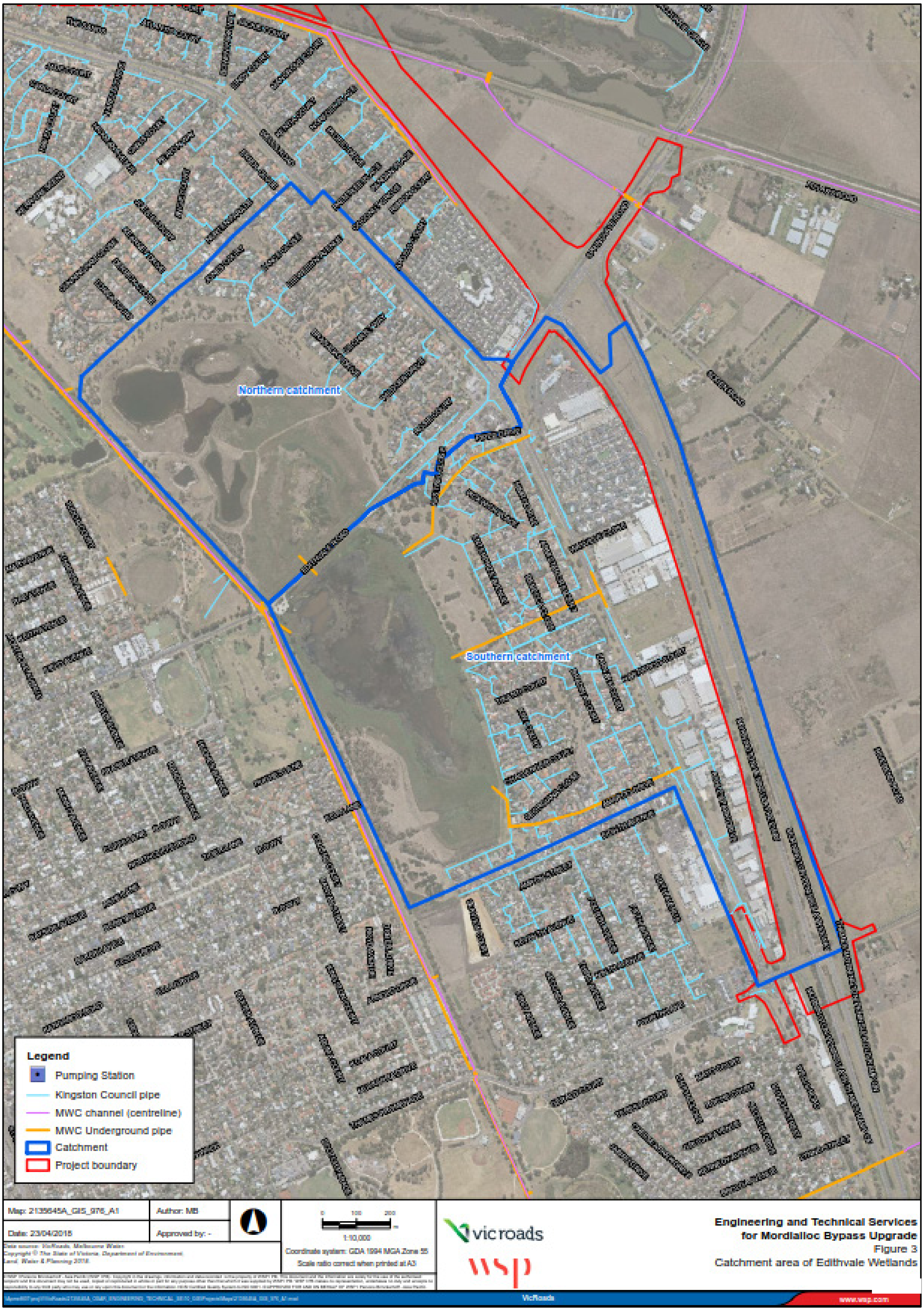

Figure 4.3 Catchment area of Edithvale Wetlands

4.2.3 FLOOD CONDITIONS ASSESSMENT

Hydrologic and hydraulic modelling (flood modelling) was undertaken for the project area and its contributing catchment. The purpose of the flood modelling is to define existing flood conditions in the project area to enable a detailed analysis of flood impacts and the subsequent investigation of mitigation options.

The approach to flood modelling in the study area was to undertake hydrologic modelling using RORB and 2-dimensional hydraulic modelling using TUFLOW. The RORB model was used to determine rainfall excess hydrographs as inflows for the TUFLOW hydraulic model.

The creation of base case hydrologic (RORB) and hydraulic (TUFLOW) models comprised the following tasks:

- Regular consultation with Melbourne Water to confirm on modelling methodology and input data.
- Review the available data and information which define the basis of modelling.
- Develop the hydrologic modelling methodology and undertake the modelling using RORB:
  - Three RORB models were obtained from previous studies and updated with latest catchment conditions. A separate RORB model was developed for the Smythes Drain catchment at the southern end of the project.
  - Rainfall depth and temporal patterns, based on AR&R 1987 procedures, were used to run the model to generate runoff hydrographs for input to the hydraulic models. Melbourne Water (MWC 2018) requires the use of AR&R 2016 procedures for the flood assessment. The flood assessment for the project has proceeded in advance of the formal adoption of the AR&R 2016 guideline. Therefore, continued use of the AR&R 1987 has been discussed and agreed with Melbourne Water
- Develop the hydraulic modelling methodology and undertake the modelling using TUFLOW:
  - The ‘North’ TUFLOW model was developed based on the 2013 Mordialloc Settlement Drain TUFLOW model (2013 TUFLOW model) and covers the section of the Mordialloc Bypass between Dingley Bypass and Mordialloc Creek; including the Dingley Bypass.
  - The new ‘South’ TUFLOW model was established for this study and covers the section of the Mordialloc Bypass between Mordialloc Creek and Thames Promenade.
- Presentation of flood mapping and the outlining of key assumptions and limitations associated with the modelling.

A range of design flood events have been assessed under the existing scenario, specifically the 20%, 5% and 1% Annual Exceedance Probability (AEP) and climate change events. Blockage factors were applied to proposed culverts and the level of blockage were determined in accordance with the ARR 2016 procedures.

4.3 RISK ASSESSMENT

As outlined in the Ministerial Guidelines for Assessment of Environmental Effects (2006) and the Scoping Requirements for the Mordialloc Bypass Project EES (2018), a risk-based approach was adopted for the EES studies to direct a greater level of effort at investigating matters that pose relatively higher risk of adverse environmental effects. The following definitions were adopted for the assessment:

- Environmental impact: is described as any change to the environment as a result of a project activities.
- Environmental risk: As defined by the Ministerial Guidelines for Assessment of Environmental Effects Under the Environment Effects Act 1978 (DSE, 2006), “Environmental risk reflects the potential for negative change, injury or loss with respect to environmental assets”.

The purpose of the risk assessment was to provide a systematic approach to identifying and assessing the environmental risks, including heritage, cultural, social, health, safety and economic aspects as a result of the project. It articulates the likelihood of an incident with environmental effects occurring and the consequential impact to the environment.

The impact assessment and risk assessment processes were integrated throughout the development of the EES. The environmental risk assessment (ERA) process allowed the project team to identify as many environmental risks as a result of the project as possible and refine and target impact assessments accordingly. The impact assessments ensured the project team has a robust understanding of the nature and significance of impacts and the mitigation measures developed to minimise and control those impacts.

The risk and impact assessment processes were essential components of the project design process and in the formulation of construction and additional mitigation measures to minimise environmental impacts. These assessments also underpin the establishment of the Environmental Performance Requirements (EPRs), which set out the desired environmental outcomes for the project.

The below methodology was developed to assess the potential impacts of the Mordialloc Bypass on surface water and sets out the process, methods and tools used to complete the impact and risk assessments.

4.3.1 RISK ASSESSMENT METHODOLOGY

The risk assessment is a critical part of the EES process as it guided the level and extent of impact assessment work required and facilitated a consistent approach to risk assessment across the various technical disciplines. The risk assessment process was based on the approach defined in *ISO 31000:2018 Risk Management – Principles and Guidelines*, which describes an environmental risk management process which is iterative and supported by ongoing communication and consultation with project stakeholders. The ERA process incorporated VicRoads key risk management requirements, specifically from the VicRoads Environmental Risk Management Guidelines (2012) and the VicRoads Environmental Sustainability Toolkit (2017).

SCOPE AND BOUNDARIES

The ERA assessed all project phases, namely: Initial Phase (the current approvals and concept design stage); Construction Phase; and Operations and maintenance Phase. The risk process evaluated environmental risks that would result from the development of the project based on the concept designs for the project, the draft construction methodology and the existing conditions of the study area, as well as the draft environmental impact assessment reports which were in development during the ERA.

RISK IDENTIFICATION

To effectively and comprehensively recognise all potential environmental risks that may result from the project, it was necessary to identify impact pathways for all project activities during all its project phases. An impact pathway is the cause and effect pathway or causal relationship that exists between a project activity and an asset, value or use of the environment

Environmental impact pathways were identified under two categories:

- Primary environmental impacts: The impacts to environmental values that are directly attributable to project activities within a cause and effect paradigm. Project activities cause environmental impacts (effects) on environmental values through an environmental impact pathway such as construction activities. The assessment of these impacts and their associated risks assumes that all standard mitigation measures are in place and working as intended.
- Cumulative impacts: The potential cumulative impacts to environmental values that may result from the implementation of the project. This allowed for the identification of:
  - Secondary environmental risks which may result from the implementation of a risk response in mitigating a primary environmental risk
  - On-site aggregate risks resulting from multiple on-site project activities on an environmental asset (risks were assessed in two ways, as a single project phase and as a whole project risk)
  - Off-site cumulative environmental risks which accounted for potential off-site cumulative impacts of the Mordialloc Bypass project in conjunction with surrounding off-site projects in the local area.

RISK ANALYSIS

With risks identified for each discipline, VicRoads and industry best practice and standard mitigation controls that are considered intrinsic to a project of this nature were identified, including requirements under relevant sections of the VicRoads Standard Specifications, EPA guidelines and Government environmental management policies.

RISK EVALUATION

The ERA process developed for the project is based on the risk analysis matrix used on recent and similar MRPA projects, as presented in Table 4.1. It follows the standard industry semi-quantitative risk analysis methodology that utilises pre-defined consequence and likelihood criteria as the factors to arrive at a risk rating.

4.3.1.1 CUMULATIVE EFFECTS

The ERA process also allowed for the assessment of cumulative effects (CE) associated with the project. CE result from multiple influences/impacts on an environmental asset and can be assessed in two categories.

- Aggregate: Where there are multiple activities within the project that impact on a single asset. Aggregate risks were included as additional risk pathways in the risk register.
- External projects: current project risks that could, when compounded with those of surrounding projects, lead to an overall increase in the environmental impact of the project. Each impact pathway was reviewed to determine if a potential cumulative effect existed.

4.3.1.2 RISK EVALUATION

The ERA process developed for the project is based on the risk analysis matrix used on recent and similar MRPA projects, as presented in Table 4.1. It follows the standard industry semi-quantitative risk analysis methodology that utilises pre-defined consequence and likelihood criteria as the factors to arrive at a risk rating.

Table 4.1 Risk assessment matrix

			LIKELIHOOD				
CONSEQUENCE	**Risk Categories**		**Rare**	**Unlikely**	**Possible**	**Likely**	**Almost Certain**
			A	**B**	**C**	**D**	**E**
	Catastrophic	**5**	Medium	High	High	Extreme	Extreme
	Major	**4**	Medium	Medium	High	High	Extreme
	Moderate	**3**	Low	Medium	Medium	High	High
	Minor	**2**	Negligible	Low	Low	Medium	Medium
	Insignificant	**1**	Negligible	Negligible	Negligible	Low	Low

Based on the project objectives and context, a set of project-specific and appropriate likelihood and consequence criteria were developed in consultation with MRPA, the TRG and technical specialists Table 4.2.

Table 4.2 Risk assessment likelihood categories

LIKELIHOOD				
Less than once in 12 months OR 5% chance of recurrence during course of the contract	Once to twice in 12 months OR 10% chance of recurrence during course of the contract	3 to 4 times in 12 months OR 30% chance of recurrence during course of the contract	5 to 6 times in 12 months OR 50% chance of recurrence during course of the contract	More than 6 times in 12 months OR 100% chance of recurrence during course of the contract
The event may occur only in exceptional circumstances	The event could occur but is not expected	The event could occur	The event will probably occur in most circumstances	The event is expected to occur in most circumstances
It has not happened in Victoria but has occurred on other road projects in Australia.	It has not happened in the greater Melbourne region but has occurred on other road projects in Victoria	It has happened in the greater Melbourne region	It has happened on an road project in the region in the last 5 years	It has happened on a road project of similar size and nature in the region within the last 2 years. OR It has happened multiple times on a road project in the region within the last 5 years.
Rare	Unlikely	Possible	Likely	Almost Certain
A	B	C	D	E

Table 4.3 Surface water environmental risk assessment consequences descriptors

		Descriptors (adopted from all)				
Discipline	**Aspects**	**Insignificant**	**Minor**	**Moderate**	**Major**	**Catastrophic**
Environmental effects						
Surface Water						
	Construction impact on water quality	State Environment Protection Policy (SEPP) (Waters of Victoria), VicRoads Water Management Guidelines water quality standards, BPEM standard and the requirements set out by Melbourne Water in Mordialloc Bypass Performance Criteria for SWQ Treatment met across the region	Temporary isolated and marginal exceedance of SEPP (Waters of Victoria) and VicRoads Water Management Guidelines	Marginal, temporary exceedance of SEPP (Waters of Victoria) and VicRoads Water Management Guidelines in a local area	Significant exceedance of SEPP (Waters of Victoria) and VicRoads Water Management Guidelines in a number of local areas	Widespread exceedance of SEPP (Waters of Victoria) and VicRoads Water Management Guidelines across the region
	Operations impact on water quality	State Environment Protection Policy (SEPP) (Waters of Victoria), VicRoads Water Management Guidelines water quality standards, BPEM standard and the requirements set out by Melbourne Water in Mordialloc Bypass Performance Criteria for SWQ Treatment met across the region	Temporary isolated and marginal exceedance of SEPP (Waters of Victoria) and VicRoads Water Management Guidelines	Marginal, temporary exceedance of SEPP (Waters of Victoria) and VicRoads Water Management Guidelines in a local area	Significant exceedance of SEPP (Waters of Victoria) and VicRoads Water Management Guidelines in a number of local areas	Widespread exceedance of SEPP (Waters of Victoria) and VicRoads Water Management Guidelines across the region
	Design changes surface water and flow regime	No detectable change to waterway, river health and flow regime	Temporary and reversible changes to waterway, river health or flow regime with minor implications	Temporary and reversible changes to waterway, river health or floodplain function with moderate implications	Waterway, floodplain function or river health significantly compromised with permanent localised effects	Extensive impact to waterway or floodplain function OR river health irreversibly disturbed with regional effects
	Design increases flooding impacts	Flooding impacts comply with the requirements set out by "Melbourne Water in "Melbourne Water standards for infrastructure projects in flood-prone areas".	Flooding impacts comply with the requirements set out by Melbourne Water in "Melbourne Water in "Melbourne Water standards for infrastructure projects in flood-prone areas". However, flooding and overland flows confined to existing flood fringe land and flood hazard category (as defined in the Australian Rainfall & Runoff Guidelines 2016) remaining unchanged.	Flooding impacts do not fully comply with the requirements set out by Melbourne Water in "Melbourne Water in "Melbourne Water standards for infrastructure projects in flood-prone areas". Flooding and overland flows that cause existing flood-free land to become flood prone with a flood hazard category of H1 OR causing existing flood prone land to experience an increase in flood hazard by one category (as defined in the Australian Rainfall & Runoff Guidelines 2016).	Flooding impacts do not fully comply with the requirements set out by Melbourne Water in "Melbourne Water in "Melbourne Water standards for infrastructure projects in flood-prone areas". Flooding and overland flows that cause existing flood-free land to become flood prone with a flood hazard category between H2 and H4 OR causing existing flood prone land to experience an increase in flood hazard for more than one category but not higher H4(as defined in the Australian Rainfall & Runoff Guidelines 2016).	Flooding impacts do not fully comply with the requirements set out by Melbourne Water in "Melbourne Water in "Melbourne Water standards for infrastructure projects in flood-prone areas". Flooding and overland flows that cause existing flood-free land to become flood prone with a flood hazard category of H5 or higher OR causing existing flood prone land to experience an increase in flood hazard to category H5 or higher (as defined in the Australian Rainfall & Runoff Guidelines 2016).
	Construction effects on protected beneficial uses	Impact on beneficial uses, as defined in the EPA State Environmental Planning Policy (SEPP) (Waters of Victoria) under Policy area Cleared Hills and Coastal Plains and Port Philip Bay (Schedule F6), are managed to be within the requirements set out in the EPA State Environmental Planning Policy (SEPP) (Waters of Victoria), Melbourne Water performance criteria and EPA construction practice guides (Doc. 275 & 480).	Short term (Construction), localised (single point source) impact on beneficial uses, as defined in the EPA State Environmental Planning Policy (SEPP) (Waters of Victoria) under Policy area Cleared Hills and Coastal Plains and Port Philip Bay (Schedule F6).	Short term (Construction), whole alignment impact on beneficial uses, as defined in the EPA State Environmental Planning Policy (SEPP) (Waters of Victoria) under Policy area Cleared Hills and Coastal Plains and Port Philip Bay (Schedule F6).	Long term (beyond construction phase of Project), whole alignment impact on beneficial uses, as defined in the EPA State Environmental Planning Policy (SEPP) (Waters of Victoria) under Policy area Cleared Hills and Coastal Plains and Port Philip Bay (Schedule F6).	Irreversible or long term (beyond construction phase of Project), regional impact on beneficial uses, as defined in the EPA State Environmental Planning Policy (SEPP) (Waters of Victoria) under Policy area Cleared Hills and Coastal Plains and Port Philip Bay (Schedule F6).
	Cumulative Effects	Scope and Boundaries: The score of the cumulative impact are to assess cumulative impact of all known proposed works in the upcoming 2 years within the Mordialloc Creek catchment that could have effect on the quantity and quality of surface waters in the water environments, which are identified to be with beneficial uses or values. The scope cumulative impact assessment are impacts on surface water qualitya nd quantity during operation phase.				

For all risks rated medium, high or extreme in the initial risk rating, technical specialists were required to identify additional controls which could be implemented to further reduce risk and to perform the residual risk rating. Additional controls specify management measures over and above those considered as Standard Controls to ensure the residual risk has been effectively avoided or mitigated to as low as reasonably practicable.

Where risks could not be eliminated or sufficiently reduced (e.g. by engineering controls or re-design), these will typically be addressed by specific conditions in a site Environmental Management Plan (EMP), or be the subject of a separate management plan, including adaptive management plans based on ongoing studies or monitoring.

ENVIRONMENTAL PERFORMANCE REQUIREMENTS

Following the evaluation of risk and through consultation with MRPA, EPR's were developed to define, relevant, achievable and measurable environmental outcomes for the project. The mitigation measures identified during the risk assessment process were used to inform the EPRs and also specify the means by which the EPRs are to be satisfied. The EPRs to surface water are referenced in Table 6.1 and Table 6.2; and outlined in Table 8.1.

4.4 IMPACT ASSESSMENT

4.4.1 OPERATIONAL PHASE IMPACTS

The operational phase impact assessment assesses the impacts of the project against the performance criteria detailed in Section 3.4. The water quality and flood models used to assess existing conditions are modified to represent the change in catchment conditions due to the proposed works. The change in catchment conditions includes the changes in road geometry and drainage infrastructure; change in catchment imperviousness and change in pollutant export rate.

For the three wetlands, total pollutant loading and flow from the affected areas to the wetlands under existing and proposed conditions are compared and assessed against the performance criteria.

4.4.2 CONSTRUCTION PHASE IMPACT

The potential stormwater and flooding impacts for the project needs to be assessed in two categories before the start of the construction:

- Floodplain management – aspects of construction stage that may increase flood risk by reducing floodplain storage and hydraulic conveyance of existing drainage systems affected by the construction. Melbourne Water applies the 1% AEP flood event as the reference event against which to assess impacts associated with major construction works. Nevertheless, Melbourne Water considers all events up to and including the 1%AEP event for impact assessment during the construction phase.
- Water quality management – aspects of the construction approach that may have the potential to reduce water quality of receiving waters. The potential increase in suspended solid and other pollutants in stormwater discharging out of the construction sites will need to be managed to avoid impact downstream of the site. There is potential for acid sulphate soil in the southern part of the project area that management plan is required and this is detailed in the Contaminated Land Management Impact Assessment Report (WSP 2018a).

The construction stage impact assessment does not seek to specify particular solutions to manage stormwater and flooding risk as these risks are dependent on the chosen construction methods and sequence of construction. The impact assessment identifies standard engineering preventative measures and principles that can be applied to mitigate adverse stormwater and flooding impacts.

4.5 CLIMATE CHANGE

4.5.1 WATER QUALITY AND FLOW REGIME

To understand the potential effect of climate change on the water quality and flow regime of the study area, the MUSIC model was used to simulate a climate change scenario using an adjusted 1951 to 1962 reference period rainfall time series and potential evapotranspiration rate. The adjustments were based on the “Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria” (DELWP 2016) and the detailed calculations are provided in Appendix G. Since only information on years 2040 and 2065 are available in the Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria (DELEP 2016), year 2065 was selected to provide a longer term overview of the WSRD preformance.

4.5.2 FLOODING

The 1% AEP event for the climate prediction for 2100 has been assessed to develop an understanding of the impact of the project under a climate change scenario. In accordance with the Melbourne Water guidelines (MWC2018), the 2100 climate scenario should be incorporates with a 0.8 metre increase in sea level and increase in rainfall intensity in accordance with AR&R 2016 procedures. The flood assessment for the project has proceeded in advance of the formal adoption of the AR&R 2016 guideline. Therefore, the climate change assessment incorporates the same increase in sea level but 19% increase in rainfall intensity as specified in a previous Melbourne Water requirements document. Since, this value is very close to the AR&R 2016 estimates of for year 2090 (RPC 8.5, temp class interval = much hotter), 19% increase in rainfall intensity is considerd as adequate to represent the change in rainfall intensity due to climate change.

There are additional flows from catchments outside the Mordialloc Creek catchment (and hence outside the extent of the hydrological models) that are diverted into the catchment. Time series of these inflows have been extracted from previous studies and are input into the hydraulic models. For the climate change scenario, a 1.19 multiplier was applied to these inflow time series. This approach is considered as reasonable in the absence of any reliable information on how such flows were derived. Although this is not strictly in line with the Melbourne Water recommendation of a 19% increase in rainfall intensity under climate change conditions, the difference is minor especially these additional flows only constitute a small proportion of the total inflow.

4.6 STAKEHOLDER ENGAGEMENT

This surface water study has involved consultation with a wide range of stakeholders through the Technical Reference Group (TRG) and meetings with Melbourne Water. Meetings with Melbourne Water included regular interface general meetings and several more specific technical meetings. In additional, Kingston City Council were also consulted through representatives in the TRG, phone conservations and emails. Key communications are highlighted in the followings sections.

4.6.1 MELBOURNE WATER REQUIREMENTS

Melbourne Water have developed a series of technical requirements documents specifically for Mordialloc Bypass. The Melbourne Water requirements relating to surface water are provided in Appendix D.

4.6.2 MELBOURNE WATER PLANNED WORKS

The Mordialloc Bypass project crosses two Melbourne Water drainage schemes, has a short interface with a further two schemes and will occur downstream of one scheme:

- Bowen Road DS (1124) – shows planned channel on Smythes Drain across project alignment
- Gartsides South DS (1107) – scheme has been completed
- Gartsides North DS (1111) – upstream of project
- Carrum Lowlands DS (1101); and
- Braeside South DS (1128) – shows planned wetland on northern side of Mordialloc Creek.

The planned works which interface with the Mordialloc Bypass project include the proposed channel along Smythes Drain which crosses the project alignment.

4.6.3 CITY OF KINGSTON

A phone discussion was held with City of Kingston (KCC, West/WSP, Lam) on 19 January 2018 to discuss the council's key concerns and issues. The conversation notes are presented in Appendix K.

4.7 ASSUMPTIONS AND LIMITATIONS

The surface water assessment is based on the following assumptions and limitations:

- It is assumed that the extents of both temporary works and permanent works will be limited to the project boundary.
- The accuracy of the flood model is reliant upon the accuracy of the input information, including digital elevations model and drainage infrastructure details.

5 EXISTING CONDITIONS

5.1 REGIONAL CONTEXT

5.1.1 DANDENONG CATCHMENT

According to the Melbourne Water Healthy Waterways Strategy, waterways within the Dandenong catchment support multiple and varied uses and values, including flood mitigation, significant plant and animal species (including platypus, dwarf galaxias, growling grass frogs) and amenity.

There has been extensive modification to rivers and creeks for flood protection (e.g. pipe, concrete lining and channel straightening) within the Dandenong catchment. The Dandenong Valley Authority Act 1963 established the Dandenong Valley Authority, the responsibilities of which were transferred to Melbourne Water under the Melbourne Water Corporation Act 1992.

A large number of ecologically and culturally significant wetlands occur throughout the Dandenong system. These include natural and semi-natural wetlands such as Edithvale-Seaford Wetlands, Wannarkladdin Wetlands and Boggy Creek Waterway Reserve and large constructed wetlands such as Dandenong Valley, Hallam Valley and Boggy Creek Stormwater Wetland.

The project is located within the Dandenong major catchment area, within the Mordialloc Creek waterway system.

5.1.2 MORDIALLOC CREEK

The Lower Dandenong Creek, Patterson River and Mordialloc Creek were all created to drain the once extensive Carrum Carrum Swamp that existed prior to European settlement. Dandenong Creek flows into Mordialloc Creek and the Patterson River via diversion structures upstream of Perry Road in Dandenong South. The main tributaries of Mordialloc Creek include the Haileybury Drain, Keysborough South Drain, Smythes Drain, Heatherton Drain, Mordialloc Settlement Drain and Braeside West Drain. Key sites within the catchment include Karkarook Lake and Wetlands, Woodlands Wetlands, Mordialloc Creek Wetlands (also known as Waterways wetlands) and several retarding basins.

The Edithvale-Seaford Wetlands are remnant ecosystems in the southern part of this system. They have cultural significance as the last and deepest remnant of the once extensive Carrum Carrum Swamp. Listed under the Ramsar convention, they are internationally significant, providing important habitat for a variety of birds and wildlife.

The Healthy Waterways strategy lists the following management objectives for Edithvale-Seaford wetlands:

- Frogs: improve abundance, distribution of expected species and species richness
- Vegetation: maintain vegetation to high quality; and
- Amenity: improve level of amenity.

5.2 CATCHMENT DESCRIPTION

The project area is largely located within the designated Braeside West and Mordialloc Creek Wetlands (also referred to as ‘Waterways’) and Smythes Drain surface water catchment. These three catchments are described below: The Braeside West catchment covers an area of approximately 21 km² within the municipalities of Kingston and Greater Dandenong (GHD, 2013). It consists of several different land use types including residential, industrial, special use and green wedge zones. The main drainage asset for this catchment is the Braeside West Drainage line which discharges to the Mordialloc Main Drain approximately 1 km east of the Wells Road Bridge.

The Mordialloc Creek Wetlands catchment is very flat and covers an area under two square kilometres within the municipality of Kingston. It consists of medium to high density development surrounding a wetland and lake system. Drainage is through the network of wetlands and eventual discharge into the Mordialloc. Both the Braeside West and

Waterways Wetlands contribute tributary runoff flow to and bounded by Mordialloc Creek to the south. Mordialloc Creek can be described as an artificial estuarine waterway which discharges to Port Phillip Bay and is bounded by levee embankments (Craigie et al., 2000).

A southern portion of the project boundary will occur within the Smythes Drain catchment area which is separated from Mordialloc Creek via a levee bank and drains to the 'Bowen Road DS' open channel drain. Smythes Drain occurs within the municipalities of Greater Dandenong and Kingston and has a catchment area of approximately seven square kilometres. The catchment consists predominantly of green wedge conservation zones and is described as being very flat with no external stream or drain flow to enter across its boundaries, particularly from neighbouring Mordialloc Creek (Craigie, 2011). The Smythes /Bowen Road DS catchments are separated from Mordialloc Creek by a constructed levee and there is a Melbourne Water pump station near Wells Road that pumps water from this catchment into Mordialloc Creek (Craigie, 2011). It is assumed that backflow through the pump station is not possible, therefore the catchment is not tidally influenced. At the interface with Patterson River, 1% AEP flood levels provided by Melbourne Water were noted to be lower in the Smythes catchment than the river banks' top elevations (read from LiDAR topography).

The Mordialloc Bypass project crosses the following drainage lines (South to North):

- Smythes Drain open channel, east of Bowen Parkway – covered by LSIO
- Mordialloc Creek Wetlands, between Mordialloc main drain and Governor Road – covered by LSIO
- Dingley Drain open channel – covered by LSIO
- Lower Dandenong Road
  - Gartsides South Drainage Scheme open channel – covered by SBO
  - Gartsides Drainage Scheme underground drainage – covered by SBO
  - Braeside West Drainage Scheme open channel – covered by LSIO
- Centre Dandenong Road
  - Old Dandenong Road Drain waterway – covered by SBO
  - Gartsides North Drainage Scheme underground drainage– covered by SBO; and
- Old Dandenong Road Drain waterway.

A surface water overview map is provided in Appendix A and the major catchments affected by the Mordialloc Bypass are shown in Figure 4.1.

5.2.1 EDITHVALE WETLAND

The Edithvale–Seaford Wetlands are significant wetlands in supporting migratory birds and were listed under the Ramsar Convention in 2001. It is one of few Australian Ramsar sites entirely situated within an urban landscape. The Edithvale-Seaaford Wetlands is listed as a wetland of international importance and recognised under the Ramsar Convention because (KBR 2009):

1. The wetlands are considered internationally important as they contain a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
2. The wetlands are considered internationally important as they support vulnerable, endangered, or critically endangered species or threatened ecological communities.
3. The wetlands are considered internationally important as they regularly support 1% of the individuals in a population of one species or subspecies of waterbird.
4. The wetlands are considered internationally important as they support populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
5. The wetlands are considered internationally important as they support plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.

Hydrologically, Edithvale Wetland is a significant water body receiving water mainly from the regional drainage system. The key hydrological functions of the wetlands are as follows (Ecology 2016):

- Receives, retains and diverts urban stormwater and other surface run-off
- Provides a critical flood storage capacity that protects surrounding and downstream properties from flooding; and
- Contributes to protecting the water quality of Port Phillip Bay by retaining and treating urban stormwater and other run-off.

Edithvale Wetland is divided into North and South Sections:

- Edithvale South Wetlands
  - Edithvale South Wetlands comprises a natural depression on the south side of Edithvale Road with the lowest point being 0.3 m below sea level (GHD 2006).
  - Edithvale South Wetlands are predominantly fed by three drains from catchments to the east which initially enter sediment ponds at the edge of the macrophyte zone. The winter and spring standing water level generally sits at around 0.00 m Australia Height Datum (AHD), but rises up to 0.78 mAHD during rain events and discharges to Edithvale North Wetlands and Centre Swamp Drain. The sill level of the pipe (inverted siphon) connecting to the North Wetlands is -0.02 mAHD, and therefore, any water above that level discharges to Edithvale North Wetlands. Reduced rainfall during summer and autumn and evaporation can cause water levels to drop below 0.00 mAHD.
  - A manually operated pump on Centre Swamp Drain can pump water when the drain holds water into the South Wetlands during dry periods.
- Edithvale North Wetlands
  - Edithvale North Wetland predominantly comprises a series of constructed wetlands within the former floodplain on the north side of Edithvale Road.
  - Stormwater enters the wetland from stormwater drains from the east via two sediment ponds and from Edithvale South Wetland via a pipe under Edithvale Road.
  - A series of weirs control flow of water between different wetland cells and limit total drawdown during prolonged dry or drought conditions. Stormwater supplies these cells from a series of drains and overland flow.

5.2.2 OTHER KEY WETLANDS

In additional to Edithvale Wetlands there are a number of key wetlands. They include:

- Braeside Wetlands – Braeside wetlands is a constructed wetland that forms part of Braeside Park upstream of the project. The Bypass will have limited impact on the flow regime of Braeside Wetlands except during flooding. During flooding, the Bypass could induce backwater to the Wetlands.
- Mordialloc Creek Wetlands (Waterways Wetlands) – The Waterways Wetlands is comprised of two systems: Mordialloc Creek system at the southern side and four constructed wetland cells, forming a treatment train for stormwater from the 2720 ha urban area that drains to it. In addition, these wetlands are, from time to time, topped up by diverted flow from Dandenong Creek and backwater from Mordialloc Creek during flooding periods. The Bypass will be located within a strip of land between the Braeside Overflow Cell in the west and the three Riparian and Open Water wetland Cells in the east. The main interaction of the Bypass is the localised discharge from the Bypass to the Overflow cell and the change in hydraulic conveyance for the connection between the Overflow cell and the Open Water cells. During low flow, the Overflow cell and the Open Water cells are connected by channel running through the strip of land separating the cells. The strip of land is also the footprint of the proposed Bypass. During flooding, flood flow is mainly conveyed from east to west through the overland surface this strip of land. This northern half of this land and the existing channel will be blocked by the proposed Bypass embankment while the southern portion will not be blocked as a bridge is proposed across the southern portion of the land. Suitable drainage system is required to maintain both the low flow and flood flow across the Bypass. This means that the

water transfers behaviour between the cells could be changed and the Bypass could induce backwater affecting the Waterways Wetland and the residential area east of the Bypass during floods.

- Woodland Industrial Estate Wetlands – The constructed wetlands in the gum trees and open area part of the Woodlands Industrial Estate, which commenced in 1992 and completed in 2003. It is located downstream of the project, and as such, the change in land use due to the project could have implications on the flow regime and water quality of the flow entering these wetlands.

5.2.3 WATER ENTITLEMENTS

A search of the Victorian Water Register listed 20 irrigation schemes and 4 Industrial/Commercial schemes that harvest surface water using an off-waterway dam or directly extract from Mordialloc Creek and Dingley Stormwater Drain. The total volume of water harvested or extracted is 1,803 ML/a.

The quality of stormwater runoff from the proposed road will affect the quality of the water extracted by these users. Also, an understanding of these water entitlements should be gained prior to the construction phase and should inform the surface water risk assessment and management procedures within the CEMP.

5.2.4 KEY WATER SENSITIVE RECEPTORS WITHIN THE CATCHMENT

Based on the discussion in previous sections, the key water sensitive receptors that require detailed assessment include:

- Edithvale Wetlands, Woodland Industrial Estates and Waterways Wetlands with beneficial uses for aquatic plants and animals. In addition, Edithvale Wetlands, according to Schedule B of the SEPP, are classified as “areas of high conservation value” which is a prioritised area for the protection and maintenance of beneficial uses. In particular, Edithvale Wetlands is Ramsar listed wetlands.
- Mordialloc Creek and Dingley Stormwater Drain with beneficial uses for industry and agriculture water users, and aquatic plants and animals.

5.3 WATER BODY HEALTH (WATER QUALITY AND FLOW REGIME)

5.3.1 WATER QUALITY

5.3.1.1 WATERWAYS AND DRAINS

Regular water quality data was collected at two sites in the Mordialloc Creek catchment (DELWP 2017). They are (see Figure 5.1):

- Mordialloc Creek at Wells Road, Mordialloc (Site ID: DAMOR0028); and
- Heatherton Drain at Bear St. Mordialloc (Site ID: DAHEA0014).

Since the Heatherton Drain site is located within a catchment outside the area of influence of the project, only the water quality at Wells Road is relevant to the proposed works. This site reflects the existing water quality conditions of Mordialloc Creek at a location downstream of the project.

Water quality data at Wells Road for the period 1994-2017 are presented in Appendix F and compared against the WQOs of both the existing and proposed SEPP. The figures in Appendix F show non-compliance of the existing water quality with WQOs for most of the indicators and metals. The exception is Nickel, for which non-compliance only occurred occasionally. However, the non-compliance is reducing over time except for DO and Salinity. Lead and Cadmium concertation comply with the WQOs about half of the time and approached compliance in 2016. Arsenic, Nickel and pH comply with WQOs for the majority of the time and exhibit an improving trend, with full compliance achieved in 2016 for Nickel and pH.

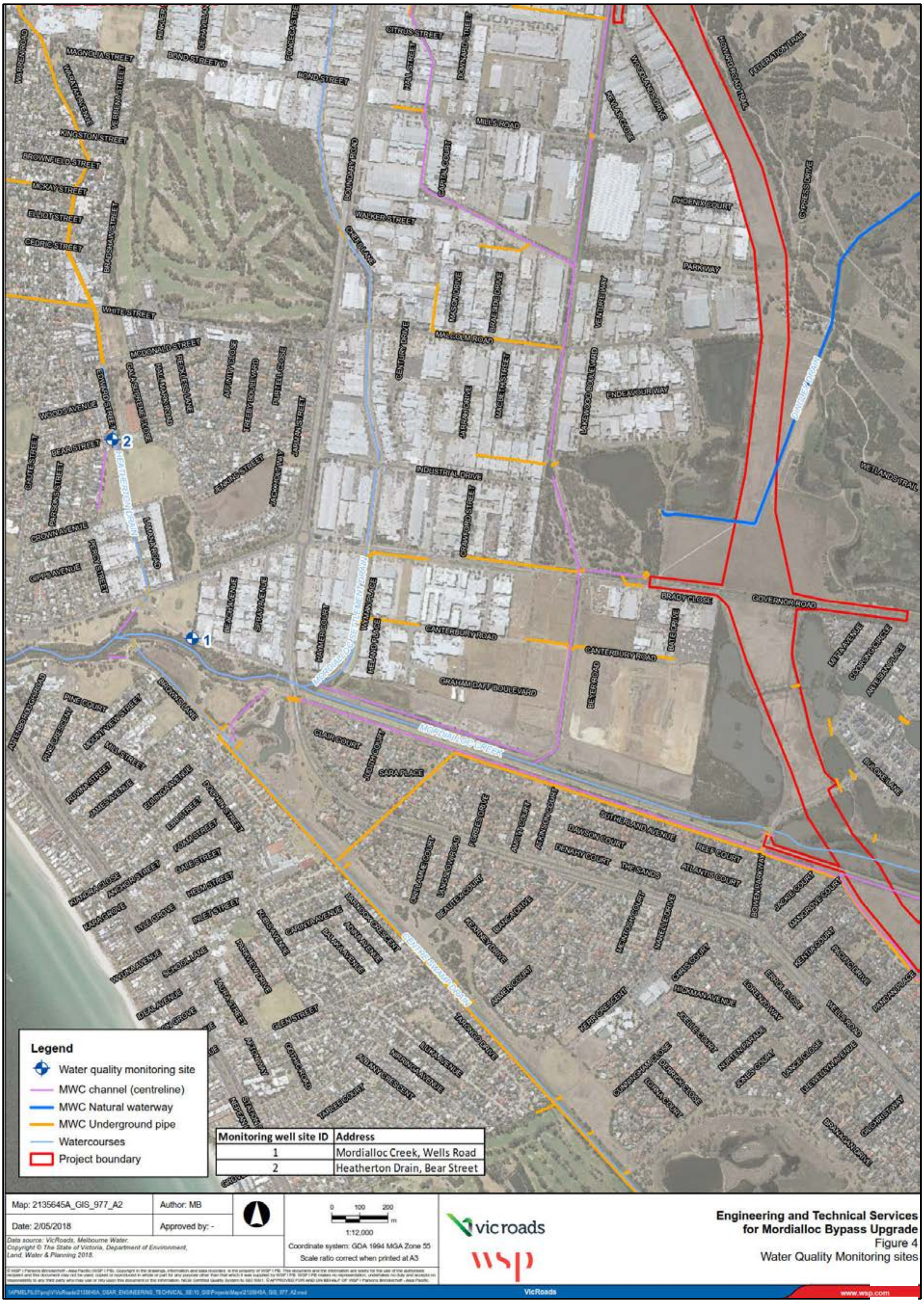

Figure 5.1 Water quality monitoring sites in Mordialloc Creek catchment: 1 – Mordialloc Creek St Wells Road, Mordialloc; 2 – Heatherton Drain at Bear St. Mordialloc

When compared with the WQOs for the proposed SEPP, Turbidity complied with the WQO occasionally and there is only occasional non-compliance for pH and DO. There is a general improvement in compliance for metals but these parameters remain mostly non-compliant.

The Water Quality Index (WQI) was computed by DELWP from 2000 to 2001 and is presented in Figure 5.2. The WQI is a scoring system calculated based on the level of attainment of the relevant indicators against the environmental water quality objectives in the SEPP (Waters of Victoria) (SEPP (WoV)). Figure 5.2 shows that while there is an improvement trend for WQI, the WQI of Mordialloc Creek at Wells Road remains classified as very poor. Figure 5.3 shows that all water quality parameters in 2016 are classified as very poor or poor; except for pH which is classified as very good.

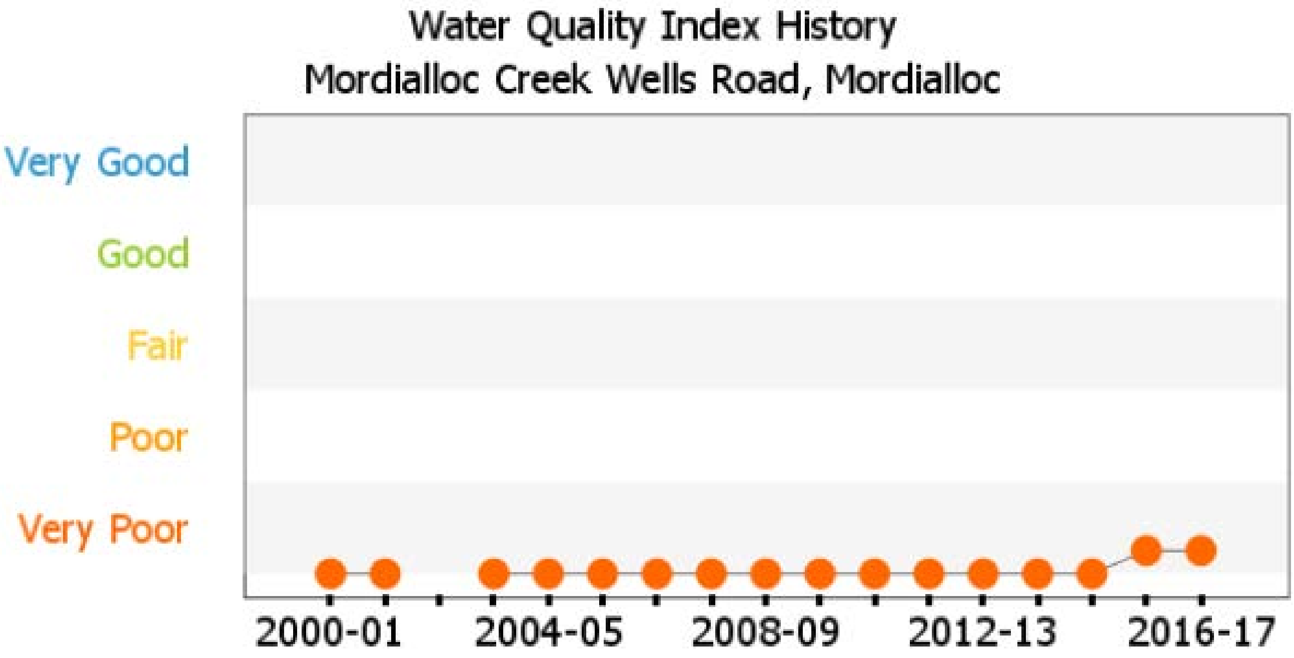

Figure 5.2 Water quality index of Mordialloc Creek at Wells Rd 2000–2017 (cited DELWP 2017)

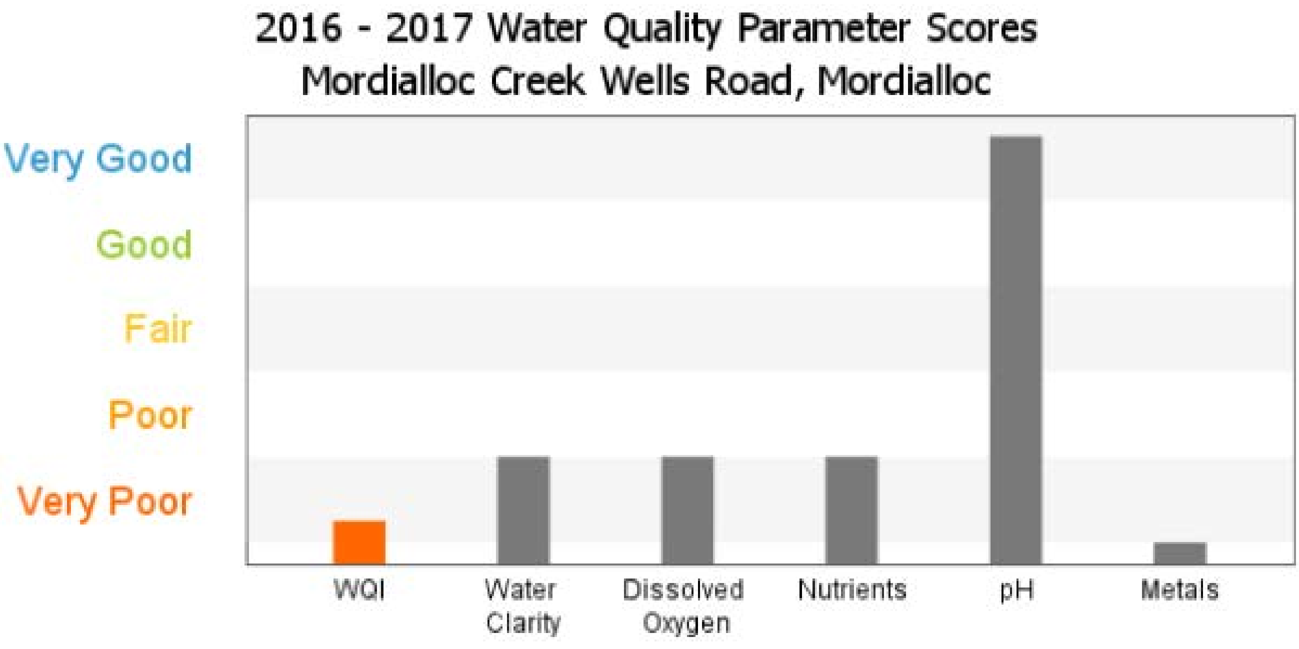

Figure 5.3 Details of water quality index of Mordialloc Creek at Wells Rd 2016–2017 (cited DELWP 2017)

5.3.1.2 EDITHVALE WETLANDS

According to the Edithvale-Seaford Wetlands Management Plan, water level monitoring has been undertaken at the wetlands since 2008 and water quality monitoring has been undertaken at Edithvale Wetlands since 2009. SKM (2011) concluded from the analysis of 2009/2010 water quality data that, while water quality varies from cell to cell, the wetlands are characterised by high turbidity, high salinity and high nutrients. One of the sites, EN2 (see Figure 5.4) is found to have high salinity and could be impacted by acid sulphate soils. SKM (2011) stated that the high nutrients in stormwater inflow encourages nuisance growth of emergent plant species which adversely affects the habitat diversity and the wetland’s visual appeal. On the other hand, at some wetland cells, high nutrients sustain high level of biomass growth that attracts a large number of birds.

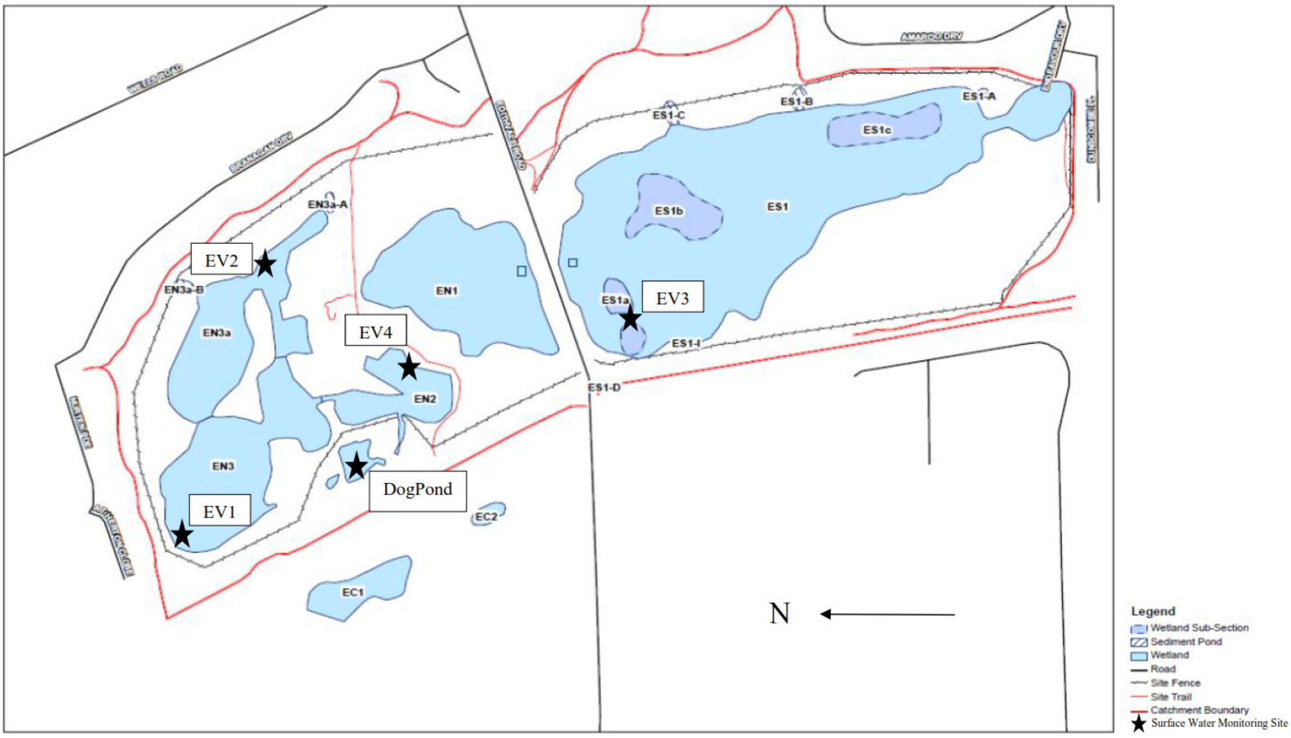

Figure 5.4 Water quality monitoring locations and wetlands cell names adopted by SKM (2011)

Additional water quality data was collected by WSP and key water quality parameters are presented in Figure 5.5. Water quality conditions in the wetlands are similar to what was described by SKM (2011). There is a general trend of improvement over time within cell EN3 (Site EV1). Other cells also show trend of improvement over the years. Cell ENS1 (Site EV3) generally has the highest nutrients and lowest water quality. In 2009, salinity in cell EN2 (Site EV4) was found to be very high. Subsequent surface water sampling completed as part of the groundwater assessment for this project confirmed that the salinity remains high in November 2017. High salinity reflects the effects of evaporation and recharge from high salinity groundwater (more detailed analysis can be found in Section 5.8 of the Groundwater Assessment Impact Report (WSP 2018b).

In summary, the water quality varies from cell to cell but generally is similar to Mordialloc Creek.

A MUSIC modelling simulation was undertaken using the 1952 to 1961 rainfall data to provide an understanding of the annual pollutant loading entering the wetlands from the catchments that are affected by the project. The results are summarised in Table 7.6 and will form the basis of the water quality impact assessment of the project on Edithvale Wetlands. According to Table 7.6, the average annual loadings for these catchments under existing conditions are 687 kg/yr for TSS, 6.38 kg/yr for TP and 70.2 kg/yr for TN. Litter is expected to be minimal as there is an existing treatment train upstream of the wetlands that will remove gross pollutants.

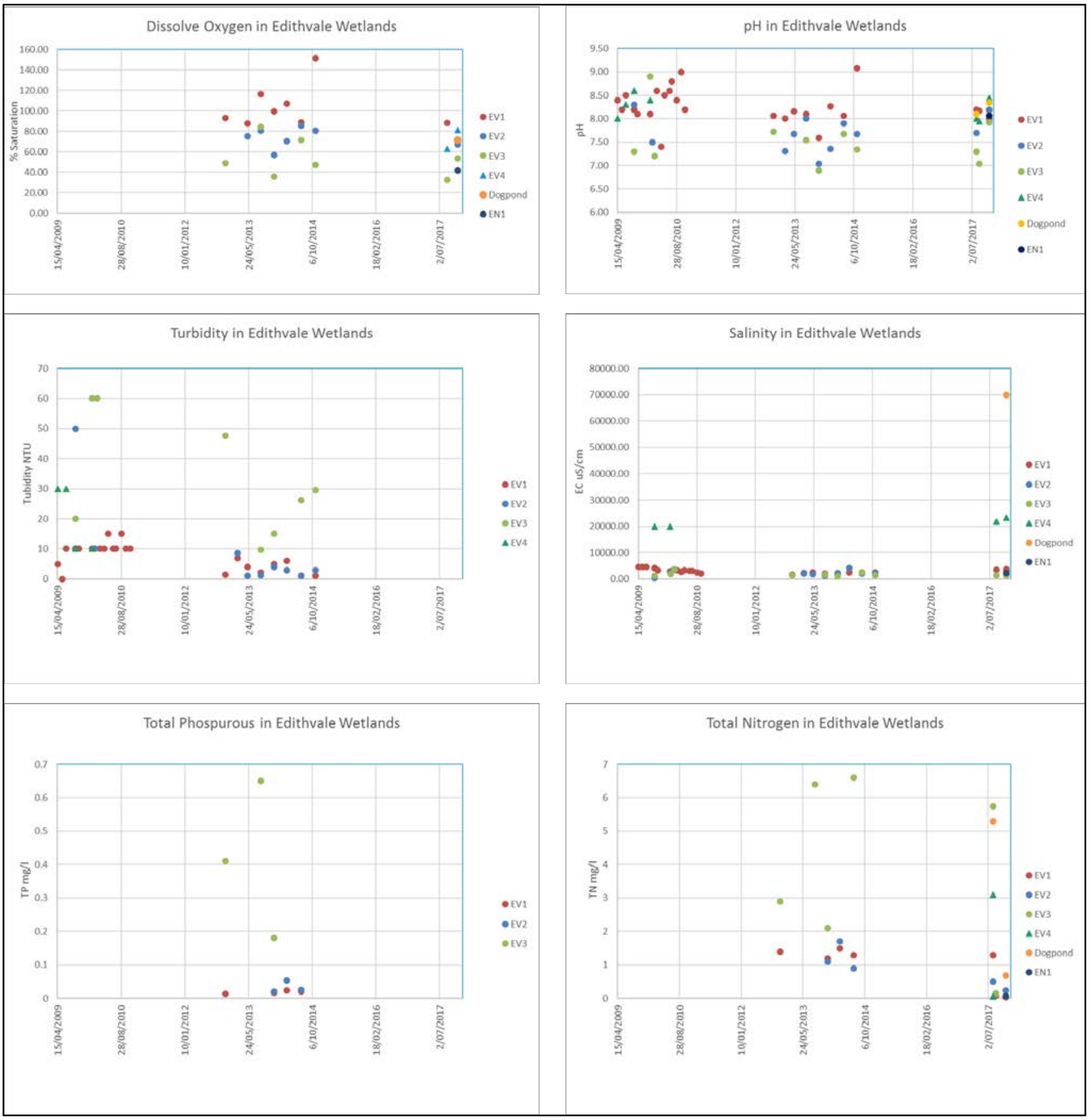

Figure 5.5 Water quality in Edithvale Wetlands 2009–2017

5.3.1.3 OTHER WETLANDS

To understand the water quality of ponds in Waterways Wetlands, water quality data were collected by WSP from 2017 in Waterways Wetlands adjacent to the proposed road corridor (see Figure 5.6). Figure 5.7 shows that DO saturation level is higher than both the Edithvale Wetlands and Mordialloc Creek, and salinity and TN are both lowest in Waterways Wetlands. pH is within a reasonable range. In general, the water quality in ponds adjacent to the road corridor are better than the water quality in Edithvale wetlands and Mordialloc Creek. It should be noted that, as mentioned in Section 3.4.1.1, there are no WQOs for constructed wetlands. Constructed wetlands act as secondary treatment devices to improve the quality of stormwater draining to them, and therefore water quality within constructed wetlands would be reasonably expected to deviate from WQOs set for the ultimate receiving waters.

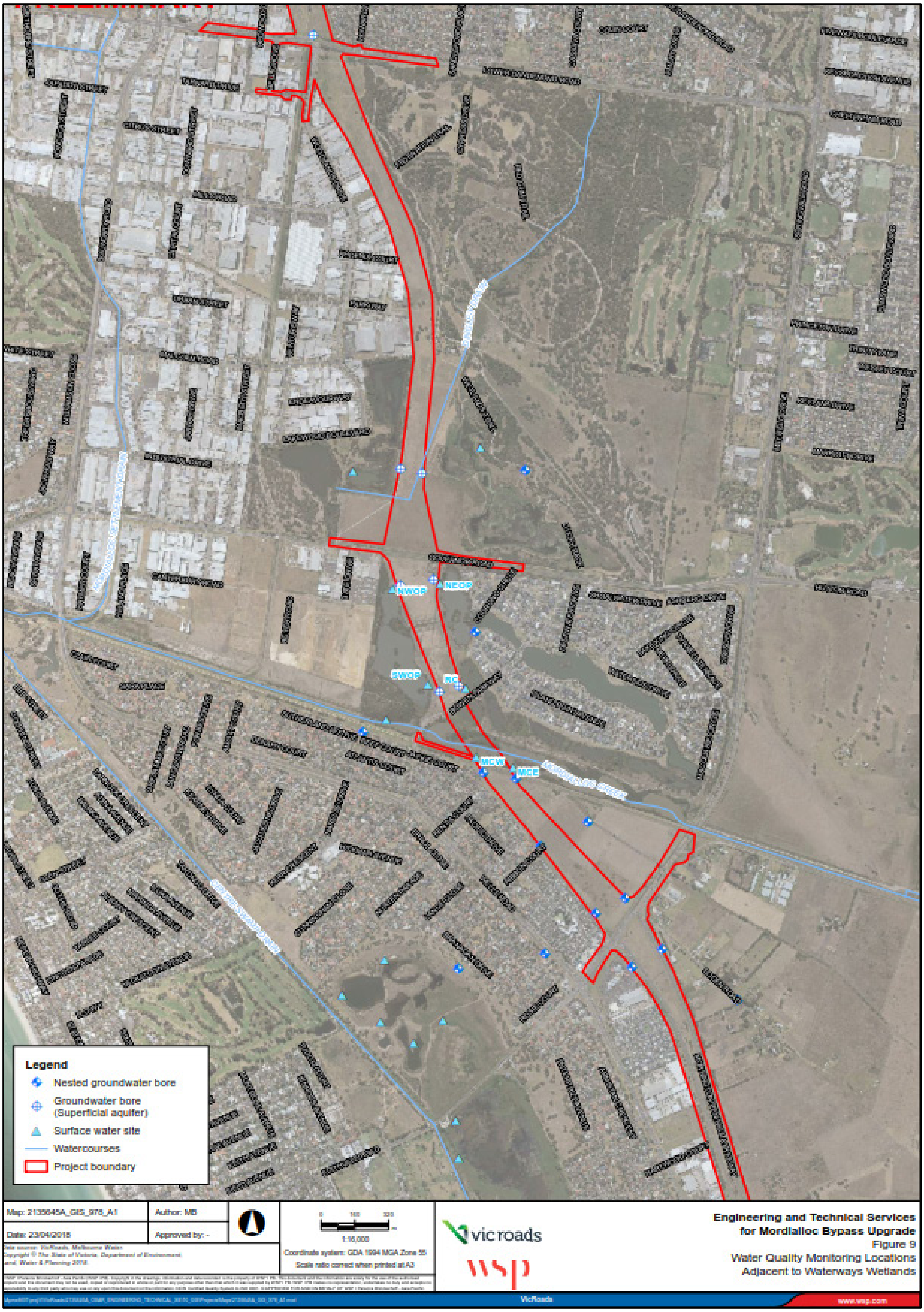

Figure 5.6 Water quality monitoring locations adjacent to Waterways wetlands

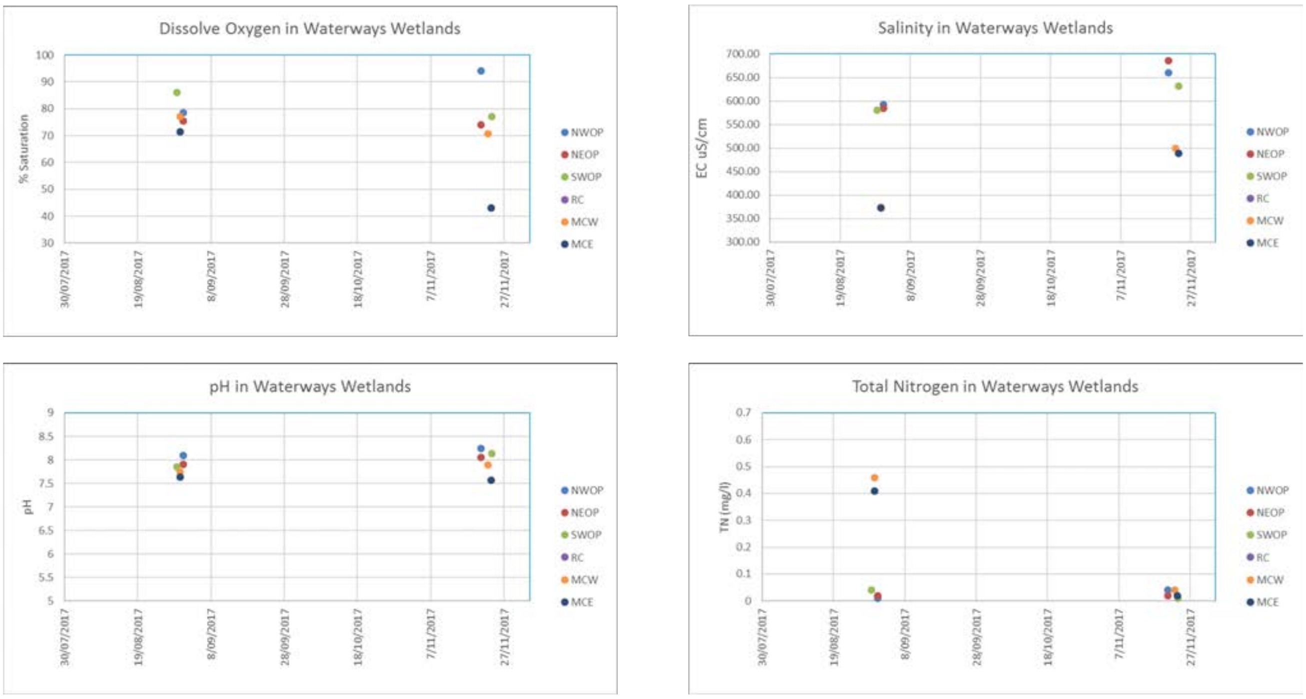

Figure 5.7 Water quality in Waterways Wetland adjacent to the proposed road corridor (August & November 2017)

There are no recorded data for the Woodland Industrial Estate Wetlands. The MUSIC model simulated annual pollutant loadings from the catchments affected by the project that drain to the two wetlands are presented in Table 7.7 and Table 7.8.

Table 7.7 shows that the average annual loadings from these catchments entering Waterways Wetlands under existing conditions are 384 kg/yr for TSS, 2.67 kg/yr for TP and 31.7 kg/yr for TN. Table 7.8 shows that the average annual loadings entering Woodlands Industrial Estate Wetlands under existing conditions are 1160 kg/yr for TSS, 6.21 kg/yr for TP and 72.8 kg/yr for TN. Litter is expected to be minimal as there is an existing treatment train provided upstream of both wetlands that will remove gross pollutants.

5.3.2 FLOW REGIME CONDITIONS

There is a flow gauge on Dunlops Drain at Citus Street (228358A) within the Mordialloc Creek Catchment (see Figure 4.2). The catchment of this gauge covers the northern parts of the Mordialloc Bypass. Analysis of flow behaviour at this gauge provides a baseline for the assessment of the flow regime impact of the Bypass. Based on a review of available information, there are no other known relevant flow gauging stations within the catchment or near the Edithvale Wetlands or Woodlands Industrial Estate Wetlands. To understand the existing flow regime, analysis of the gauge data and simulated rainfall runoff modelling using MUSIC has been undertaken.

The flow regime analysis was undertaken at the following locations downstream of the project:

- Dunlops Road Drain (also known as Braeside West D.S.) at Citrus Street: based on rainfall runoff modelling using the calibrated MUSIC hydrology module for the 1951 to 1962 Melbourne Water recommended rainfall period and sensitive tested for the 1975 to 2017 rainfall period.
- Dingley Drain at Woodlands Industrial Estate wetlands: based on rainfall runoff modelling using the MUSIC hydrology module for the 1951 to 1962 rainfall period; and sensitive tested for the 1975 to 2017 rainfall period.
- Edithvale Wetlands: based on rainfall runoff modelling using the SIMHYD hydrology module as part of the water balance model using SOURCE. Details of the water balance modelling can be found in the Groundwater Impact Assessment Report (WSP 2018b).

- Waterways Wetland – based on rainfall runoff modelling using the MUSIC hydrology module for the 1951 to 1962 rainfall period for stormwater runoff from the catchments affected by the Bypass only; not for the whole upstream catchment.

The catchments of Edithvale Wetlands and Woodlands Industrial Estate Wetlands are presented in Figure 4.3 and Figure 4.2.

Figure 7.1 to Figure 7.4 present the simulated flow duration curves for the Dunlops Road Drain, Edithvale Wetlands and Woodlands Industrial Estate Wetlands respectively. Observations from these curves are summarised as follows:

- Dunlops Road Drain:
  - Running dry (flow less than 0.1 ML/d) about 3% of the time for the 1952 to 1961 period, which extends to 20% in 2065
  - Running dry (flow less than 0.1 ML/d) about 20% of the time for the 1975 to 2017 period, which extends to 32% of the time in 2065
  - The median and mean daily flows are approximately 1.20 ML/d and 5.6 ML/d respectively for the 1952 to 1961 period and reduce to 0.51 ML/d and 5.0 ML/d in 2065. and
  - The median and mean daily flows are approximately 0.50 ML/d and 5.0 ML/d respectively for the 1975 the 2017 period and reduce to 0.37 ML/d and 4.5 ML/d in 2065.
- Woodlands Industrial Estate Wetlands:
  - Running dry (flow less than 0.1 ML/d) about 5% of the time for the 1952 to 1961 period, which extends to 21% of the time in 2065
  - Running dry (flow less than 0.1 ML/d) about 20% of the time for the 1975 to 2017 period, which extends to 35% of the time in 2065
  - The median and mean daily flows are approximately 0.98 ML/d and 3.4 ML/d respectively for the 1952 to 1961 period and reduce to 0.42 ML/d and 2.9 ML/d in 2065; and
  - The median and mean daily flows are approximately 0.52 ML/d and 3.0 ML/d respectively for the 1975 to 2017 period and reduce to 0.31 ML/d and 2.7 ML/d in 2065.
- Waterways Wetlands:
  - MUSIC modelling estimated that annual flow contributed from catchments affected by the proposed Bypass is estimated to be 16.3 ML/year for the 1952-1961 period.
- Edithvale Wetlands:
  - Details of the existing conditions of the wetlands can be found in the Groundwater Impact Assessment Report (WSP 2018b).

5.4 FLOODING IMPACT

A key Melbourne Water requirement for the project is that there must be no increase in flood risk and hazard as a result of the project for events up to 1% AEP (Annual Exceedance Probability). Tuflow modelling of the existing case conditions found that key existing overland flow paths that could be affected by the project are as below (see flood maps in Appendix C-1 and Appendix C-2):

- Old Dandenong Road drain at Dingley Bypass
- Old Dandenong Road drain at Centre Dandenong Road
- Gartsides D.S. at Lower Dandenong Road
- Dingley Drain at Braeside Park
- Dingley Drain near Woodlands Industrial Estate wetlands
- Waterways Wetlands area.

6 RISK ASSESSMENT

Impacts to surface water can be summarised into 6 categories:

- R-SW1 – water quality impact due to pre-construction activities
- R-SW2 – hydrology and flooding impacts during construction phase
- R-SW3 – water quality impact due to during construction
- R-SW4 – hydrology and flooding impacts during operation of the Bypass
- R-SW5 – water quality impacts due to oil and fuel spillage on the Bypass
- R-SW6 – water quality impacts due to change in land uses.

The primary environmental risks identified for surface water is provided in Table 6.1. The residual risk ratings presented below for both project and cumulative impacts consider standard inherent controls as listed in the Environmental Risk Assessment Report (WSP 2108c). The additional controls listed in the tables below are those recommended to further mitigate and minimise the primary environmental risks which were risk rated as medium or above. Primary environmental risks which were scored as low did not require additional controls to be applied.

Also included in the table below are any identified on-site project related cumulative risks, including: secondary risks (resulting from the implementation of a risk response in mitigating a primary environmental risk) and on-site aggregate cumulative risks (the aggregate/combined primary environmental risks resulting from diverse project activities having an impact on the same environmental asset.

Table 6.1 Surface water environmental risk assessment register

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION/CONTROLS	EPR	RESIDUAL RISK		
				Consequence	Likelihood	Rating			Consequence	Likelihood	Rating
R-SW1	Water quality impact due to pre-construction activities.	Geotechnical investigations impact water quality		Moderate	Rare	Low	Not required	W3, W5	Moderate	Rare	Low
R-SW2	Hydrology and flooding impacts during construction phase.	Placement of temporary works, stockpiles, equipment and plant results in a reduction in flood conveyance or floodplain storage, potentially leading to increases to flood levels, flow velocities and flood frequency		Moderate	Rare	Low	Not required	W4	Moderate	Rare	Low
R-SW3	Water quality impact due to erosion and soil instability during construction.	Erosion from construction sites contributes to sediment loads or hazardous spills impacts in downstream waterways	Surface water quality	Moderate	Rare	Low	Not required	W3, W5	Moderate	Rare	Low

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION/CONTROLS	EPR	RESIDUAL RISK		
				Consequence	Likelihood	Rating			Consequence	Likelihood	Rating
R-SW4	Flooding impacts during operation of the Bypass.	Changes to ground levels or other permanent works result in changes to flooding conditions such as frequency and duration of flooding, increases to flood levels or flow velocities.		Moderate	Unlikely	Medium	Develop and implement a maintenance handbook to clearly detail maintenance requirements for all stormwater assets to ensure they are functioning at design capacity during high rainfall events.	W2, W6	Moderate	Rare	Low
R-SW5	Hydrology impacts during operation of the Bypass.	Changes to ground levels, ground surface imperviousness or other permanent works result in changes to stormwater surface runoff and hence the hydrological regime of the creeks and waterways downstream of the project area.		Insignificant	Likely	Low	No mitigation measure required	W1, W6	Insignificant	Likely	Low
R-SW6	Water quality impacts due to oil and fuel spillage in the Bypass.	Traffic accidents and resultant fuel/chemicals spills and chemicals (from firefighting activities) contaminate surface water		Major	Unlikely	Medium	Provide adequate spill containment storage in the drainage system so that spilled fuel will not arrive at the downstream waterway system.	W1, W2, W5, W6	Major	Rare	Medium

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION/CONTROLS	EPR	RESIDUAL RISK		
				Consequence	Likelihood	Rating			Consequence	Likelihood	Rating
R-SW7	Water quality impacts due to change in land uses.	Increase to the storm water pollutant loads entering the environment as a result of the increase of impervious areas		Moderate	Unlikely	Medium	Provision of Bio-retention swale to further remove pollutants discharging into the water sensitive receptors	W1, W2, W5, W6	Moderate	Rare	Low
Cumulative Impacts – On-Site Aggregate											
R-SW8	Water quality impacts due to multiple activities and operations	Erosion due to multiple project activities and associated sedimentation, along with project related spills and leaks have a detrimental impact on surface water quality.		Moderate	Unlikely	Medium	Provision of Bio-retention swale to further remove pollutants discharging into the water sensitive receptors. Provide adequate spill containment storage in the drainage system so that spilled fuel will not arrive at the downstream waterway system.	W1, W2, W3, W4, W5, W6	Moderate	Rare	Low
R-SW9	Flooding impacts due to multiple activities and ring operations	Placement of temporary works, stockpiles, equipment and plant as well as changes to ground levels or other permanent works result in a reduction in flood conveyance or floodplain storage, potentially leading to increases to flood levels, flow velocities and flood frequency.		Moderate	Possible	Medium	Provide maintenance handbook to ensure all stormwater infrastructures and flood mitigation measures are well maintained and fully functional.	W1, W2, W3, W4, W6, CLM2	Moderate	Unlikely	Medium

The assessment of cumulative impacts was competed in two stages, namely the assessment of aggregate project impacts and the assessment of the cumulative impact of multiple off-site projects in addition to the Mordialloc Bypass project for surface water. The cumulative environmental risks identified for surface water is provided in the Table 6.2.

Table 6.2 Surface water cumulative effects environmental risk assessment

RISK ID	IMPACT PATHWAY	PROJECTS CONSIDERED	CUMULATIVE RISK DESCRIPTION	ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
						Consequence	Likelihood	Rating
R-SW1	Water quality impact due to pre-construction activities	LXRA Edithvale and BonBeach level crossing removal projects. and other urban development projects within the waterway Catchments that discharge into that part of the Port Phillip Bay (SEPP (WoV) Schedule F6) that could interact with the proposed projects to form cumulative impacts. Mordialloc Creek is the major creek system discharging to that part of Port Phillip Bay that key focus is on activities within this catchment. The following projects are identified as project with higher cumulative impact risk: — City of Kingston development of Chadwick Reserve — City of Kingston development of projects identified in Green Wedge Plan — Living Links Projects — Hawthorn Football Club development — Mordialloc Creek Tidal Waterway Restoration and Freshwater Wetland System (Melbourne Water).	If the investigation works of the projects are proceed concurrently, the impact will be cumulation of pollutants in waterways due to geotechnical investigation and eventually discharge to Port Phillip Bay. That could results in localised high pollutants concentration around the month of Mordialloc Creek.		W3, W5	Moderate	Unlikely	Medium

RISK ID	IMPACT PATHWAY	PROJECTS CONSIDERED	CUMULATIVE RISK DESCRIPTION	ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
						Consequence	Likelihood	Rating
R-SW2	Hydrology and flooding impacts during construction phase.	LXRA Edithvale and BonBeach level crossing removal projects. and other urban development projects within the waterway Catchments that discharge into that part of the Port Phillip Bay (SEPP (WoV) Schedule F6) that could interact with the proposed projects to form cumulative impacts. Mordialloc Creek is the major creek system discharging to that part of Port Phillip Bay that key focus is on activities within this catchment. The following projects are identified as project with higher cumulative impact risk: — City of Kingston development of Chadwick Reserve — City of Kingston development of projects identified in Green Wedge Plan — Living Links Projects — Hawthorn Football Club development — Mordialloc Creek Tidal Waterway Restoration and Freshwater Wetland System (Melbourne Water).	The change in flow regime can accumulate as the flow goes downstream.		W4	Moderate	Rare	Low

RISK ID	IMPACT PATHWAY	PROJECTS CONSIDERED	CUMULATIVE RISK DESCRIPTION	ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
						Consequence	Likelihood	Rating
R-SW3	Water quality impact due to erosion and soil instability during construction.	LXRA Edithvale and BonBeach level crossing removal projects. and other urban development projects within the waterway Catchments that discharge into that part of the Port Phillip Bay (SEPP (WoV) Schedule F6) that could interact with the proposed projects to form cumulative impacts. Mordialloc Creek is the major creek system discharging to that part of Port Phillip Bay that key focus is on activities within this catchment. The following projects are identified as project with higher cumulative impact risk: — City of Kingston development of Chadwick Reserve — City of Kingston development of projects identified in Green Wedge Plan — Living Links Projects — Hawthorn Football Club development — Mordialloc Creek Tidal Waterway Restoration and Freshwater Wetland System (Melbourne Water).	If the construction works of the projects are proceed concurrently, the impact will be cumulation of pollutants in waterways due to geotechnical investigation and eventually discharge to Port Phillip Bay. That could results in localised high pollutants concentration around the month of Mordialloc Creek.		W3, W5	Moderate	Unlikely	Medium

RISK ID	IMPACT PATHWAY	PROJECTS CONSIDERED	CUMULATIVE RISK DESCRIPTION	ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
						Consequence	Likelihood	Rating
R-SW4	Flooding impacts during operation of the Bypass.	LXRA Edithvale and BonBeach level crossing removal projects. and other urban development projects within the waterway Catchments that discharge into that part of the Port Phillip Bay (SEPP (WoV) Schedule F6) that could interact with the proposed projects to form cumulative impacts. Mordialloc Creek is the major creek system discharging to that part of Port Phillip Bay that key focus is on activities within this catchment. The following projects are identified as project with higher cumulative impact risk: — City of Kingston development of Chadwick Reserve — City of Kingston development of projects identified in Green Wedge Plan — Living Links Projects — Hawthorn Football Club development — Mordialloc Creek Tidal Waterway Restoration and Freshwater Wetland System (Melbourne Water).	The proposed works could cumulatively block existing floodway that flooding impact could be aggregated.		W2, W6	Moderate	Unlikely	Medium

RISK ID	IMPACT PATHWAY	PROJECTS CONSIDERED	CUMULATIVE RISK DESCRIPTION	ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
						Consequence	Likelihood	Rating
R-SW5	Hydrology impacts during operation of the Bypass.	LXRA Edithvale and BonBeach level crossing removal projects. and other urban development projects within the waterway Catchments that discharge into that part of the Port Phillip Bay (SEPP (WoV) Schedule F6) that could interact with the proposed projects to form cumulative impacts. Mordialloc Creek is the major creek system discharging to that part of Port Phillip Bay that key focus is on activities within this catchment. The following projects are identified as project with higher cumulative impact risk: — City of Kingston development of Chadwick Reserve — City of Kingston development of projects identified in Green Wedge Plan — Living Links Projects — Hawthorn Football Club development — Mordialloc Creek Tidal Waterway Restoration and Freshwater Wetland System (Melbourne Water).	The proposed works could cumulatively increase the surface runoff and have aggregated effect on the hydrologic regime of the creeks and waterways in the catchment.		W1, W6	insignificant	Likely	Low

RISK ID	IMPACT PATHWAY	PROJECTS CONSIDERED	CUMULATIVE RISK DESCRIPTION	ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
						Consequence	Likelihood	Rating
R-SW7	Water quality impacts due to change in land uses	LXRA Edithvale and BonBeach level crossing removal projects. and other urban development projects within the waterway Catchments that discharge into that part of the Port Phillip Bay (SEPP (WoV) Schedule F6) that could interact with the proposed projects to form cumulative impacts. Mordialloc Creek is the major creek system discharging to that part of Port Phillip Bay that key focus is on activities within this catchment. The following projects are identified as project with higher cumulative impact risk: — City of Kingston development of Chadwick Reserve — City of Kingston development of projects identified in Green Wedge Plan — Living Links Projects — Hawthorn Football Club development — Mordialloc Creek Tidal Waterway Restoration and Freshwater Wetland System (Melbourne Water).	Increases to impervious areas increase the storm water pollutant loads from roads to downstream waterways and Port Phillip Bay. In particular, Edithvale Wetlands could also interact with groundwater impact of LXRA on the wetlands.		W1, W2, W5, W6	Moderate	Unlikely	Medium

7 IMPACT ASSESSMENT AND MITIGATION

7.1 OPERATIONAL PHASE IMPACTS

Changes to ground levels, including new embankments or widening of existing roads, and changes to drainage elements, including bridges, culverts and underground drainage, can result in changes to drainage or flooding behaviour during operation.

7.1.1 WATER BODY HEALTH IMPACT

7.1.1.1 WATER QUALITY IMPACTS

As part of the road design, swales are provided to treat the stormwater runoff prior to discharge to the receiving environment. Locations and descriptions of these discharge locations or outfalls are presented in tables and maps in Appendix H. The overall change in pollutant loading entering the Mordialloc Creek catchment under the proposed project conditions are presented in Table 7.1. This summary of the MUSIC modelling shows that pollutant loadings meet the required WSRD targets as a whole. This means compliance can be achieved downstream of confluences of all outfalls. Water quality impact on water sensitive receptors downstream of the confluence such as Port Philip Bay are expected to be comply with the WSRD requirements. The WSRD targets are achieved for most outfalls except Outfalls D, E, G and I. Outfall G and I drain to wetlands that additional treatment will be required and discussed in the next paragraph. Outfall E is only marginally non-compliant with TN (45% vs 42%). Outfall D is not able to achieve the WSRD targets due to physical constraints in intercepting and treating the stormwater runoff from the Bypass. Nevertheless, both outfalls discharge to Melbourne Water Drains and eventually to Mordialloc Creek. There are no important water sensitive receptors downstream of these outfalls and localised adverse effects are not expected to be significant. The treatment effectiveness is reduced under 2065 climate change scenarios but still meets the WSRD targets overall. No further mitigation is required to meet the performance criteria for the overall project.

For sensitive receptors, the MUSIC model simulated annual pollutant loadings from the project area to the Edithvale Wetlands, Waterways wetlands and Woodlands Industrial Estate wetlands (see Table 7.2, Table 7.3 and Table 7.4 respectively). The results show increases in loading on the three wetlands when compared to existing conditions. This means that additional treatment, in addition to the grassed swales, is recommended to further reduce the pollutant loadings on these wetlands.

Table 7.1 Music model simulated total annual pollutants loadings form the catchments affected by the Project (based on1952–1961 rainfall): Swales only

	TARGETED % REDUCTION	TOTAL LOADING FROM UNTREATED ROAD CATCHMENTS	TOTAL LOADING REDUCTION AT OUFALLS AFTER TREATMENT	% REDUCTION FROM TREATMENT AREAS	% REDUCTION UNDER 2065 CONDITIONS
TSS (kg/yr)	80	4.84E+04	4.38E+04	90.4	91.2
TP (kg/year)	45	111	74.6	67.2	68.8
TN (kg/year)	45	863	435	50.4	50.8
Litter (kg/year)	70	1.04E+04	1.03E+04	98.8	98.8

+ TSS – Total Suspended Solid, TN – Total Nitrogen, TP = Total Phosphorus

Table 7.2 Music model simulated annual Pollutants loadings form the catchments affected by the Project entering Edithvale Wetlands (based on1952–1961 rainfall and with swales only)

INDICATORS	EXISTING CONDITIONS	PROPOSED CASE WITH STANDARD SWALES	
	AVERAGE ANNUAL LOADING	AVERAGE ANNUAL LOADING	% CHANGE FROM EXISTING
TSS (kg/yr)	687	842	23%
TP (kg/year)	6.38	7.78	22%
TN (kg/year)	70.2	86.5	23%
Litter (kg/year)	0	0	0%

+ TSS – Total Suspended Solid, TN – Total Nitrogen, TP = Total Phosphorus

Table 7.3 Music model simulated annual Pollutants loadings form the catchments affected by the Project entering Waterways Wetlands (based on1952–1961 rainfall and with swales only)

INDICATORS	EXISTING CONDITIONS	PROPOSED CASE WITH STANDARD SWALES	
	AVERAGE ANNUAL LOADING	AVERAGE ANNUAL LOADING	% CHANGE FROM EXISTING
TSS (kg/yr)	384	352	-8%
TP (kg/year)	2.67	3.25	25%
TN (kg/year)	31.7	37.3	18%
Litter (kg/year)	0	0	0%

+ TSS – Total Suspended Solid, TN – Total Nitrogen, TP = Total Phosphorus

Table 7.4 Music model simulated annual Pollutants loadings form the catchments affected by the Project entering Woodlands Industrial Estate Wetlands (based on1952–1961 rainfall and with swales only)

INDICATORS	EXISTING CONDITIONS	PROPOSED CASE WITH STANDARD SWALES	
	AVERAGE ANNUAL LOADING	AVERAGE ANNUAL LOADING	% CHANGE FROM EXISTING
TSS (kg/yr)	1160	951	-18%
TP (kg/year)	6.21	8.77	41%
TN (kg/year)	72.8	98.3	35%
Litter (kg/year)	1.78	0	-100%

+ TSS – Total Suspended Solid, TN – Total Nitrogen, TP = Total Phosphorus

OIL AND FUEL SPILLAGE

The project introduces additional traffic through the road corridor and this will increase the risk of oil and fuel spillage due to traffic incidents. If oil and fuel spills are discharged to the downstream water bodies, the health of these water bodies may be compromised. A spill risk assessment (see Appendix L) was conducted for each outfall based on the likelihood of a spill, which is estimated based on the road characteristics (geometry) of the outfall catchment, and its proximity to the downstream water sensitive receptors (i.e. consequence of the spill). It was found that spills occurring in catchments of Outfall F and Outfall H discharging to Woodlands Industrial Estate Wetland, Outfall I and Outfall J discharging to Waterways Wetlands, and Outfall M discharging to Edithvale Wetlands generally pose moderate spill impact risk to the wetlands. However, spill impact risk is identified as high if the spill occurs near the following locations:

- Chainage 27900 within the catchment of Outfall F
- Chainage 28475 within the catchment of Outfall I
- Chainage 28750 within the catchment of Outfall J; and
- Chainage 30760 within the catchment of Outfall M.

Suitable mitigation measures are required for high and moderate spill risk areas. For Outfalls contain both catchments with moderate risk and high risk, these Outfall are considered as with high risk and mitigation measures for high risk catchments are required. This means Outfalls F, I, J and M are considered as with high risk and Outfall H is considered as with moderate risk only.

7.1.1.2 FLOW REGIME IMPACT

The increase in impervious pavement areas in the proposed project will increase the stormwater runoff in the downstream waterway system. This increase has the potential to impact on the downstream drainage system during major flooding events and also during regular wet weather events, i.e. the full flow regime of the downstream waterway system. Flow duration curves were generated using daily flow simulated by the MUSIC model to provide an understanding of the impact of the proposed road on the overall flow regime.

Figure 7.1 to Figure 7.4 show that there are insignificant changes in the flow duration curves for Mordialloc Creek (at Dunlops Road Drain) and Woodlands Industrial Estate Wetlands for both the 1952–1961 and 1975–2017 periods, indicating that the project will have no impact on the downstream flow regime. The figures demonstrate that climate change could cause a notable decline in water availability for 80% of the time; however, this is solely due to the change in climate and not related to changes to the catchments caused by the project.

The inflow from the sub-catchments affected by the project into the Waterways Wetlands increases from 16.3 ML/yr to 27.8 ML/year (only increase to 24.3 ML/year under the climate change scenario). While this flow increase seems significant, 16.3 ML/year represents less than 0.4% of the total flow entering the Waterways Wetlands. This means that the increase in flow from the affected sub-catchments only represents an increase in flow of less than 0.3% of the total inflow to the wetlands.

The project is therefore anticipated to have minimal impact on the waterways and wetlands system and hence the industry and agriculture water users, and aquatic plants and animals. No mitigation measures are considered necessary for the minimal flow increases caused by the project.

It should be noted that analysis in this section aims to assess impact on change in flow regime, which could results in change in riparian ecology and geomorphology of the waterways. However, the impact on small flow events such as 1.5 year ARI events are addressed as part of the drainage design that the post development peak flow from the outlets are not to be higher than existing conditions and, if necessary, flow retardation is to be provided.

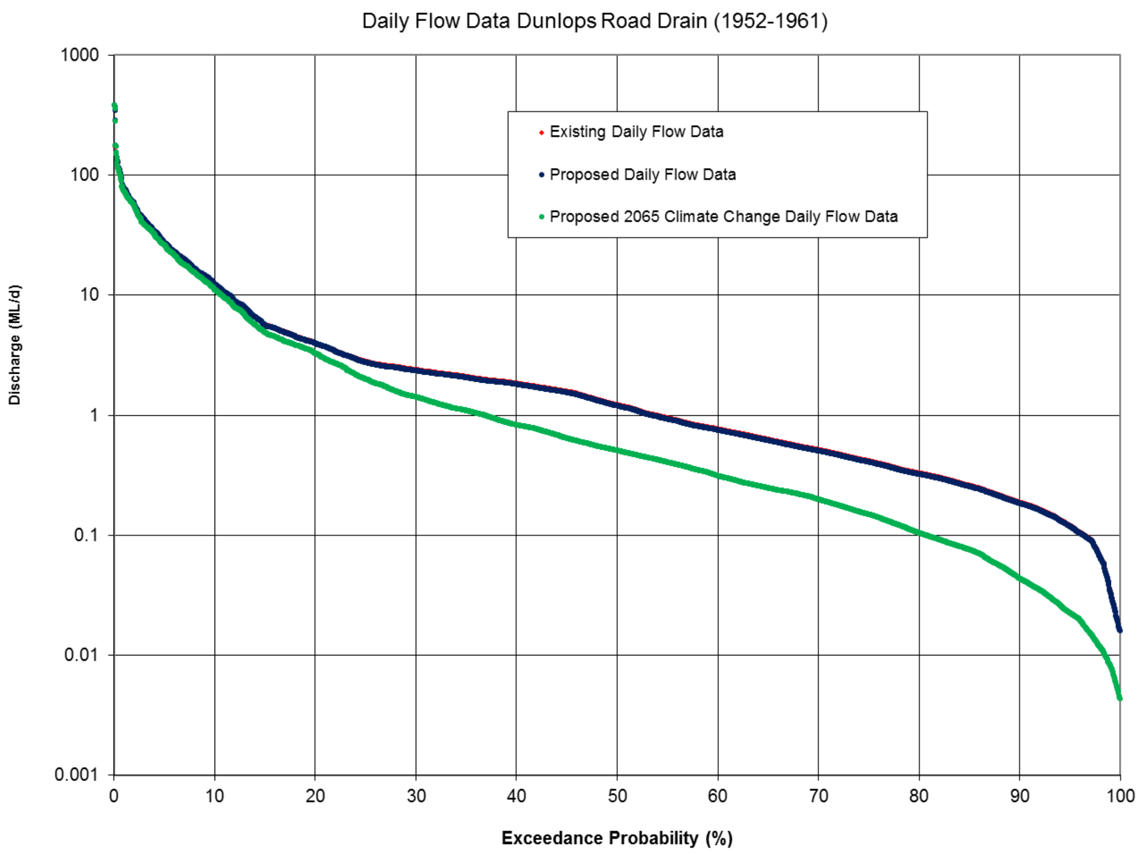

Figure 7.1 Flow duration curve at Dunlops Rd Drain gauge (1952–1961)

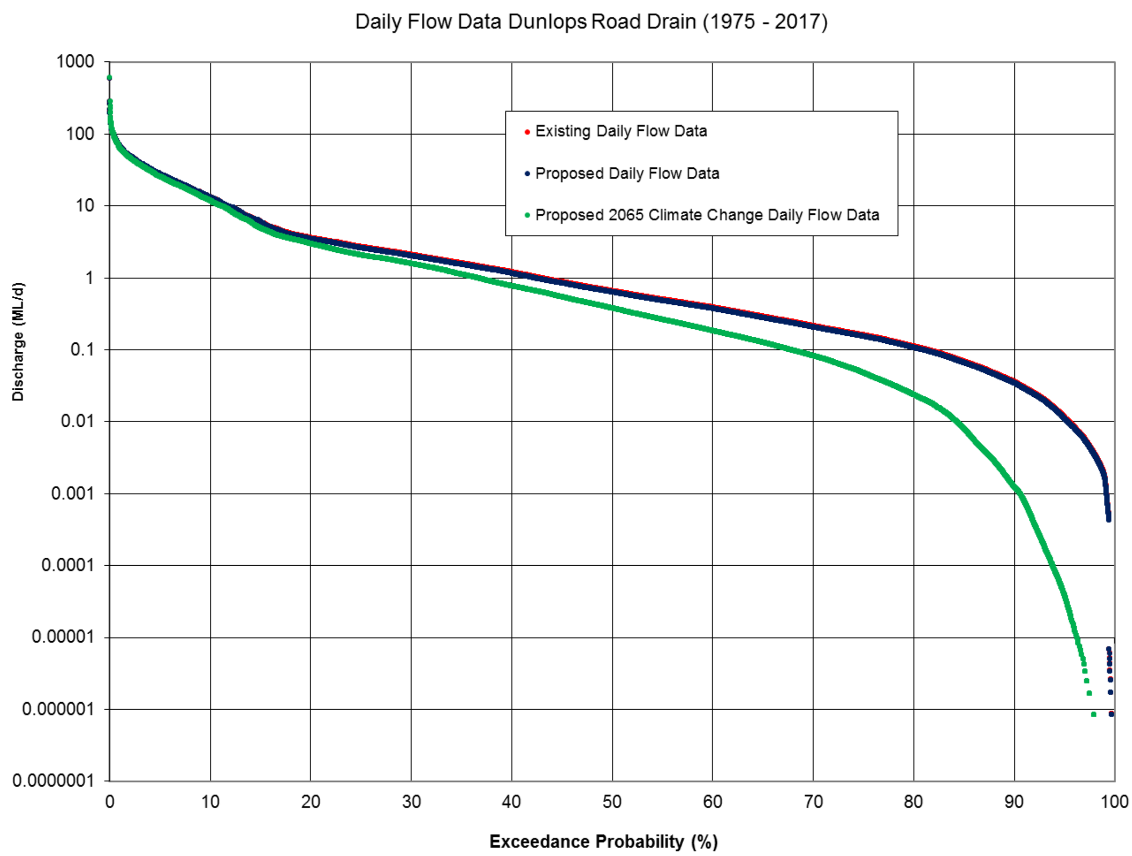

Figure 7.2 Flow duration curve at Dunlops Rd Drain gauge (1975–2017)

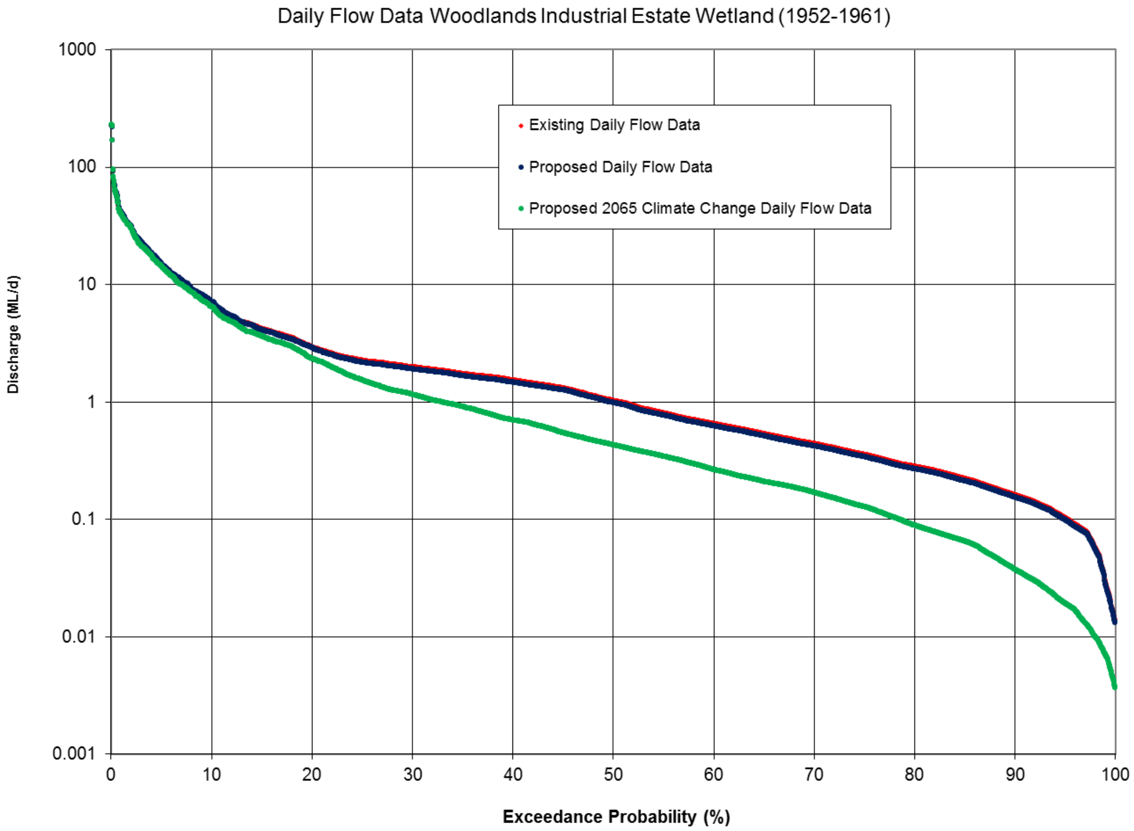

Figure 7.3 Flow duration curve for flow entering Woodland Industrial Estate Wetlands (1952–1961)

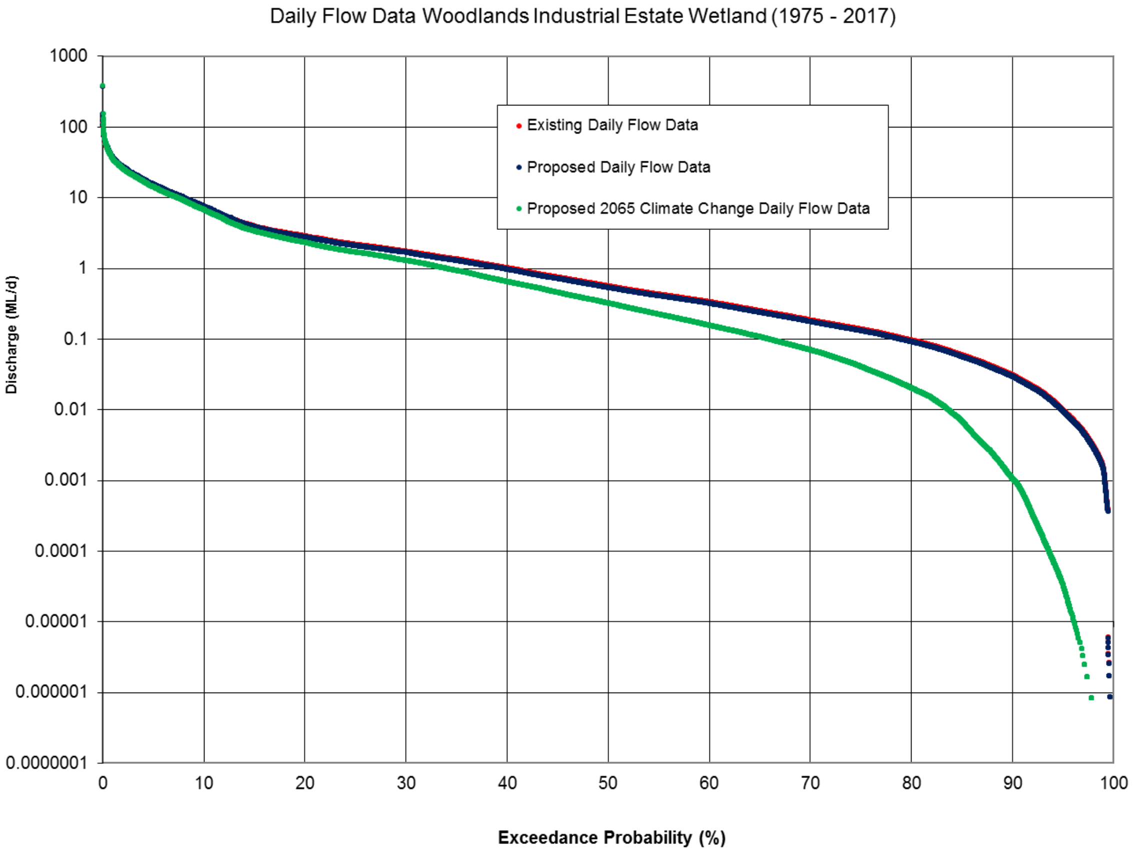

Figure 7.4 Flow duration curve for flow entering Woodland Industrial Estate Wetlands (1975–2017)

7.1.2 EDITHVALE WETLAND

In addition to the water quality impact identified in Section 7.1.1.1, the Groundwater Impact Assessment (WSP 2018b) identified that the combined effects of surface and groundwater induced the bypass have insignificant hydrology and hydraulic effect on the wetland. Ecological impacts from hydrology and hydraulic aspects is anticipated to be insignificant.

7.1.3 FLOODING IMPACT

The reference design has incorporated standard swales and additional flood storage areas next to Braeside Park and Woodlands Wetlands. These measures were incorporated into the reference design to minimise the changes to the flood behaviour caused by the project elements that are located within the floodplain. The measures consist of wide shallow depressions to store floodwater and compensate for existing floodplain storage lost to the proposed road embankment.

A general assessment of the impacts of the project against the performance criteria for floodplain management (see Section 3.4.1.2) is as follows, demonstrating that the impacts mostly meet these key requirements:

- Requirement: Risk to people and property must not increase as a result of the development
  - Impact assessment: Impacts do not increase flood risk to people (i.e. no change to flood hazard) or property (i.e. no change to flood damage and use of the affected land).
- Requirement: Works or structures should not affect floodwater flow capacity
  - Impact assessment: Impacts do not obstruct or divert flood flows as sufficient hydraulic capacity has been provided in the cross drainage design to pass flow.
- Requirement: Works or structures should not reduce floodwater storage capacity
  - Impact assessment: Some infrastructure elements need to be located within the floodplain, which displaces some of the floodwater. This has been offset as far as possible by introducing compensatory flood storage measures (swales and flood storage areas) into the design within the project boundary. The remaining loss of flood storage is minor and results in minor localised increases in flood level that do not contravene the other key principles and standards of Melbourne Water.
- Works or structures should not create new hazards or increase existing hazard
  - Impact assessment: The impacts do not create new flood hazards or increase the existing hazard categories within the areas experiencing a minor increase in flood level.

Further detail on the locations with flood impact outside the project area and the causes are summarised in Table 7.5 for 1% AEP flood events.

In addition, an assessment of attenuation or detention requirements has been completed for each outfall location and is summarised in the Appendix H. In general, where the works result in an increase to catchment area and/or fraction impervious, the following has been adopted:

- For outfalls to major main drains or waterways: impacts due to increased runoff have been assessed using the flood models
- For outfalls to minor drainage systems (e.g. council underground drains): detention systems provided to maintain existing flow rates.

Where it has been determined that detention systems are required, preliminary detention sizing has been completed using the methods outlined in Austroads Part 5 to ensure the feasibility of accomodating the storages. Further investigation and obtaining agreement between City of Kingston and VicRoads on the ownership and maintenance responsibility are recommended during detailed design.

Table 7.5 Summary of locations with flood impacts outside the project area for 1% AEP flood events (Also see Figure 7.5, Figure 7.6 and Figure 7.7)

NO. ID	LOCATION	DRAINAGE SYSTEM	IMPACT	DETERMINED CAUSE(S)
1.	South of Lower Dandenong Road	Braeside West D.S.	**Occurrence** South of Road: Between Lower Dandenong Road and Tarnard drive crossing, within the banks of the Braeside West D.S. open channel. North of Road: Eastern and Western sides of the Freeway. **Magnitude** South of Road 1% AEP – Between 0.1 and 0.5 metres. North of Road 1% AEP – Between 0.01 and 0.07 metres.	South of Road: Overland flow diversion from predominantly east-west under base case conditions to east-south (i.e. Toward braeside west drain) under proposed case conditions. Diversion occurs via proposed swale drainage which increases the total volume of incoming flow in braeside west drain. North of Road: The current solution does not fully restore base case flow behaviour in this region including the timing of flow concentration at Lower Dandenong Road, as well as the direction and depth of upstream flooding.
2.	Braeside Park	Dingley Drain/ Governor Road drain	**Occurrence** Extent of impact is outside of project boundary area, however contained within Braeside Parkland. **Magnitude** 1% AEP – Between 0.01 and 0.046 metres.	Net reduction, through embankment earthworks, of the available area for floodplain storage.
3.	East of *the Bowen Parkway* road	Bowen Road D.S.	**Occurrence** Downstream of the proposed Smythes drain crossing. Impact within banks of the Bowen Road D.S. open channel. **Magnitude** 1%, AEP – Between 0.01 and 0.055 metres.	The proposed culvert has a greater hydraulic capacity than the existing channel its replacing, and hence allowing more water downstream causing afflux.

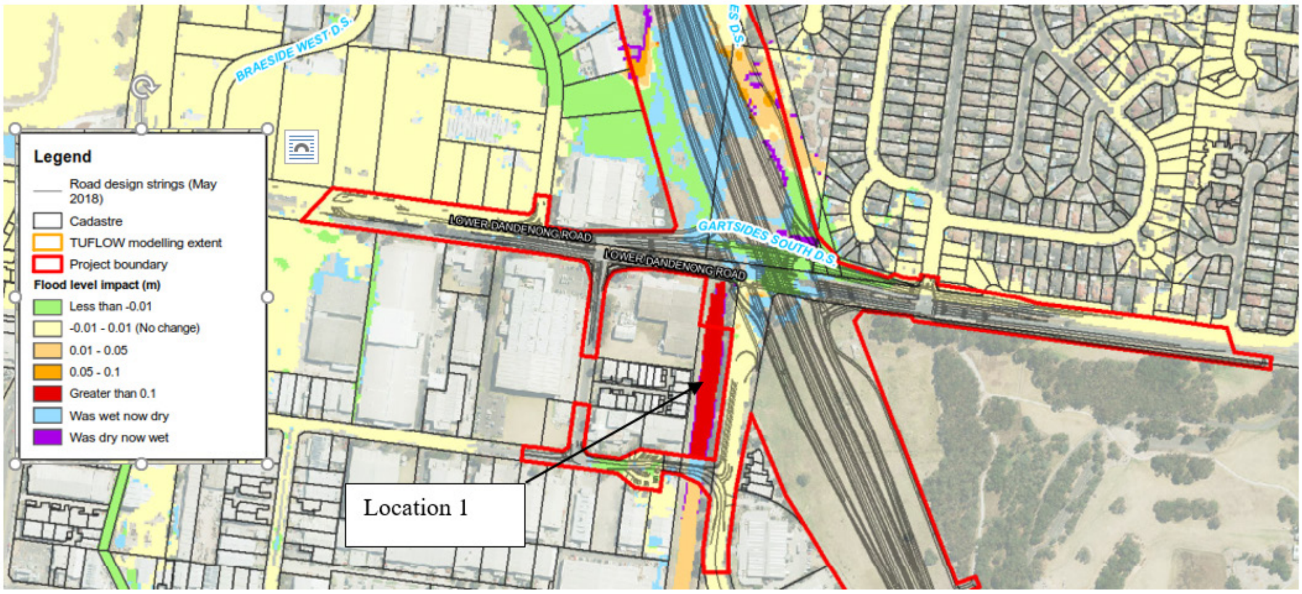

Figure 7.5 Flooding impact Location 1

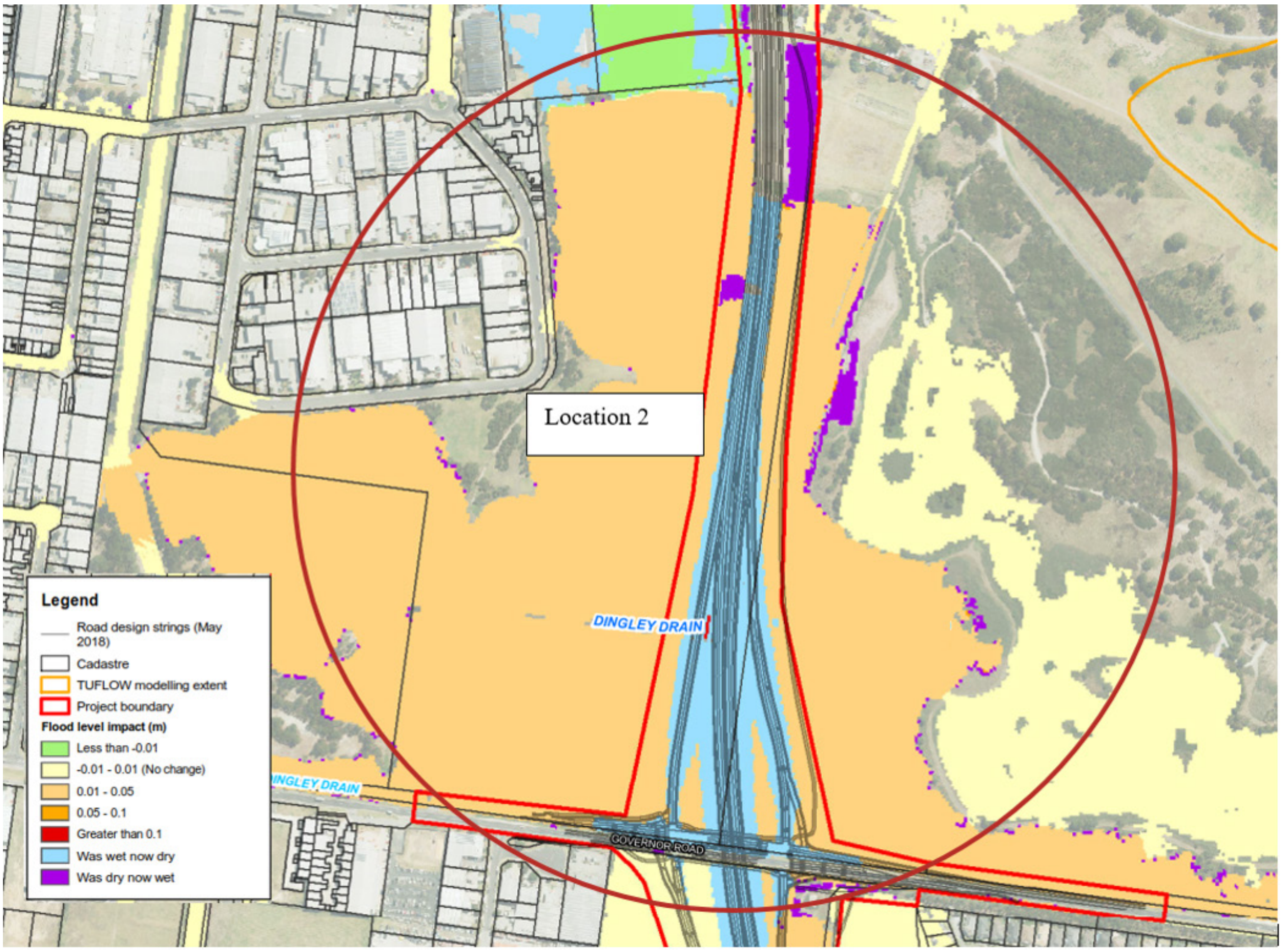

Figure 7.6 Flooding impact Location 2

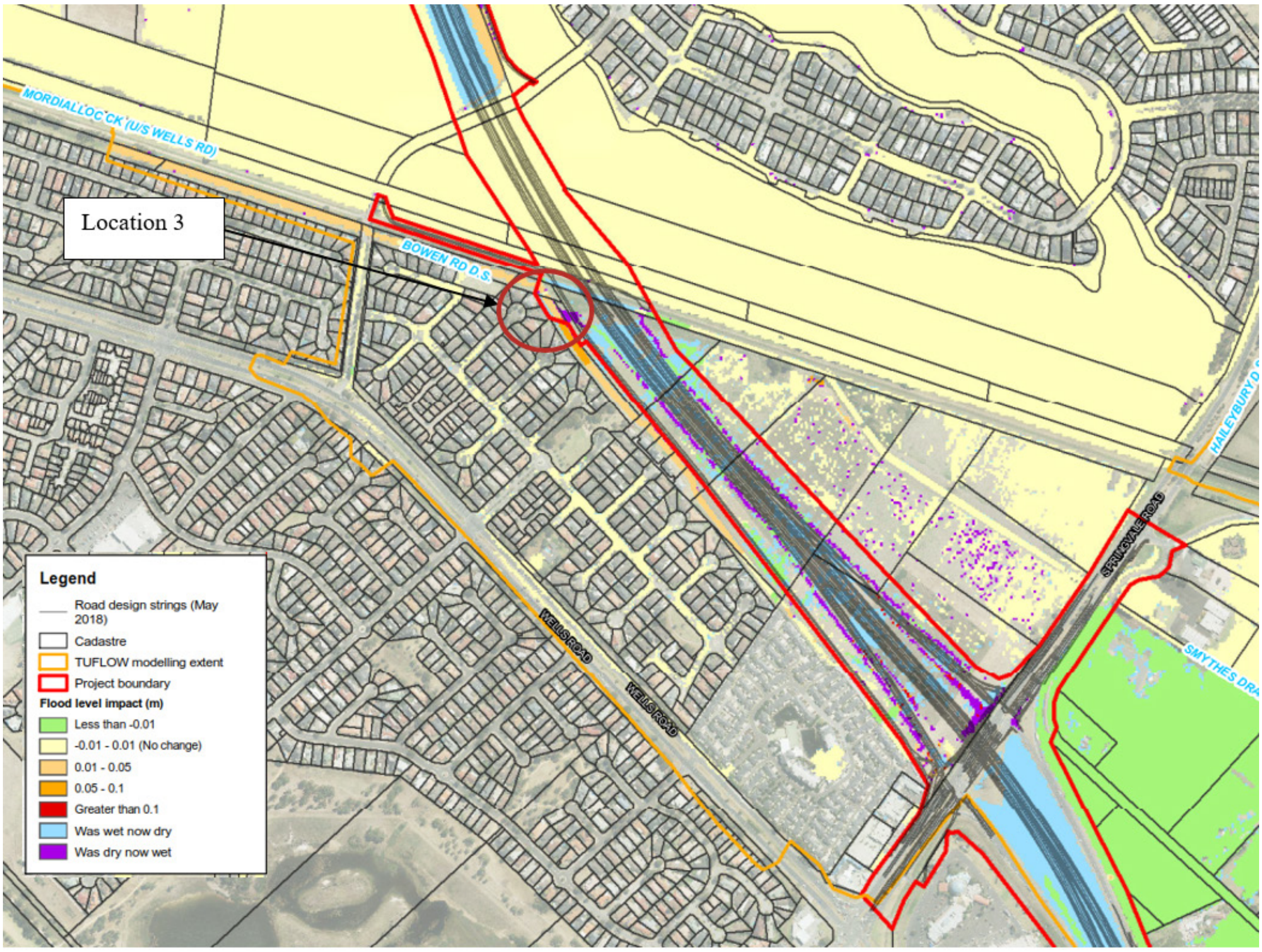

Figure 7.7 Flooding impact Location 3

7.1.3.1 DISCUSSION OF FLOODING IMPACTS

At Location 1, the current solution does not fully restore base case flow behaviour in this region that future mitigation measures as detailed in Table 7.9 will be required.

At Location 2, the proposed design has already incorporated mitigation measures in the form of compensatory flood storage within the project boundary. Further mitigation measures are likely to result in undesirable side effects on other aspects of the environmental impact such as ecology. The current design solution is considered to provide the best overall outcome, balancing flood risk with cost, ecology and program impacts. In fact, the areas experiencing increases in flood levels are parklands and grasslands. While some of the footpaths in the park are inundated during flooding, the flood impact at these inundated zones is less than 0.01 metres increase in water level, which does not introduce new flood hazards or change the existing hazard categorisation.

Regarding impact to a single private property on the western side of Braeside (corner of Governor Rd and Industrial Dr), Close examination of aerial photography and Google StreetView confirmed that there seems to be an error in the LiDAR at this location allowing floodwater to flow over an elevated building. This property is not expected to be flooded. Thus, the predicted flood impacts will have no adverse effects, with no change to flood risk to people or property.

No further mitigation is proposed for Location 2.

At Location 3, Smythes Drain is covered by the Melbourne Water Bowen Road Drainage Scheme (No. 1124), which is the master plan for drainage infrastructure in the catchment to allow for future urban development. While there is a minor increase in flood levels downstream of culvert CD K1, the culvert and downstream channel are designed for the larger ultimate flow rate (provided by Melbourne Water). As such, floodwater is contained within the Bowen Road open channel.

In relation to private properties to the east of Wells Road at the end of Maidenhair Mews near Locaton 3, they could be affected by flood impact of the proposed culvert K1 in Locaton 3. As mentioned before, this culvert is design for ultimate flow rate provided by Melbourne Water. Thus, the proposed culvert has a greater hydraulic capacity than the existing channel its replacing, and hence allowing more water downstream causing afflux. On closer inspection, it seems that these private properties have a large drainage channel running through their backyards, so it may be possible that the drainage arrangement has recently changed at this location to allow this development. It was assumed in the assessment that the downstream drainage system has been designed with a capacity for the ultimate flow rates, which results in the afflux but all afflux are contained in bank, and hence, does not pose flood risk to surrounding properties. However, it is recommended to confirm this with Melbourne Water during detailed design stage so that the proposed culvert K1 can be sized in accordance with Melbourne Water latest drainage scheme design. No further mitigation action is recommended.

7.2 CONSTRUCTION PHASE IMPACT

7.2.1 FLOODPLAIN MANAGEMENT IMPACT

Aspects of the construction process have the potential to temporarily worsen flooding due to the presence of temporary works (such as access tracks, piling platforms, stockpiles, etc.) in the floodplain causing reductions in flood conveyance or floodplain storage. Temporary diversion of overland flow and restriction of flow paths also has the potential to worsen flooding.

Wherever possible construction works required for the project should occur outside the extent of the 1% AEP floodplain, to reduce the risk of increased inundation of properties. However, due to the location of the project and the extensive nature of the 1% AEP floodplain, the construction elements are likely to occur within the extent of the 1% AEP floodplain. Possible elements include: excavations for piling at the elevated structures, piling platforms, access tracks, stockpiles of excavated materials, construction compounds, etc. depending on the construction method. More detailed assessment is required before the construction works commence. In addition, a flood management plan will be required to submit to Melbourne Water for any temporary works.

7.2.2 WATER BODIES HEALTH IMPACT

Erosion of disturbed areas within construction sites has the potential to contribute large sediment loads to downstream areas. Sediment laden runoff from disturbed areas, stockpiles, storage areas and haulage routes may increase turbidity of receiving water bodies resulting in reduced water quality. There is also potential for runoff to contain pollutants including contaminated sediments, oils and/or chemicals.

During construction, it may be necessary to dispose of runoff from excavated areas after rainfall events using temporary pumping. Surface water pumped from construction areas may be high in sediment, turbidity and other pollutants. Without water quality control measures pumped discharge may adversely impact on nearby waterway networks.

Water supplies may be needed during construction for controlling dust and other purposes. Depending on the quantities required and the source of the water, this may have potential impacts on users of the water resource and aquatic fauna and flora.

7.3 CUMULATIVE IMPACTS

Any proposed works that have potential impacts on the surface water quality or flow regime within the Mordialloc catchment could combine with the impacts of this project. However, with the implementation of the SEPP (Waters of Victoria), regulatory control by Melbourne Water and local Councils, each individual project is expected to mitigate its own impacts and therefore the cumulative impact of all projects within the catchment is expected to be minimal. The Level Crossing Removal Authority (LXRA) project is one of the projects potentially interacting with the proposed bypass. However, any potential cumulative impacts, if any, are related to groundwater impact rather than surface water and this is to be addressed in the Groundwater Impact Assessment Report (WSP 2018b). Appendix I provides a list of projects, in additional to LXRA, that could potentially have a combined impact with this project. The combined list of projects are not expected to generate significant cumulative impacts with this project, however, due to the proximity of some of the projects (see Appendix I for details), further review or assessment is recommended at the detailed design stage. The projects with most potential for cumulative impacts with this project include:

- Item 5. City of Kingston development of Chadwick Reserve
- Item 6. City of Kingston development of projects identified in Green Wedge Plan
- Item 7. Living Links Projects
- Item 8. Hawthorn Football Club development
- Item 9. Mordialloc Creek Tidal Waterway Restoration and Freshwater Wetland System (Melbourne Water).

It should also be noted that some of the proposed projects listed in Appendix I, such as Chadwick Reserve development could be integrated with the proposed WSRD assets of this project to optimise the benefits of both projects. This aspect is recommended to be investigated during the detailed design stage.

7.4 MITIGATION MEASURES

7.4.1 GENERAL

The impact assessment has identified several potential risks posed by the project to the water sensitive receptors in the catchment. This section discusses mitigation measures required to reduce the risks to an acceptable level.

7.4.2 OPERATIONAL PHASE MITIGATION MEASURES

7.4.2.1 WATER BODY HEALTH IMPACT

As discussed in Section 7.1.1, no mitigation measures are required for impacts on the flow regime, however, mitigation measures are recommended for water quality to ensure that there is no increase in pollutant loadings entering the wetlands. Bio-retention systems are proposed as the most suitable mitigation measures, with specific measures identified as follows:

1. Edithvale Wetlands – provision of bio-retention systems near Outfall M.
2. Waterways Wetlands – provision of bio-retention systems near Outfall J.
3. Woodlands Industrial Estate Wetlands – provision of bio-retention systems near Outfall F.

The bio-retention swales are sized based on MUSIC model and is on top of the swales provided in the proposed drainage design. MUSIC modelling results in Table 7.6, Table 7.7 and Table 7.8 show that the proposed mitigation measures will reduce the annual average loadings entering the three wetlands below the existing conditions loadings for TSS and nutrients. Alternatively, additional WSRD treatments can be provided to stormwater discharge from existing residential area instead of runoff from swales as long as the “no pollutants loading increase” target is achieved. However, this may not be feasible if the WSRD treatments need to be located outside the project boundary. The environmental performance requirement for water body health is EPR W1 (refer to Section 8).

Table 7.6 Music model simulated annual Pollutants loadings form the catchments affected by the Project entering Edithvale Wetlands (based on1952–1961 rainfall)

INDICATORS	EXISTING CONDITIONS	PROPOSED CASE WITH STANDARD SWALES		PROPOSED WITH ADDITIONAL BIORETENTION SWALES		
	Average Annual Loading	Average Annual Loading	% Change from Existing	Average Annual Loading	% Change from Existing	% Change from existing under 2065 Climate conditions
TSS (kg/yr)	687	842	23%	659	-4%	-20%
TP (kg/year)	6.38	7.78	22%	5.42	-15%	-28%
TN (kg/year)	70.2	86.5	23%	68.4	-3%	-18%
Litter (kg/year)	0	0	0%	0	0%	0%

Table 7.7 Music model simulated annual Pollutants loadings form the catchments affected by the Project entering Waterways Wetlands (based on1952–1961 rainfall)

INDICATORS	EXISTING CONDITIONS	PROPOSED CASE WITH STANDARD SWALES		PROPOSED WITH ADDITIONAL BIORETENTION SWALES		
	Average Annual Loading	Average Annual Loading	% Change from Existing	Average Annual Loading	% Change from Existing	% Change from existing under 2065 Climate conditions
TSS (kg/yr)	384	352	-8%	251	-35%	-42%
TP (kg/year)	2.67	3.25	22%	2.18	-18%	-28%
TN (kg/year)	31.7	37.3	18%	29.2	-8%	-20%
Litter (kg/year)	0	0	0%	0	0%	0%

Table 7.8 Music model simulated annual Pollutants loadings form the catchments affected by the Project entering Woodlands Industrial Estate Wetlands (based on1952–1961 rainfall)

INDICATORS	EXISTING CONDITIONS	PROPOSED CASE WITH STANDARD SWALES		PROPOSED WITH ADDITIONAL BIORETENTION SWALES		
	Average Annual Loading	Average Annual Loading	% Change from Existing	Average Annual Loading	% Change from Existing	% Change from existing under 2065 Climate conditions
TSS (kg/yr)	1160	951	-18%	608	-48%	-53%
TP (kg/year)	6.21	8.77	41%	5.25	-15%	-25%
TN (kg/year)	72.8	98.3	35%	71.4	-2%	-13%
Litter (kg/year)	1.78	0	-100%	0	-100%	-100%

OIL AND FUEL SPILL RISK

The spill risk assessment in Section 7.1.1.1 found that there is a moderate spill risk within the catchments of Outfall H. To mitigate this spill risk, swales need to be extended and widened to provide additional storage and increase the travel time for any spill to reach the project boundary. This allows additional time for emergency crews to block the drainage system and additional volume for the spill to be contained within the road drainage system.

However, for the high spill risk Outfalls F, I, J and M more rigorous mitigation measures such as the provision of spill containment with a minimum spill containment capacity of 20,000 litres are required. This is roughly the size of a small tank in a fuel truck. This means the containment is sufficient to contain all fuel contained in a fully loaded fuel tanker, which is considered as adequate. The spill containment can be integrated as part of the bio-retention systems design. Specific maintenance and management plan is recommended to ensure the containments are fully functional. The environmental performance requirement for water body health, including spill containment, is EPR W1 (refer to Section 8).

7.4.2.2 EDITHVALE WETLANDS

In addition to the bio-retention systems and spill containment at Outfall M, there are no other mitigation measures is proposed.

7.4.2.3 FLOODING IMPACT

Table 7.9 tabulates the potential options for further mitigation at the detailed design stage of the project for the higher impact locations listed in Table 7.5. With the recommended further mitigation measures, the impact of the project on floodplain management will further be reduced. At Locations 1, 2 and 3, flood impact occurs within channel banks (1 and 3), while at location 2, flood impact occurs within parkland areas. There are no flood sensitive receptors affected by flood impact noted at all locations.

Table 7.9 Summary of recommended mitigation measures to reduce flood impacts across the study area

NO. ID	LOCATION	DRAINAGE SYSTEM	IMPACT	DETERMINED CAUSE(S)	MITIGATION RECOMMENDATION(S)
1.	South of Lower Dandenong Road	Braeside West D.S.	**Occurrence** South of Road: Between Lower Dandenong Road and Tarnard drive crossing, within the banks of the Braeside West D.S. open channel. North of Road: Eastern and Western sides of the Freeway. **Magnitude** South of Road: 1% AEP – between 0.1 and 0.5 metres. North of Road: 1% AEP – between 0.01 and 0.07 metres.	South of Road: Overland flow diversion from predominantly east-west under base case conditions to east-south (i.e. Toward braeside west drain) under proposed case conditions. Diversion occurs via proposed swale drainage which increases the total volume of incoming flow in braeside west drain. North of Road: The current solution does not fully restore base case flow behaviour in this region including the timing of flow concentration at Lower Dandenong Road, as well as the direction and depth of upstream flooding.	**1** Recommended option – Revise conveyance/diversion layout: Reduce Braeside West drain incoming flow rates back to base case levels by replicating base case conditions flow behaviour upstream of Lower Dandenong Road. This will likely include a slight reduction in the size of culvert CD E3 and allowing spill from the western swale to reinstate an existing overland flow path to the west of the proposed freeway. **2** Supplementary option – Retardation or detention: Provide detention to retard flow rates back to base case levels.

NO. ID	LOCATION	DRAINAGE SYSTEM	IMPACT	DETERMINED CAUSE(S)	MITIGATION RECOMMENDATION(S)
2.	Braeside Park	Dingley Drain / Governor Road drain	**Occurrence** Extent of impact is outside of project boundary area, however contained within Braeside Parkland. **Magnitude** 1% AEP –Between 0.01 and 0.046 metres.	Net reduction, through embankment earthworks, of the available area for floodplain storage.	No further mitigation action is recommended.
3.	East of *the Bowen Parkway* road	Bowen Road D.S.	**Occurrence** Downstream of the proposed Smythes drain crossing. Impact within banks of the Bowen Road D.S. open channel. **Magnitude** 1% AEP – Between 0.01 and 0.055 metres.	Increased upstream flow rates sourced from transverse drain *CD K1*	No further mitigation action is recommended.

In additional, to ensure the proposed works modification will not have unacceptable adverse impacts, Melbourne Water, Kingston City Council and Greater Dandenong City Council, as appropriate should be consulted during the design stage to ensure the volume, peak flow and quality of surface water discharges during operation have no adverse impact to the drainage network capacities. The environmental performance requirement for flooding impacts in design and operation is EPR W6 (refer to Section 8).

7.4.3 CONSTRUCTION PHASE MITIGATION MEASURES

7.4.3.1 FLOODPLAIN MANAGEMENT

Where construction is required within the 1% AEP floodplain the following activities should be managed in consultation with the relevant floodplain authority:

- Stockpiles
- Location of equipment and plant
- Formwork and temporary works
- Temporary diversions or cofferdams
- Access and/or working platforms
- Modifications to banks and levees.

All MRPA maintenance and construction projects are required to develop a Construction Environmental Management Plan (CEMP). The CEMP should outline how the contractor will comply with any environmental conditions for the project and provide a framework to ensure that environmental risks are properly managed.

To minimise the impact of construction work on overland flow paths and floodplains, the works should be carried out in accordance with Melbourne Water requirements and in consultation with any other relevant drainage authority. Melbourne Water have outlined requirements during the construction phase related to flooding (Melbourne Water, June 2017) that include:

- Prior to the commencement of any works, hydraulic modelling is to be submitted to Melbourne Water demonstrating minimum flood impacts as a result of the temporary works; and
- Where there is a temporary impact on the floodplain, the project will be required to submit a method of mitigation to eliminate or reasonably manage such risk.

The environmental performance requirement for flooding impacts during construction is EPR W4 (refer to Section 8).

7.4.3.2 WATER QUALITY AND WATER BODY HEALTH IMPACT

Clause 56 of the SEPP requires construction works be managed to minimise land disturbance, soil erosion and the discharge of sediment and other pollutants to surface waters. To achieve this, stormwater management should be developed prior to construction works and should be consistent with guidance in the EPA publications Construction Techniques for Sediment Pollution Control (1991) and Environmental Guidelines for Major Construction Sites (1996).

If stockpiling of material is necessary, runoff from these areas would need to be minimised and managed in accordance with Environmental Guidelines for Major Construction Sites (1996) using techniques such as:

- Minimise the storage volume and area of stockpiled material
- Minimise the time construction materials are stockpiled on site
- Covering materials that may have fine particles and are easily eroded
- Diverting flow from external catchments away from the base of stockpiled material
- Providing sediment control measures for runoff from stockpiled materials.

The rate, quality and location of pumped discharge would need to be agreed with the relevant drainage authorities, including Council and Melbourne Water. The discharge should not adversely impact on existing flood levels or the capacity of the stormwater network.

A Construction Environmental Management Plan should be prepared which indicates how potentially contaminated runoff will be characterised, treated and disposed of. If runoff from site occurs, it must meet SEPP requirements. The environmental performance requirement for water quality during construction is EPR W3 (refer to Section 8).

7.4.4 WATER MANAGEMENT AND MONITORING PLAN

A water management and monitoring plan (WMMP) is recommended to to ensure the project will not adversely affect the environment. The WMMP should be prepared in consultation with EPA Victoria and relevant water authorities, and be implemented during construction and for five years following opening the project to the public. It is recommended that the WMMP incorporates both surface water and groundwater quality monitoring. The management should be developed, incorporating the baseline data, and include detail of the monitoring parameters, specific trigger levels and action plans upon exceedance and detailed reporting requirements. The environmental performance requirements for water quality during operation are EPR W5 and EPR W6 (refer to Section 8).

8 ENVIRONMENTAL PERFORMANCE REQUIREMENTS

The EPR's outlined in the table below set out the desired environmental outcomes for the project. The EPRs are applicable to all project phases and provided certainty regarding the projects environmental performance.

Table 8.1 Surface water environmental performance requirements

EPR NUMBER	ENVIRONMENTAL PERFORMANCE REQUIREMENT (EPR)	PROJECT PHASE
W1	**Water body health** During design and operation, impacts on surface water quality and flow must be minimised through adoption of measures to avoid an increase in discharge of pollutant loading (to higher than existing conditions levels) on beneficial uses due to the construction of the project in accordance with CSIRO *Best Practice Environmental Management Guidelines for Urban Stormwater (1999)* and Water Sensitive Road Design (WSRD). In addition, the project must incorporate spill containment at the outfalls which pose a high risk to sensitive receptors, including Braeside Park Wetlands, Waterways Wetlands, Woodlands Wetlands and Edithvale Wetlands. The design of surface water control measures must comply with the VicRoads *Integrated Water Management Guidelines (2013)* and CSIRO *Best Practice Environmental Management Guidelines for Urban Stormwater (1999)*.	Design and Operation
W2	**Flood impacts** Changes to flood behaviour resulting from the project must meet the requirements of Melbourne Water's guideline "*Melbourne Water standards for infrastructure in flood prone areas*". Design-specific maintenance requirements relating to floodwater, and that do not form part of standard VicRoads maintenance requirements, must be included in the Water Management and Monitoring Plan (EPR W5).	Design and Operation
W3	**Surface water management (construction)** — Protect local waterways by applying best practice sedimentation and pollution control measures in accordance with EPA Victoria publication 480 *Environmental Guidelines for Major Construction Sites* and EPA publication 275 *Construction techniques for sediment pollution control* through the Construction Environmental Management Plan(s) and other plans. Implement a water collection and treatment system to ensure that stormwater discharges comply with the *State Environment Protection Policy (Waters of Victoria) 2004* and Melbourne Water performance criteria. Such plans and systems should be prepared in consultation with relevant authorities before the commencement of works.	Construction

EPR NUMBER	ENVIRONMENTAL PERFORMANCE REQUIREMENT (EPR)	PROJECT PHASE
W4	**Flood protection (construction)** During construction, the requirements of the "*Melbourne Water standards for infrastructure in flood prone areas*" must be complied with. Measures must be implemented to the satisfaction of Melbourne Water and in consultation with any other relevant drainage authority, to ensure that temporary construction activities do not increase flood risks (including flood levels, flows and velocities) to the surrounding areas. A flood management plan must be developed in consultation with and not objected by Melbourne Water for any temporary works.	Construction

W5	**Water Management and Monitoring Plan**
	A Water Management and Monitoring Plan (WMMP) must be prepared in consultation with EPA Victoria and relevant water authorities, and be implemented prior to construction, during construction and for five years following opening the project to the public. The WMMP must incorporate both surface and groundwater monitoring.
	Incorporating the baseline data collected to date, the WMMP must include:
	— Detail of the monitoring parameters, including the frequency and location of surface water monitoring points and groundwater monitoring bores
	— Specific trigger levels (water quality in surface water bodies and groundwater bores) and details of contingency plans in the case trigger levels are exceeded
	— Detailed reporting requirements
	— Roles and responsibilities, not limited to:
	    — The owner of monitoring network assets
	    — The manager of monitoring network assets and results
	    — The party (or parties) undertaking monitoring (prior to construction, during construction and for five years following opening).
		All

W6	**Surface water management (design and operation)** The volume, peak flow and quality of surface water discharges during operation must have no adverse impact to the drainage network capacities in consultation with Melbourne Water, Kingston City Council and Greater Dandenong City Council, as appropriate.	Design and Operation

9 CONCLUSION

This report detailed the assessment of the potential impacts of the project on flooding and the health of the waterways and wetlands that will receive runoff from the project. The impacts and mitigation measures identified for the operational phase are summarised as follows:

1. Water body health – The project is assessed to have low impact on the health of water bodies. The proposed design can achieve the required WSRD targets for the project area as a whole. However, localised mitigation measures are required to ensure no increase in pollutants loadings entering the three wetlands (water sensitive receptors). This can be achieved with the provision of bio-retention systems. The impact on the flow regime will be negligible and no mitigation measures are deemed to be required.
2. Flooding impact – The proposed works, with the implementation of the proposed mitigation measures, are expected to meet the flooding performance requirements. With the implementation of the proposed further mitigation measures, the impact is anticipated to further reduced. Higher flood impact locations are found to be around Dingley Drain near Braeside Park but the impact is still satisfied the performance requirements. The flood impact affected areas are limited to parkland and no flood impact sensitive receptor is in this area. Also, the current design solution is considered to provide the best overall outcome for the state, balancing flood risk with cost, ecology and program impacts. Areas of higher impact are restricted to parkland, channel banks and road reserve areas and overall there are no significant changes in flood conditions noted. Thus, no futher improvement work is recommended in this area.
3. Edithvale Wetlands – This report assessed and confirmed that the surface water impact of the proposed project, with the implementation of mitigation measures, is minimal on flooding and water quality aspects. However, the key impact of the project is considered to be the wetlands interaction with the groundwater. This aspect and the overall impact accounting for both impact of surface and ground waters are assessed and presented in the Groundwater Impact Assessment report (WSP2018).

For surface water impact during construction phase, there is potential to temporarily worsen flooding due to the presence of temporary works (such as access tracks, piling platforms, stockpiles, etc.) in the floodplain causing reductions in flood conveyance or floodplain storage. Temporary diversion of overland flow and restriction of flow paths also has the potential to worsen flooding.

Erosion of disturbed areas within construction sites has the potential to contribute large sediment loads to downstream areas. Sediment laden runoff from disturbed areas, stockpiles, storage areas and haulage routes may increase turbidity of receiving water bodies resulting in reduced water quality. There is also potential for runoff to contain pollutants including contaminated sediments, oils and/or chemicals.

During construction, it may be necessary to dispose of runoff from excavated areas after rainfall events using temporary pumping. Surface water pumped from construction areas may be high in sediment, turbidity and other pollutants. Without water quality control measures pumped discharge may adversely impact on nearby waterway networks.

The mitigation measures required to minimise the impacts depends on the construction staging and methods, which will only be available at later stage. However, if, prior to commencement of construction, a Construction Environmental Management Plan (CEMP) that outlines how the contractor will comply with any environmental conditions for the project and provide a framework to ensure that environmental risks are properly managed, is prepared and approved by the relevant authorities. The residual impact risk is anticipated to be minimal.

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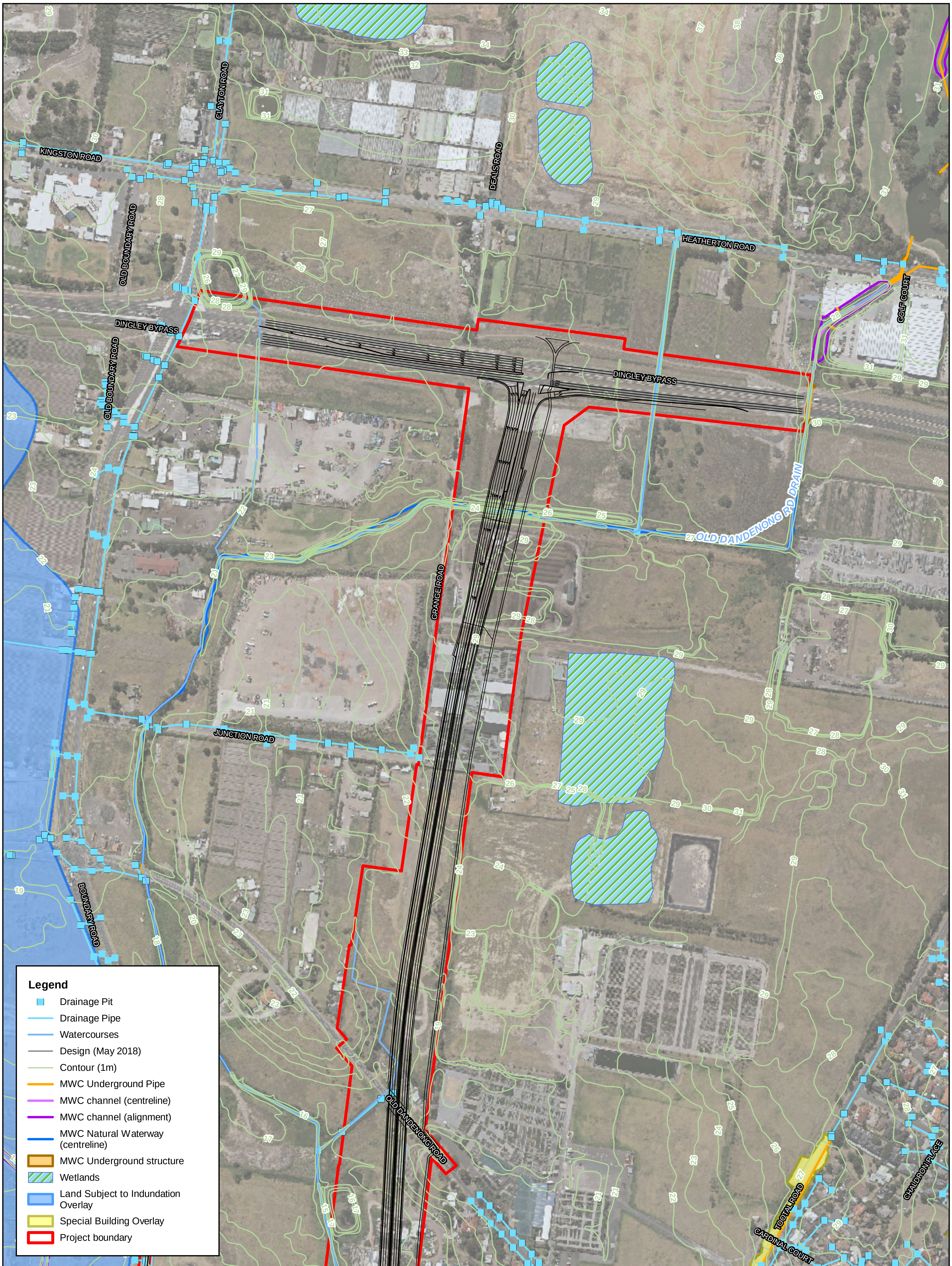
APPENDIX A

SURFACE WATER OVERVIEW MAPS



Map: 2135645A_GIS_160_A5 | Author: AS

Date: 28/05/2018 | Approved by:

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Surface Water Overview - Map 1

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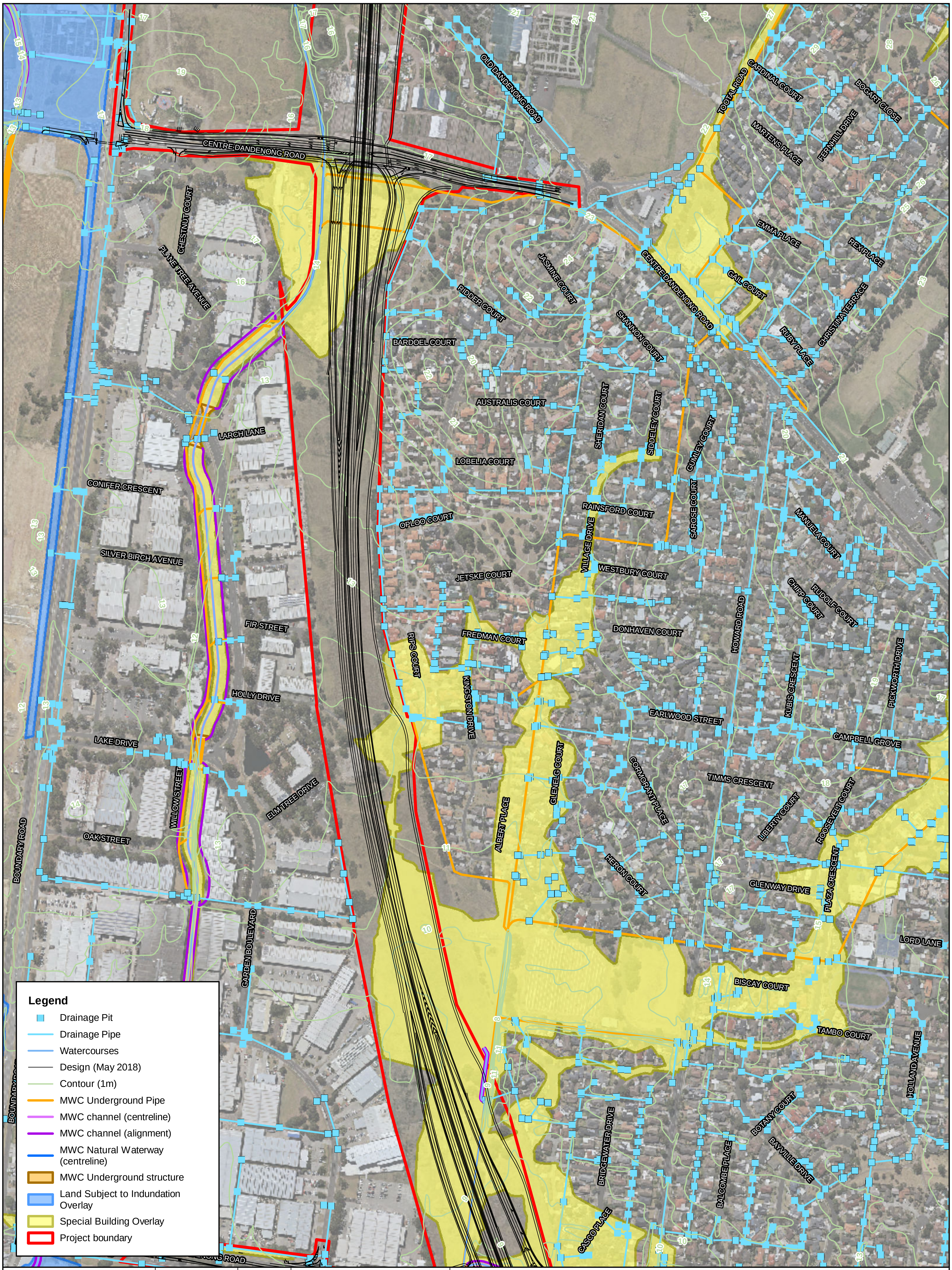

Map: 2135645A_GIS_160_A5

Author: AS

Date: 28/05/2018

Approved by:

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Coordinate system: GDA 1994 MGA Zone 55

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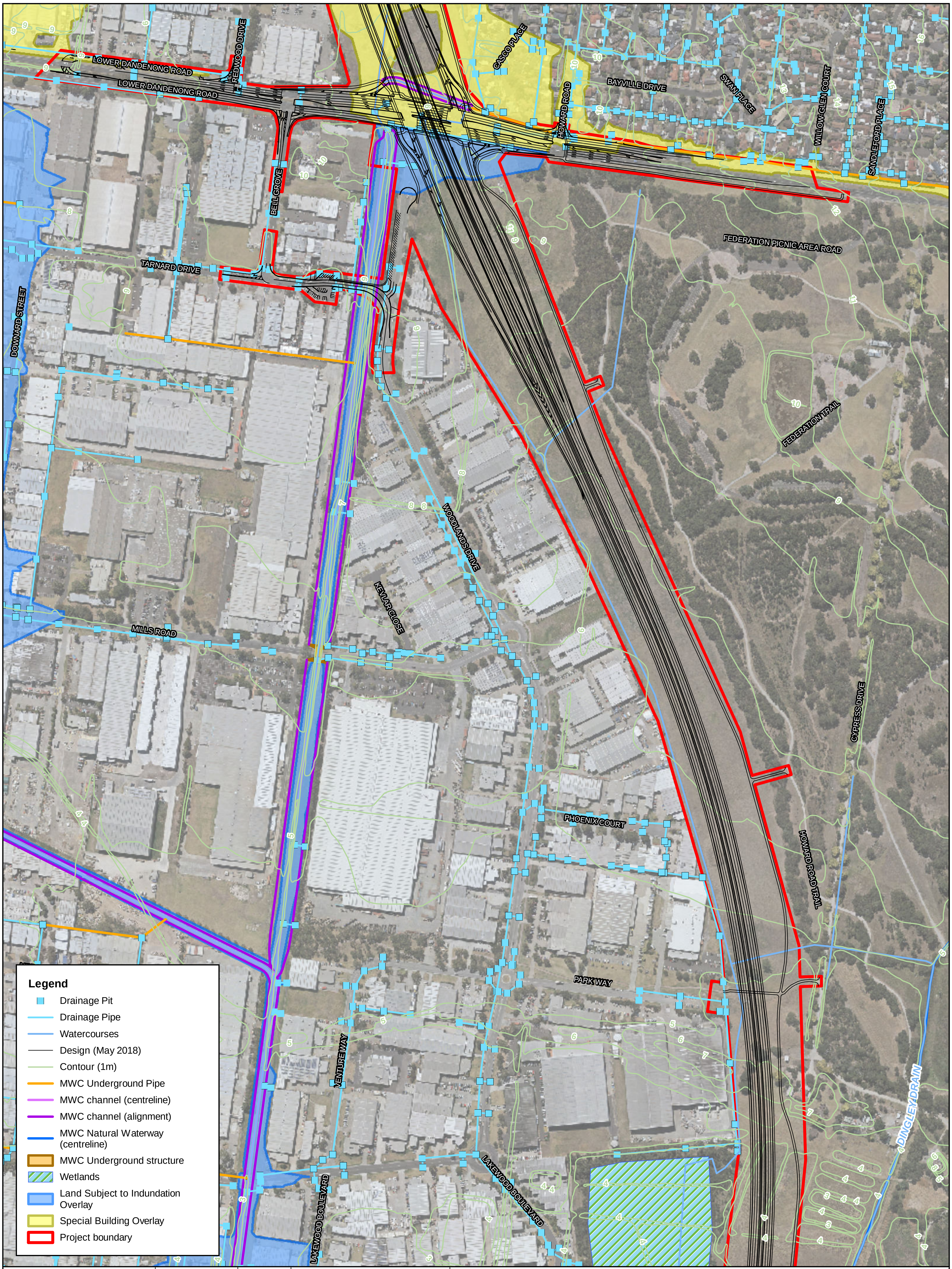
Surface Water Overview - Map 2



Map: 2135645A_GIS_160_A5	Author: AS
Date: 28/05/2018	Approved by:

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Surface Water Overview - Map 3

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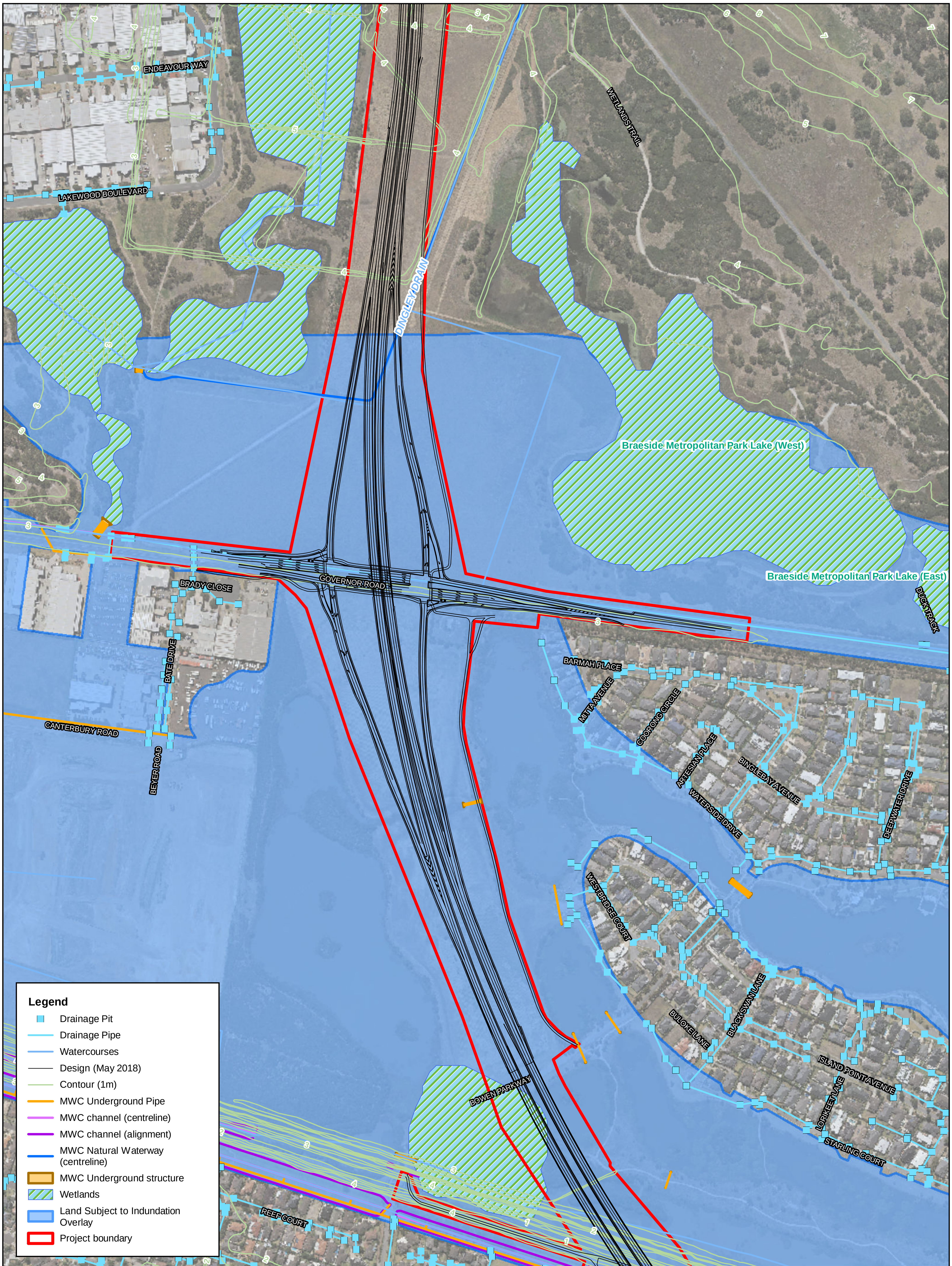

Map: 2135645A_GIS_160_A5	Author: AS	
Date: 28/05/2018	Approved by:	

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Surface Water Overview - Map 4

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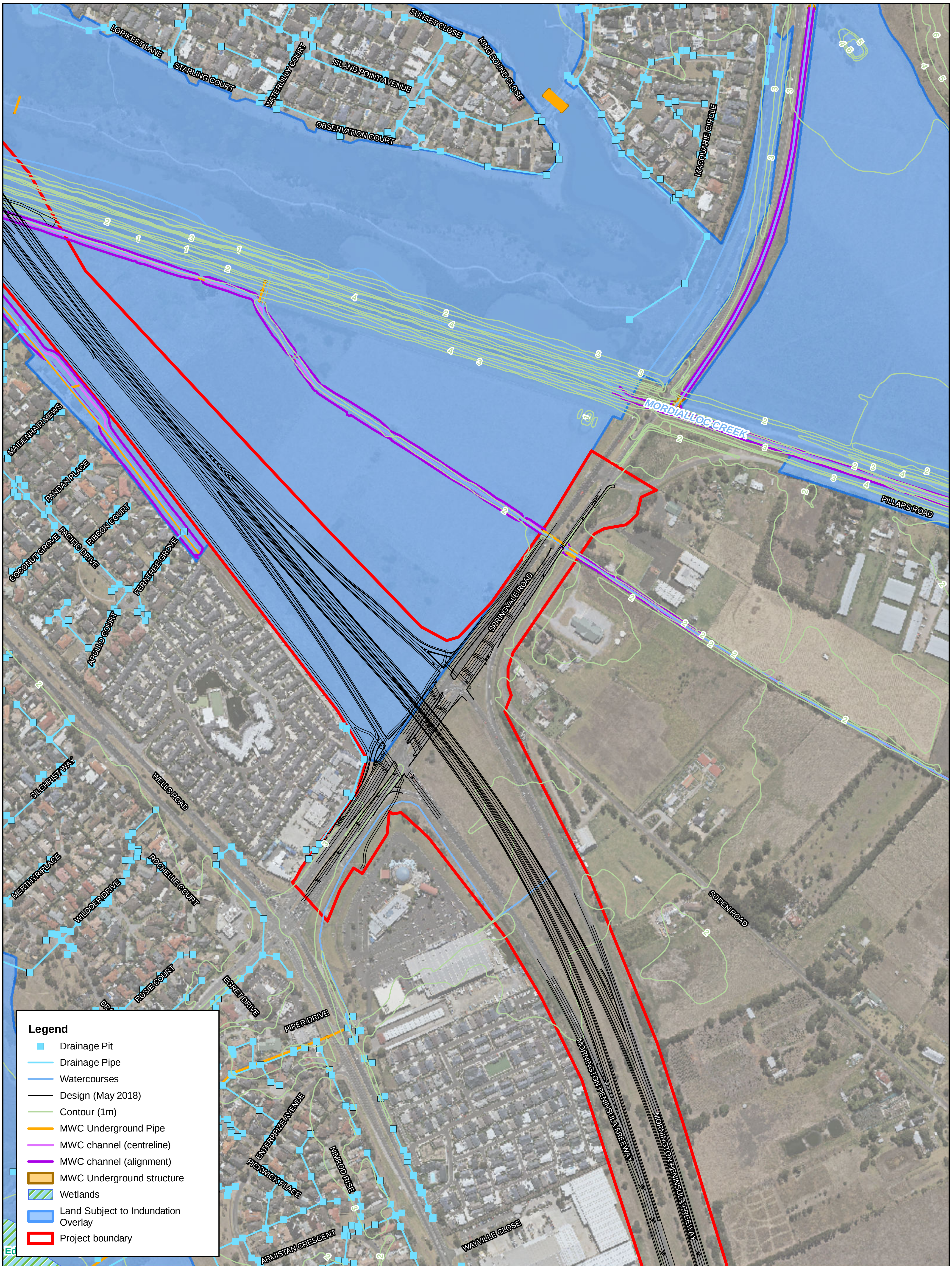

Map: 2135645A_GIS_160_A5	Author: AS
Date: 28/05/2018	Approved by:

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Surface Water Overview - Map 5

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Engineering and Technical Services for Mordialloc Freeway Upgrade

Surface Water Overview - Map 6

APPENDIX B

REVIEW OF PREVIOUS STUDIES

B1 MORDIALLOC BYPASS DESKTOP HYDROLOGY ASSESSMENT

GHD completed the Draft Mordialloc Bypass Desktop Hydrology Assessment for VicRoads in October 2016. The purpose of the report was to provide preliminary sizing for cross-drainage to enable the development of a business case proposal for the Mordialloc Bypass. It follows previous work undertaken for the concept design completed for VicRoads (GHD, 2013) and utilises the flood modelling and mapping completed for Melbourne Water (GHD, 2013).

Key points from the draft report include:

- Based on the concept design (GHD, 2013), the proposed bypass crosses existing flow paths at 11 identified existing flow paths, as listed in Table B.1.
- Existing conditions flood levels and flows for the cross-drainage assessment have been adopted from the Melbourne Water Mordialloc Settlement Drain flood mapping project, which included a TUFLOW hydraulic model covering most of the alignment of the MBP.
- A short southern section of the Mordialloc Bypass project was not covered by the extent of the TUFLOW model. The assessment assumed it did not correspond to any major flow path or overland flooding.
- One-dimensional hydraulic modelling using HEC-RAS steady state and/or SWMM was undertaken to determine preliminary sizes for cross drainage structures. Features and assumptions of the modelling include:
  - Model extent was limited to within the road corridor
  - The TUFLOW 'model geometry' was adopted; and
  - Flow and flood levels were extracted from the TUFLOW model to use as upstream and downstream boundary conditions.
- Outstanding issues and limitations outlined in the report include:
  - Effects of loss in floodplain storage not accounted
  - Consultation with Melbourne Water and Kingston City Council potential for works within Braeside Park (Waterways Area)
  - Consultation with Melbourne Water about works close to the sewer pump station on the southern side of Lower Dandenong Road
  - Consultation with Melbourne Water, Kingston City Council and land owners about the potential for works outside the project boundary, specifically upstream and downstream of Centre Dandenong Road (proposed swale option); and
  - Confirmation of afflux and blockage requirements by Melbourne Water is needed.

Table B.1 Identified locations of existing flow paths crossed by the project

GENERAL LOCATION	EXISTING FLOW PATH
Waterways	MC1 – Mordialloc Creek MC2 – Waterways Wetland
Governor Road	DD1 – Dingley Drain (via Braeside wetlands) DD2 – Dingley Drain DD3 – Dingley Drain breakaway
Lower Dandenong Road	G1 – Gartsides South G2 – Gartsides G3 – Gartsides breakaway 1 G4 – Gartsides breakaway 2
Centre Dandenong Road	OD1 – Old Dandenong Road Drain
Dingley Bypass	OD2 – Old Dandenong Road Drain

B2 DINGLEY BYPASS CROSS-DRAINAGE HYDRAULIC ASSESSMENT

GHD completed the Dingley Bypass cross drainage hydraulic assessment for Thiess and VicRoads in October 2014. The purpose of the report was to confirm the hydraulic design of cross drainage for review and acceptance by Melbourne Water.

Key points from the report include:

- The existing conditions flood levels and flows for cross-drainage were adopted from the Mordialloc Settlement Drain flood mapping project (GHD, 2013).
- A table extract of cross drainage infrastructure with relevance to the Mordialloc Bypass project catchment area is shown in Table B.2.
- Regarding the cross-drainage culvert at location ‘G’ (adjacent Grange Road), it was noted that ‘at some point in the future a new pipe will be constructed that will divert flood flows from the Deals Road Drainage Scheme to crossing ‘G’.
- The effect of the diversion on total catchment flow, as it relates to the Mordialloc Bypass catchment, is insignificant in that its main impact is diverting flood flow which would otherwise flow through Dunlops Drain (also known as Old Dandenong Road Drain), which already occurs within the Mordialloc Bypass catchment.
- Flows from Crossing ‘G’ will be conveyed to Dunlop’s Drain along a proposed channel running parallel to Grange Road.
- Tuflow hydraulic modelling of a design case scenario with cross-drainage assets found that there is limited increase in flood levels downstream of the bypass. Furthermore, there was generally no significant increase in flood levels upstream from the bypass.
- It was recommended that Grange Road is lowered to increase the conveyance of flood flows in Dunlops Drain for the 100 year ARI event. This would in turn lower the increase in flood levels upstream of the Road which currently acts as a partial barrier. Tuflow modelling indicated that Grange Road would need to be lowered by 200 mm and its verges by 500 mm, where it crosses the drain, to prevent the upstream afflux in flooding.

Table B.2 Identified locations of existing flow paths crossed by the project

WATERWAY CROSSING	STRUCTURE TYPE	COMMENTS
Crossing ‘F’ for Mordialloc Settlement Drain	Bridge	
Crossing ‘G’ to accommodate Deals Road Drainage Scheme	Culvert	Channel required downstream to connect into Dunlop’s Drain adjacent to Grange Road.
Crossing ‘I’ at Dunlops Drain / Old Dandenong Road Drain	Culvert	
Crossing ‘J’	Culvert	An unnamed drain, west of Tootal Road. Not included in MWC supplied GIS

B3 MORDIALLOC SETTLEMENT DRAIN FLOOD MAPPING

GHD completed the Mordialloc Settlement Drain Flood Mapping project for Melbourne Water in May 2013. The study area covers the Braeside West and Mordialloc Creek wetlands (Waterways) catchments, which the MBP is a part of. Hydrologic modelling was undertaken through RORB models of the assessed catchments, with the purpose of providing hydrographs for input into a TUFLOW hydraulic model. The TUFLOW model was created using drainage details and LiDAR-based terrain data from Melbourne Water and inflow hydrographs from RORB.

As part of the flooding impact assessment of the MBP, it is proposed that the aforementioned RORB and TUFLOW models be used as a basis for the development of (a) a base case (existing conditions) TUFLOW model which covers the study area catchment, and (b) a proposed case TUFLOW model which contains the MBP design alignment. The following considerations will be accounted for during the modelling task (refer recommendations for corresponding actions):

- A short southern section of the MBP project is not covered by the extent of the RORB and TUFLOW models. A review of the existing flooding and hydrology information is required to determine a suitable approach the flooding assessment at this section, and particularly if detailed modelling is required.
- The adopted data and modelling assumptions were described as generally being the best available for the time the data was obtained. In some instances, the RORB and TUFLOW models may not reflect changes (if any) to development or drainage detail that have taken place since finalisation of the models in 2013. One such example, which was discussed with Melbourne Water, was where the TUFLOW model made allowance for a temporary retarding basin which was yet to be built near Moorabbin Airport. Since then, the basin, at present known as Moorabbin Airport Retarding Basin, has been built.

B4 SMYTHES DRAIN/SPRINGS DRAIN BANGHOLME FLOODING INVESTIGATION DISCUSSION PAPER

Full reference: Craigie, N M (2011). Smythes drain/springs drain Bangholme Flooding Investigation Discussion paper, Draft version 3. For Melbourne Water and City of Greater Dandenong, August 2011.

An investigation was commissioned by Melbourne Water and the City of Greater Dandenong in response to the localised rain storm event that occurred in the Bangholme area in 4/5 February 2011. Notable conclusions from the paper by the author Neil M Craigie are extracted below:

- The average rainfall conditions over the Bangholme area were likely equivalent to a 500 year ARI (appx 0.02% AEP) event for durations between 1.5 and 14.5 hours.
- Catchment expected to be in a saturated condition at the time of the 4/5 February 2011 flood, and likely to have caused a high proportion of runoff.
- An estimated 41% of the rainfall input volume was stored upstream of Springvale Road emphasising how impeded surface drainage was in the study area. Private crossings are noted to interfere with the free passage of floodwaters in this area.
- Recorded peak flood levels 4/5 February 2011:
  - In the Soden Road and Riverend area flood levels reportedly reached 2.2 metres AHD based on survey of debris markings, given as being equivalent to a 500 year ARI (appx 0.2% AEP) flood event
  - A flood level of 2.01 mAHD was recorded for Smythes Drain immediately on the south side of the levee indicating that (a) little relief had occurred at Soden Road at this time and (b) about 200 mm of potential backflow head occurred across the twin 600 mm floodgates **(now blocked, see preceding conclusions)**
  - Peak levels in the Waterways area reached 3.0 metres AHD, given as being between the 100 year ARI (appx 1% AEP) level of 2.85 mAHD and 500 year ARI (appx 0.2% AEP) level of 3.22 mAHD.
- Water levels in the levee banked waterways flanking the subject area were well below the levee crest and posed no threat in this event.
- It has been noted that the ‘potential for incremental filling to create problems in the future is clear’.
- The most critical flood response action taken by Melbourne Water was to divert the Smythes Drain overflow channel into the Bowen Road Drainage Scheme channel. After the diversion was cut, water levels started to drop slowly within the Soden Road area.
- The Smythes drain floodgates were blocked by Melbourne Water by insertion of steel plates on 9 February 2011.
- The prolonged surface flooding around the Southern Obedience Dog Club indicates that there is no effective low-level drainage serving the club property.
- The author notes that high ponded levels in the Waterways during the 2011 flood event did not play any significant role in the flooding of the Bangholme area.

B5 “THE WATERWAYS” – MORDIALLOC CREEK FLOODPLAIN WETLAND SYSTEM, HYDROLOGIC, HYDRAULIC, WATER QUALITY AND ENVIRONMENTAL PERFORMANCE

The report details the deign intent and functionality of the “Waterways” wetlands.

According to the report, the Waterway wetland is essential two systems:

1 Mordialloc Creek system at the southern side. Water sources are:
   - a 10 ML/d dry weather flow from the Dandenong Creek diversion structure at Pillars Crossing (usually bypassing the other cells)
   - b Stormwater runoff from catchment upstream of Springvale Road.

2 Riparian and Open water cells (surrounding the residential and industrial development). Water sources are:
   - a Stormwater from 2720 ha of runoff from upstream of Springvale Road (feed through from Mordialloc Creek cell)
   - b If required, topped up by low flow from Dandenong Creek diversion structure at Pillar Road
   - c From Mordialloc Creek during wet time (twice a month for 3 or more days on average).

3 The Braeside overflow cell. Water sources from:
   - a Stormwater upstream of Springvale Road feeding from Open water cell
   - b Overflow from Braeside during very wet weather
   - c Stormwater runoff from local residential estates.

Four cells form a series of treatment train of a stormwater constructed wetland feed by 2720 ha of the urban area; time to time topped up by diverted flow from Dandenong Creek and backwater from Mordialloc Creek during flooding time.

The report provides an overview and historical behaviour of flow regime and water quality of Mordialloc Creek up to 2000 before the construction of the “Waterways”. Potential environmental issues of the “Waterways” was also anticipated.

This report also provides an estimation of flooding conditions of the site including possible warning time for evacuation.

There is no information on the existing operation conditions of the “Waterways”.

B6 EDITHVALE-SEAFORD WETLANDS RAMSAR SITE MANAGEMENT PLAN

The key points from this management plan are:

- The Edithvale–Seaford Wetlands are significant wetlands in supporting migratory birds and were listed under the Ramsar Convention in 2001. It is one of few Australian Ramsar sites entirely situated within an urban landscape. The Edithvale-Seaaford Wetlands is listed as a wetland of international importance and recognised under the Ramsar Convention because:
  - The wetlands are considered internationally important as they contain a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
  - The wetlands are considered internationally important as they support vulnerable, endangered, or critically endangered species or threatened ecological communities.
  - The wetlands are considered internationally important as they regularly support 1% of the individuals in a population of one species or subspecies of waterbird.
  - The wetlands are considered internationally important as they support populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
  - The wetlands are considered internationally important as they support plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
- Average annual rainfall of 709 mm recorded at Moorabbin Airport (Station Number 86077; Lat. 37.98° S; Lon. 145.10° E; Elevation: 12 m asl; data 1950-current), the closest weather station with long-term rainfall data.
- The hydrology of the Edithvale-Seaford Wetlands has been significantly altered since European Settlement, such that Edithvale Wetlands receive water largely from local stormwater inlets, with groundwater intrusions also occurring.
- The hydrological function of the Edithvale-Seaford wetlands:
  - Are an essential component of the regional drainage system, receiving, retaining and diverting stormwater and other surface run-off
  - Have a critical flood storage capacity that protects surrounding and downstream properties from flooding; and
  - Contribute to protecting the water quality of Port Phillip Bay by retaining and treating stormwater and other run-off.
- The water quality of the Edithvale–Seaford Wetlands has been adversely affected by surrounding urban development and earlier excavations. Unfortunately, there is a lack of detailed water quality data available for the site to confirm this.
- Saline groundwater intrusions and consequent rising salinity levels are impacting a number of wetland components such as vegetation composition. Considerable work has gone into improving water quality by isolating saline cells and decreasing saline intrusions, as well as installing litter traps, sediment ponds and macrophyte zones (Lane et al. 2000).
- Process threatening the wetlands include:
  - Altered hydrology
  - Increasing salinity
  - Decreasing water quality
  - Pest plants and animals
  - Recreation
  - Fire
  - Climate change

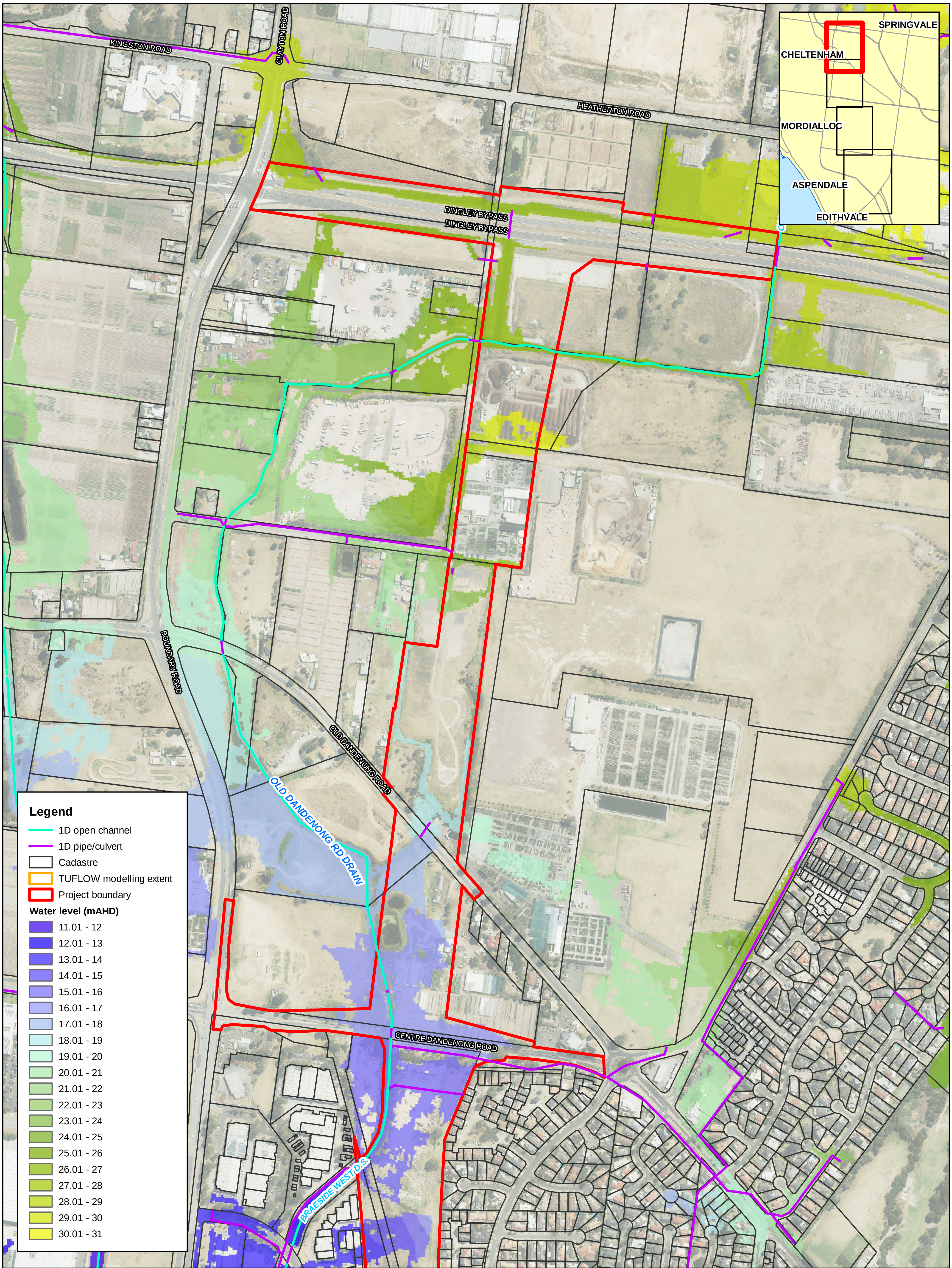
  - Unclear roles and responsibilities
  - Data gaps.
- Hydrological function in supporting key wetland values
  - The status of wetlands as permanent or temporary, shallow or deep depends on the frequency and duration of flooding.
  - The remaining areas of shallow freshwater marsh at Edithvale–Seaford Wetlands are representative of a depleted wetland type in the Gippsland Plain Bioregion.
  - Waterbirds use wetlands for a variety of purposes, including feeding, roosting and nesting.
  - The seasonality, frequency, duration and magnitude of wetland inundation are a key determinant of habitat availability for waterbirds.
  - These hydrological components give rise to the conditions required to stimulate food production, create the conditions for vegetation to flourish, and provide appropriate habitat (e.g. open water or mud flat areas) that waterbirds rely on for feeding, roosting, nesting or breeding.
  - Optimal conditions vary between waterbird species. For example, Edithvale South dries and floods rapidly due to its shallow nature, providing diverse habitat for a wide variety of species as habitats become available then disappear again.
  - Community composition and the species of vegetation present in a wetland are significantly determined by hydrology.
  - The seasonality, depth and length of inundation play a significant role in the distribution and abundance of wetland vegetation species and communities.
- Threats to key values of Edithvale–Seaford Wetlands related to hydrology
  - Optimal waterbird foraging habitat and species diversity at Edithvale–Seaford Wetlands is significantly determined by the extent, depth and duration of inundated land available.
  - The provision of shallow mudflat areas is critical to the numbers of sharp-tailed sandpipers. If these habitats are not available, either by increasing the duration of inundation or changing the depth of inundation, the wetlands are unable to support such high numbers.
  - Changes in hydrology impact on vegetation condition and extent.
  - Vegetation communities are zoned in concentric rings at Edithvale–Seaford Wetlands, correlating with water depth. The loss of water depth through decreased levels or frequencies of inundation may impact on the vegetation types able to survive at the wetlands, impacting on species and community diversity.
  - Common reed and cumbungi dominance is encouraged by water levels and the extended saturation of wetland areas. It appears that some areas of open water are becoming overgrown with these invasive native species, to the detriment of the bird species which favour open water or open mudflats.
- Actions for the management of water quality:
  - Develop and implement an integrated monitoring program incorporating seasonal water quality and macroinvertebrate assessments
  - Develop and implement a program for monthly stormwater quality monitoring—with particular reference to sediment, nutrients, heavy metals and other toxicants
  - Develop an education program for nearby residence on their influence on storm water quality
  - Establish communication schedule between respective monitoring groups
  - Integrate seasonal water quality monitoring program with established Waterwatch group
  - Schedule regular maintenance of litter traps/stormwater inlets.

- Actions for the management of hydrology
  - Determine the environmental flow requirements for the Ramsar site, including recommendations for appropriate volumes, seasonality, and duration of inundation patterns. Ensure recommendations mimic natural seasonal wetting and drying cycles as much as possible
  - Prepare a detailed and integrated hydrological management plan which integrates any recommendations of the environmental flow study. Update regularly Determine the ability of current hydrological facilities to manage for a range of recommended level settings or conditions. Address any shortcomings of infrastructure as required
  - Monitor and track ecological response to the hydrological management of the system. Adaptively manage as required in response to findings
  - Investigate the role of hydrological manipulations in limiting the invasion of dominant native species including common reed and cumbungi (Edithvale South)
  - Monitor and track hydrological inflow and outflow volumes, including surface/groundwater interactions
  - Investigate whether stormwater drains are effectively delivering water to the Ramsar site, particularly where recent construction activities may have interfered with this process
  - Ensure acid sulfate soils remain undisturbed and inundated to prevent acidification. Explore further opportunities and strategies for their management
  - Monitor (every 10 years) the period of inundation, depth, and salinity levels in wetland cells using the Corrick and Norman types to provide a benchmark
  - Investigate current and future options to provide water for drought management during periods of extended dry weather (including the use of water from the Eastern Treatment Plant (ETP) and drought refuge pools)
  - Investigate and document the risks that climate change will pose to the wetlands, including potential hydrological regime changes and any subsequent changes to wetland water requirements
  - Investigate the potential for the wetlands to receive additional water through an Environmental Water Reserve entitlement (or its equivalent) to address the risks of continuing dry conditions and/or climate change
  - Prioritise wetland cells (based on values and threats) for receiving flows should the current drought conditions continue and/or climate change risks are realised. Incorporate these findings into the drought management strategy
  - Develop and implement a program of hydrological manipulations, based on previous investigations, to limit the invasion of dominant native species including common reed and cumbungi (Seaford Swamp and Edithvale South)
  - Complementary to the above action, develop and implement investigation programs to ascertain the role of hydrology in the control of pest plants and animals at the site
  - Prepare a capital works program to undertake the capital investment works outlined in Appendix A of the GHD (2005) report. The program should take into consideration the priorities assigned The program should be updated regularly to also take into consideration the recommendations of any environmental flow study
  - Regularly inspect the condition and efficiency of water supply and distribution infrastructure at Edithvale Wetlands. Repair and maintain as required
  - Ensure the siphon under Edithvale Road is functioning effectively, to enable efficient transfer of stormwater from Edithvale South to Edithvale North Wetlands
  - Develop an integrated management strategy for the use of any additional flows to the wetlands sourced from ETP following its upgrade. Update the plan regularly.

APPENDIX C

FLOOD MAPS

APPENDIX C-1
1% AEP PEAK WATER LEVEL – EXISTING CASE



Map: 2135645A_GIS_627_A7	Author: VD
Date: 7/08/2018	Approved by: ZM

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Engineering and Technical Services for Mordialloc Freeway Upgrade

Base case conditions
Existing climate scenario
1% AEP peak water levels
Map 1

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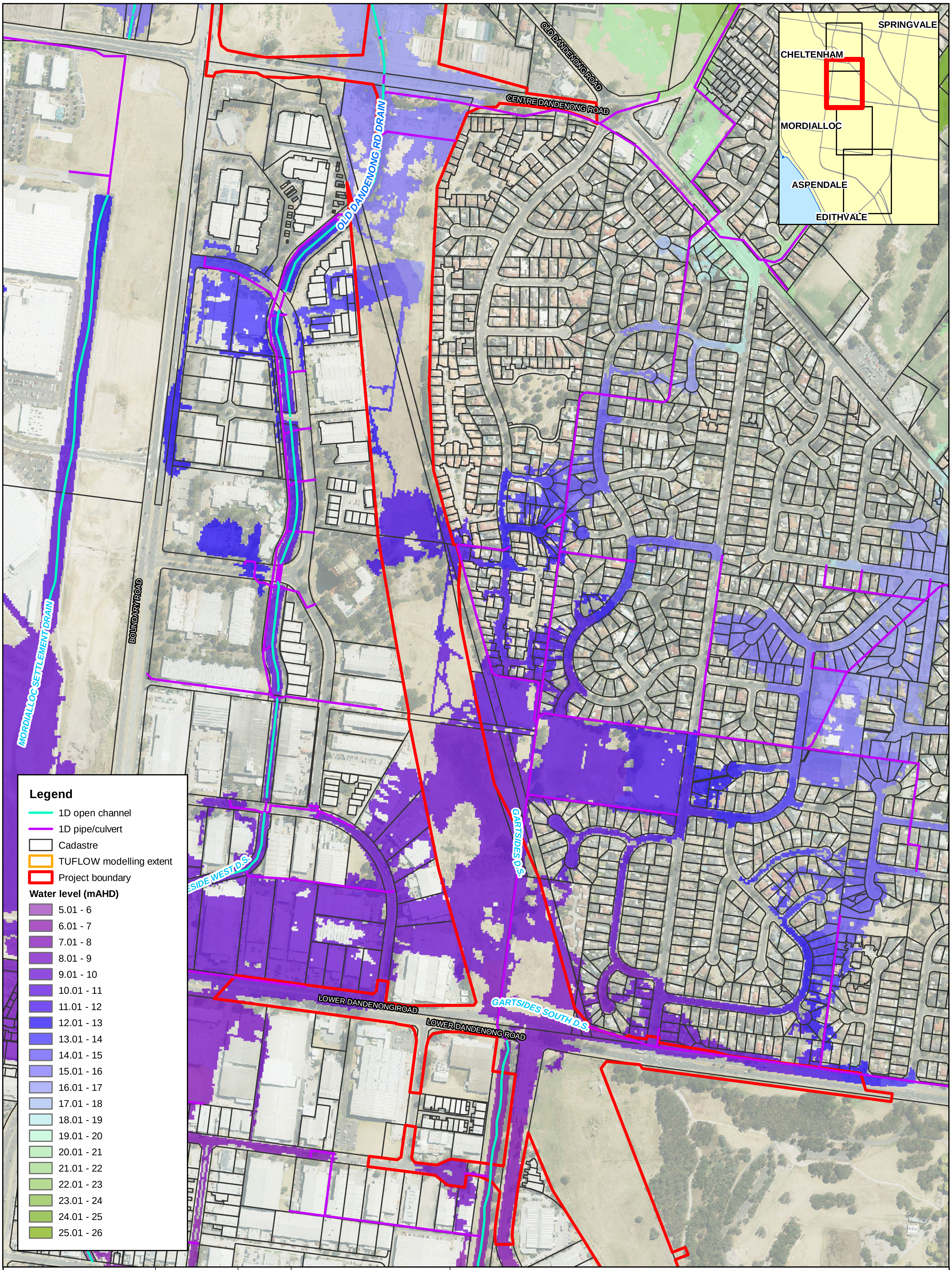

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Engineering and Technical Services for Mordialloc Freeway Upgrade

Base case conditions
Existing climate scenario
1% AEP peak water levels
Map 2

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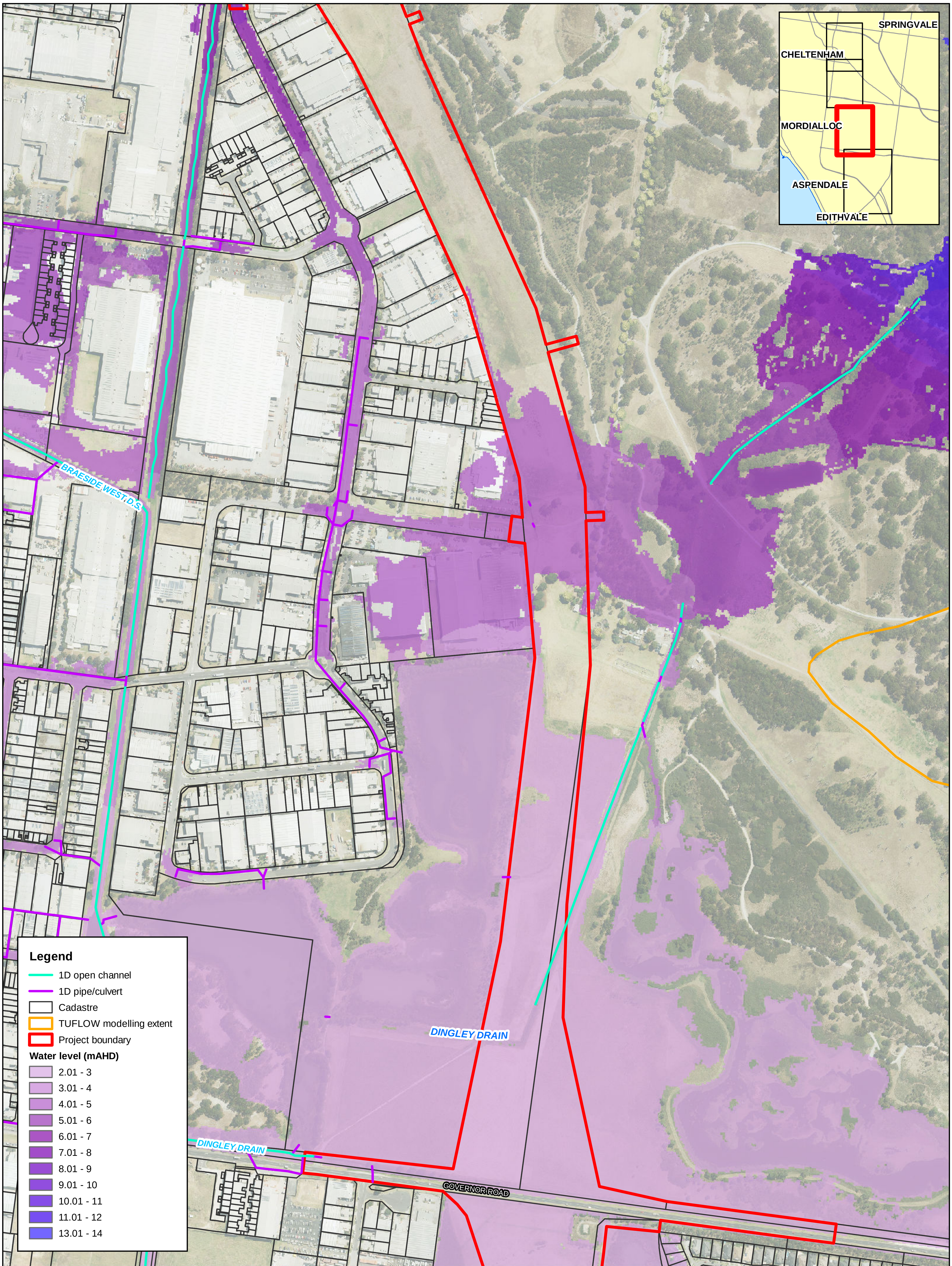

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Date: 7/08/2018	Approved by: ZM	

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Coordinate system: GDA 1994 MGA Zone 55

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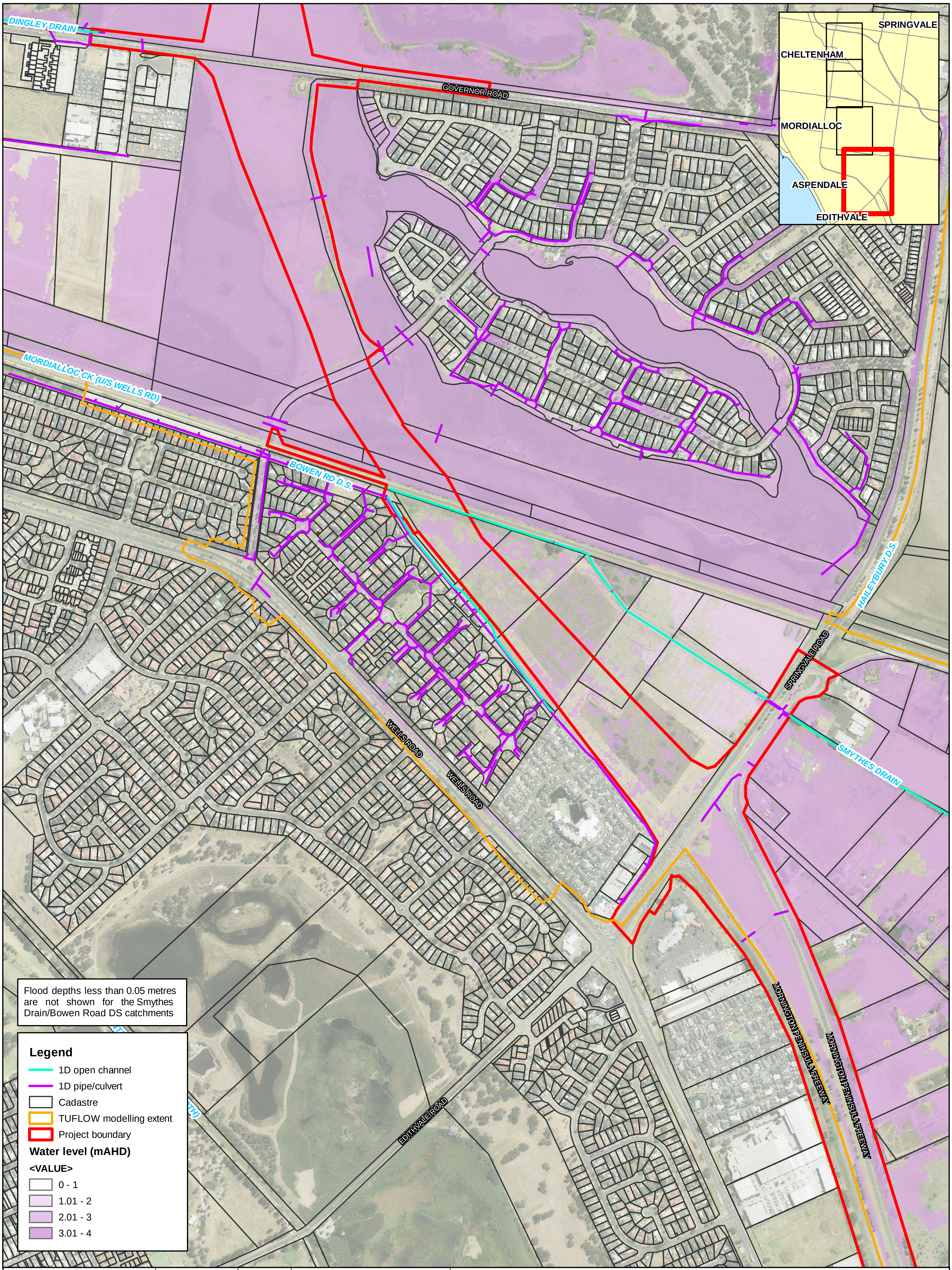
Engineering and Technical Services for Mordialloc Freeway Upgrade

Base case conditions
Existing climate scenario
1% AEP peak water levels
Map 3



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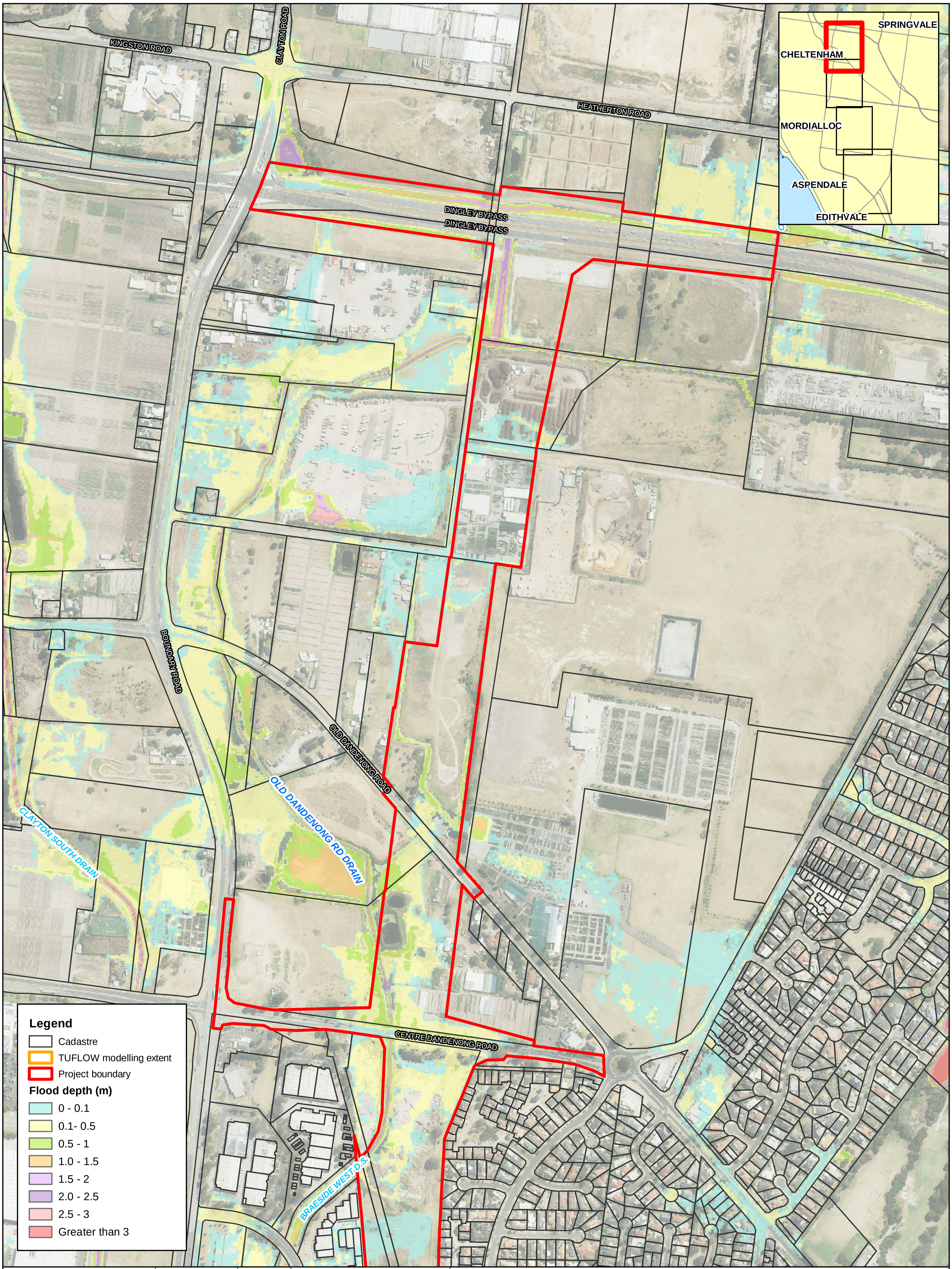
Engineering and Technical Services for Mordialloc Bypass

Base case conditions
Existing climate scenario
1% AEP peak water levels
Map 4

APPENDIX C-2
1% AEP PEAK DEPTH – EXISTING CASE



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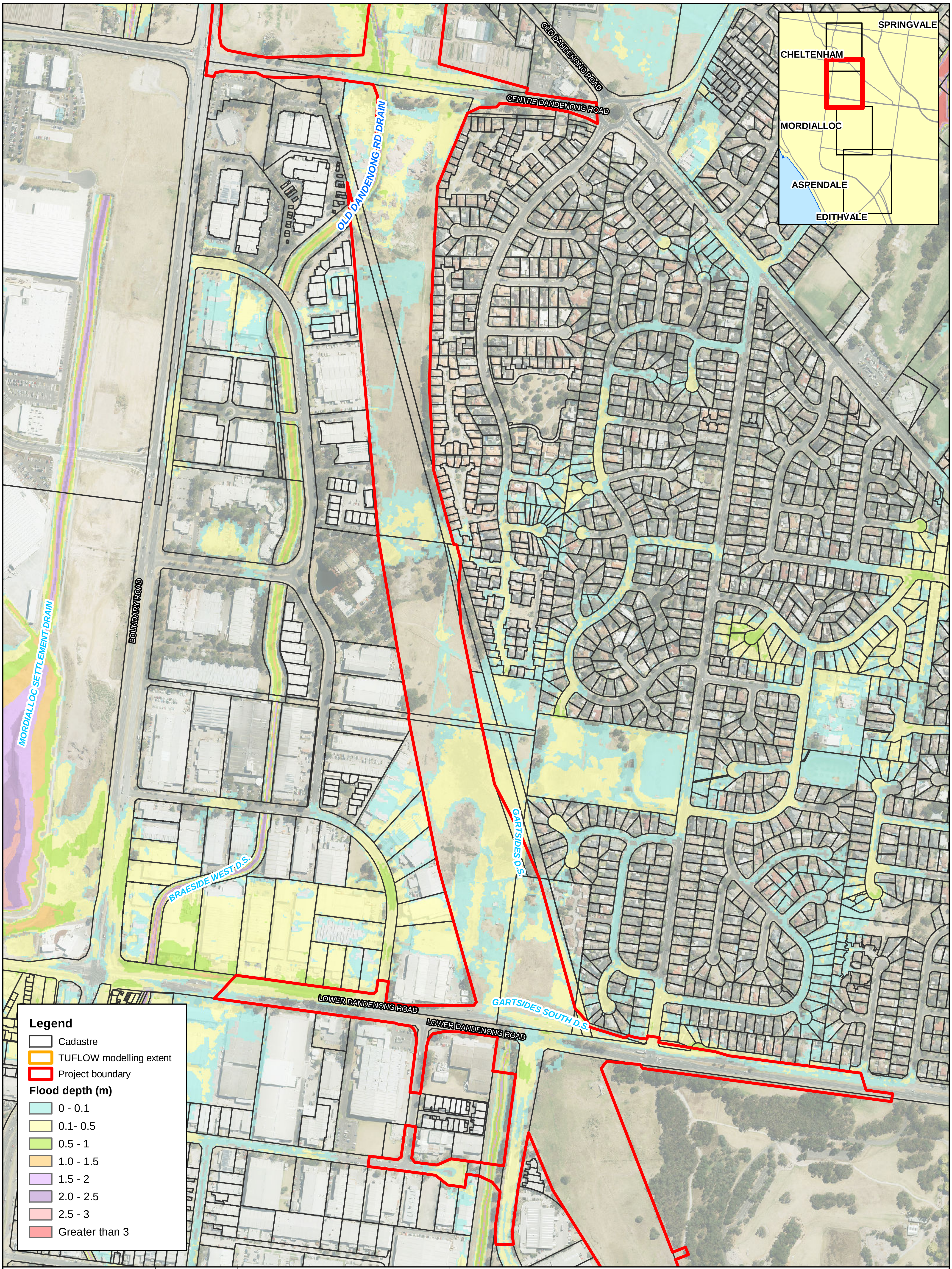
Engineering and Technical Services for Mordialloc Freeway Upgrade

Base case conditions
Existing climate scenario
1% AEP peak water depths
Map 1



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Engineering and Technical Services for Mordialloc Freeway Upgrade

Base case conditions
Existing climate scenario
1% AEP peak water depths
Map 2

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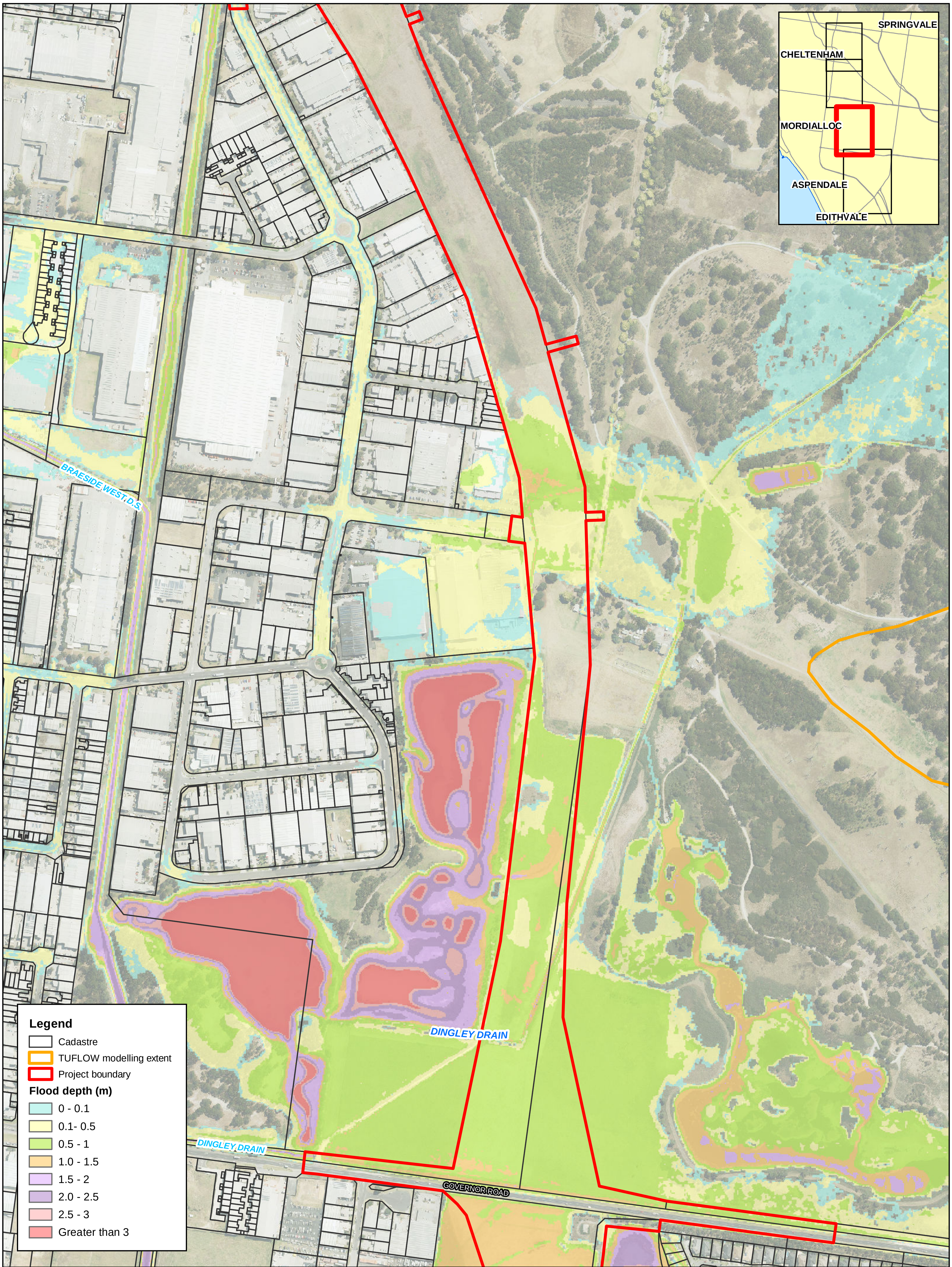

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Engineering and Technical Services for Mordialloc Freeway Upgrade

Base case conditions
Existing climate scenario
1% AEP peak water depths
Map 3

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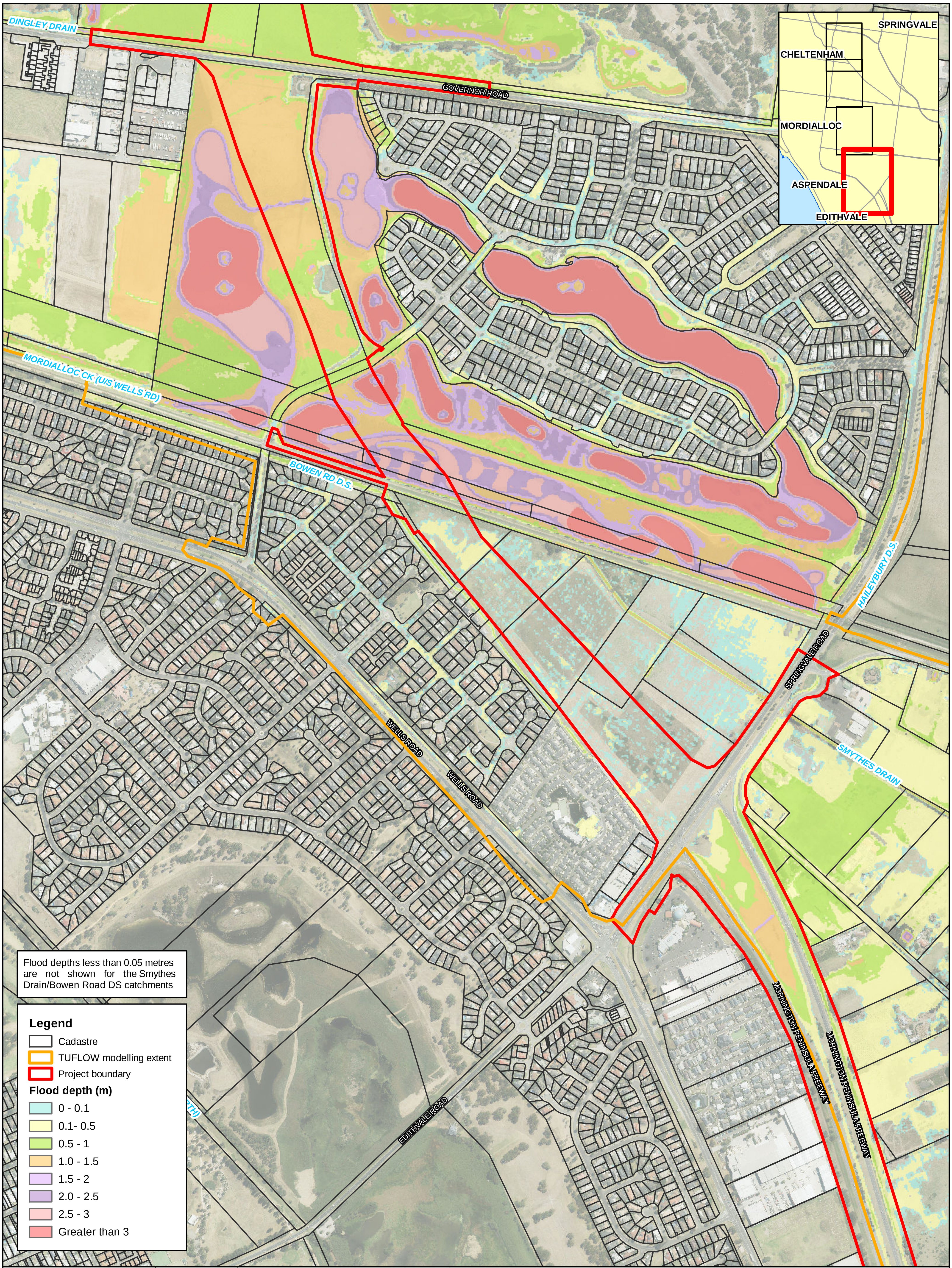

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Engineering and Technical Services for Mordialloc Freeway Upgrade

Base case conditions
Existing climate scenario
1% AEP peak water depths
Map 4

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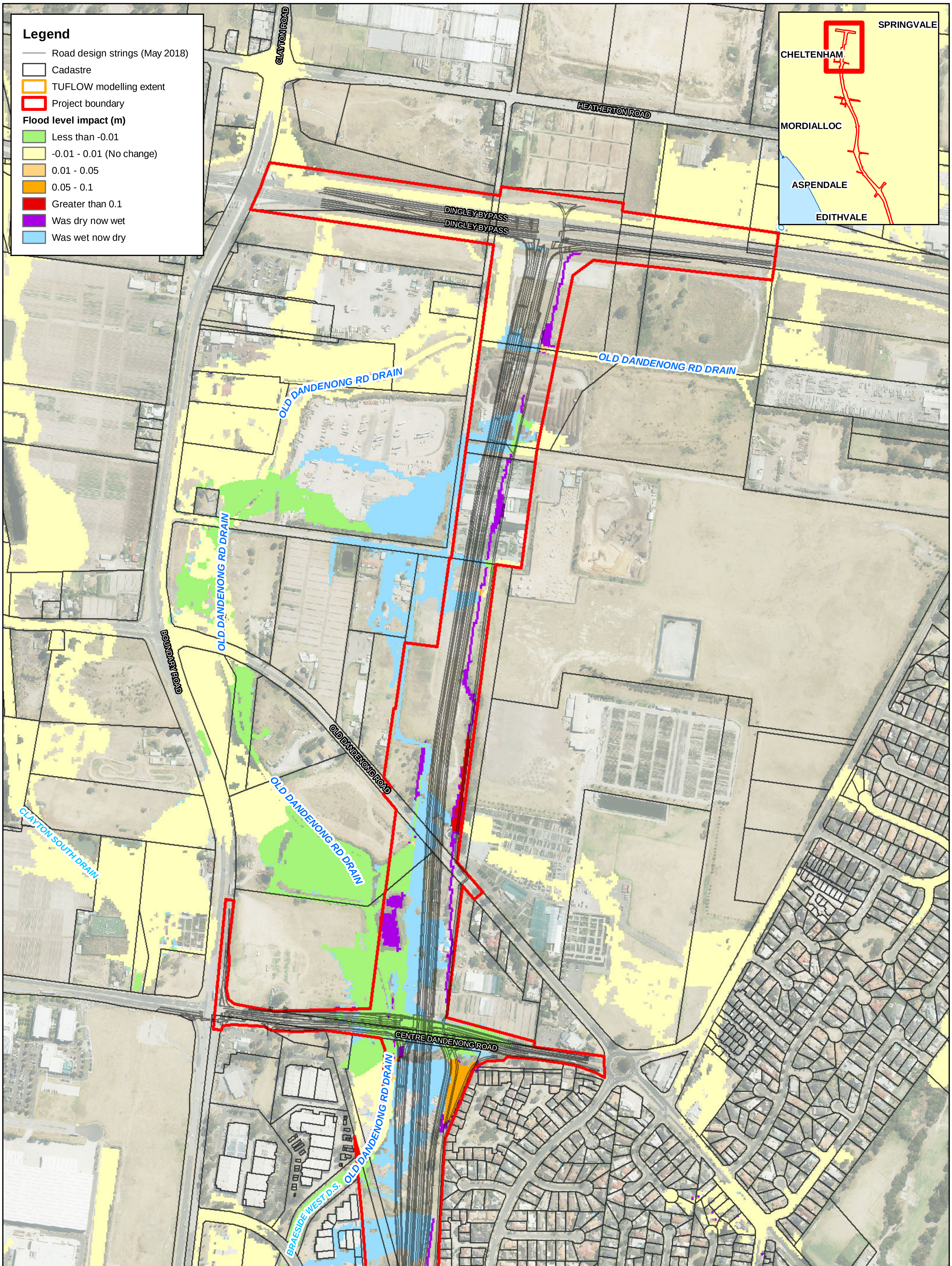
APPENDIX C-3
1% AEP FLOOD LEVEL IMPACT



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Date: 13/08/2018	Approved by: ZM

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Engineering and Technical Services for Mordialloc Freeway Upgrade

Proposed case conditions
1% AEP peak flood level impact
Map 1

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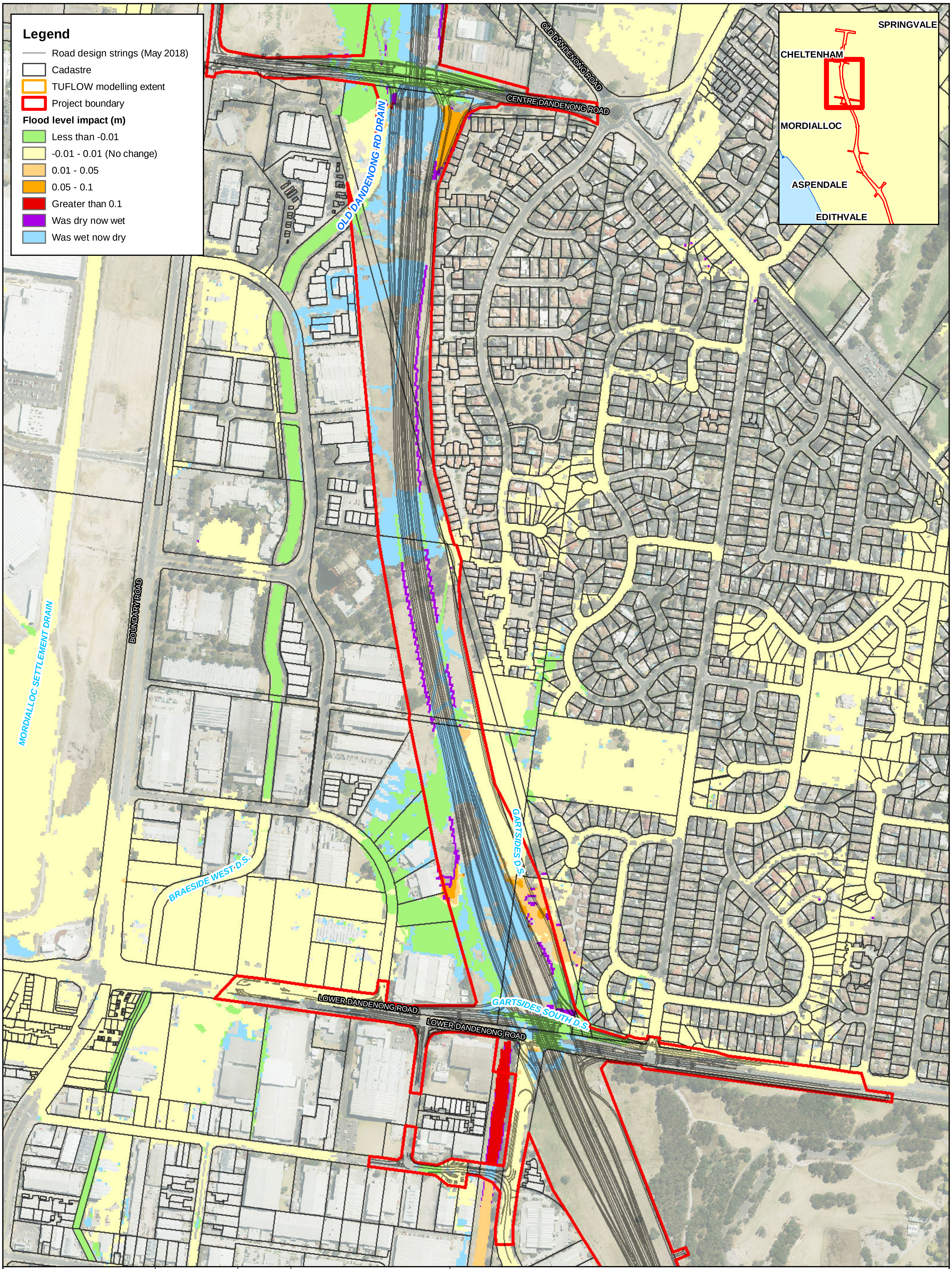

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Engineering and Technical Services for Mordialloc Freeway Upgrade

Proposed case conditions
1% AEP peak flood level impact
Map 2

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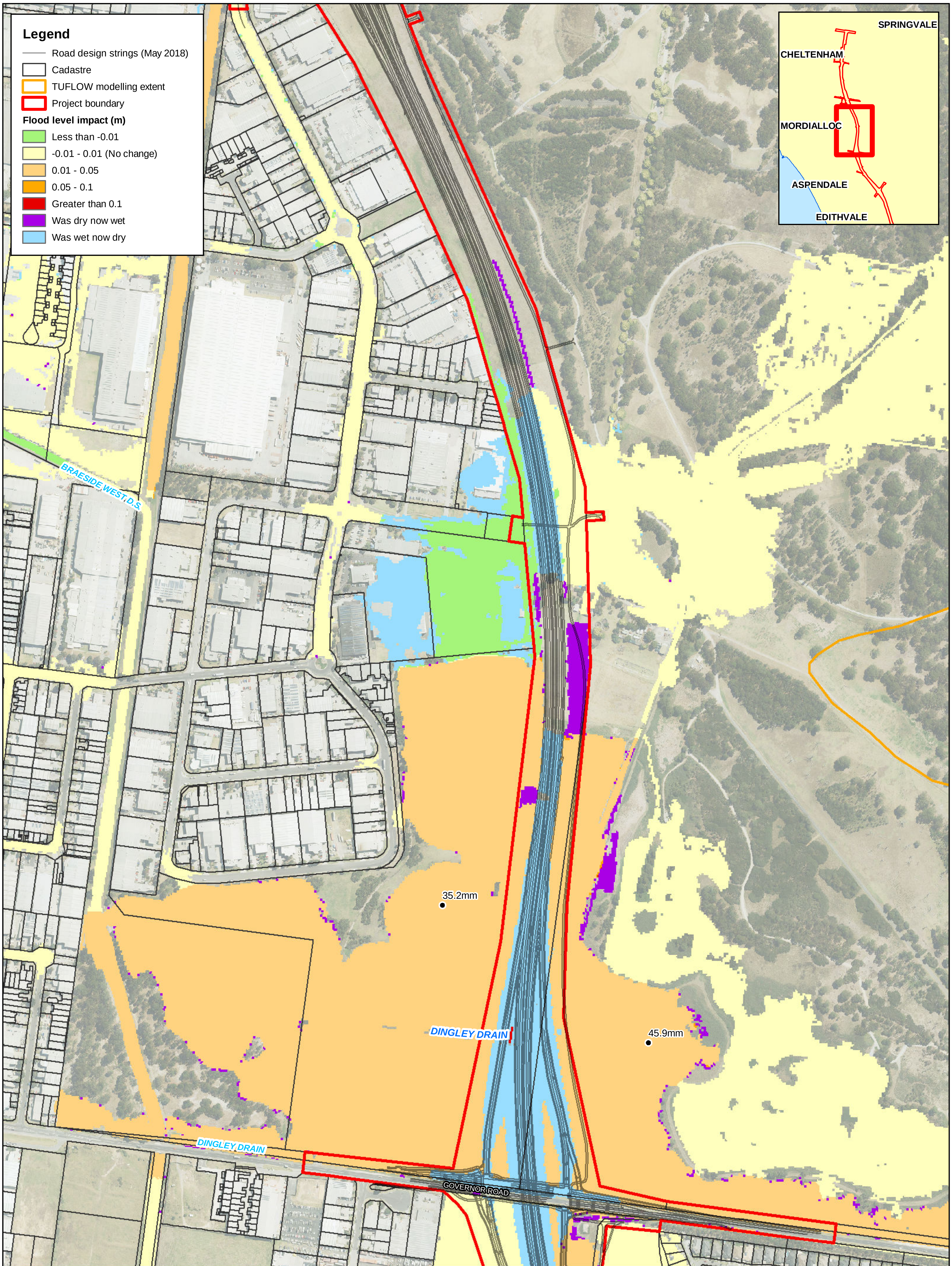

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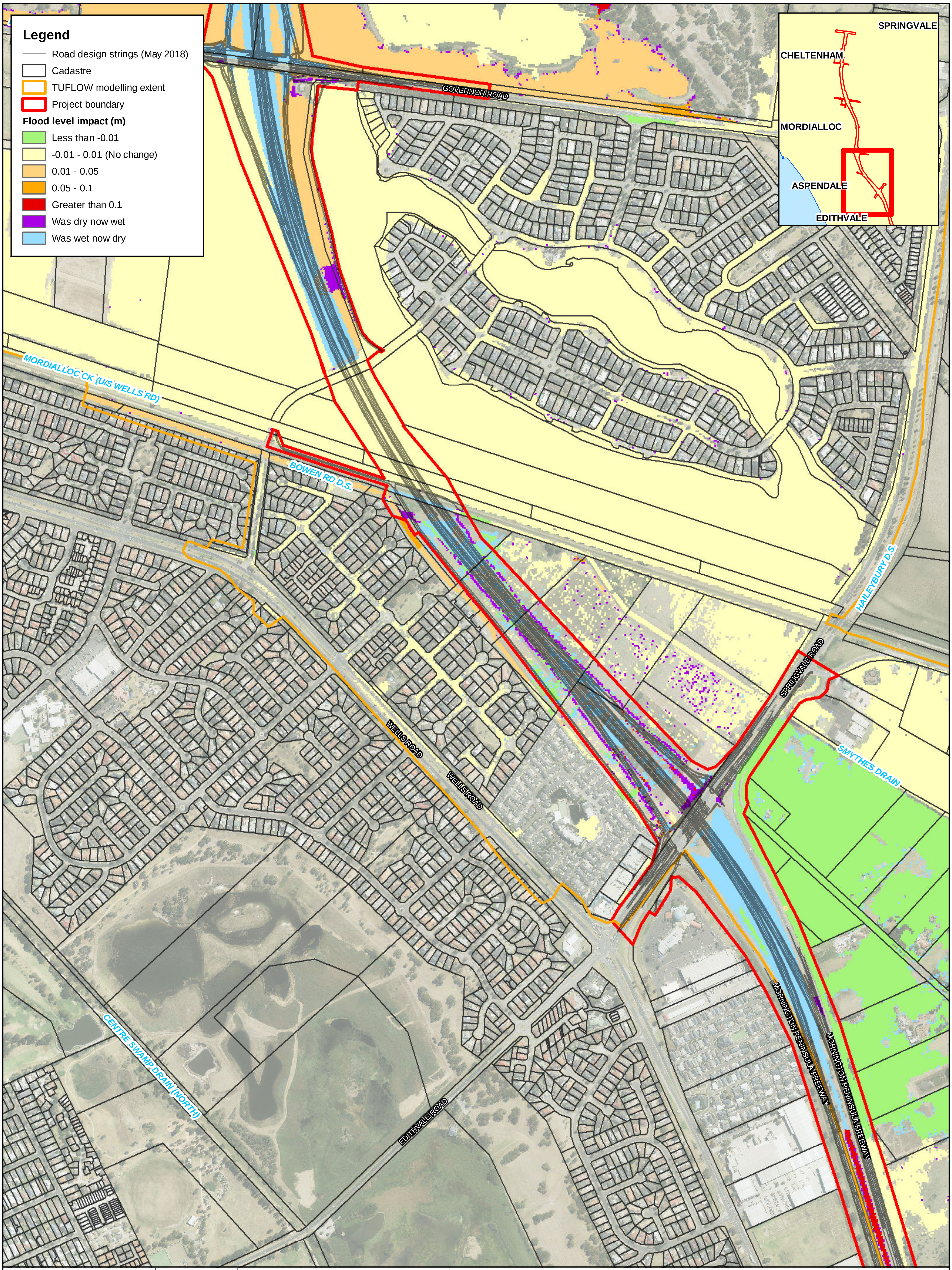
Engineering and Technical Services for Mordialloc Freeway Upgrade

Proposed case conditions
1% AEP peak flood level impact
Map 3



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Engineering and Technical Services for Mordialloc Freeway Upgrade

Proposed case conditions
1% AEP peak flood level impact
Map 4

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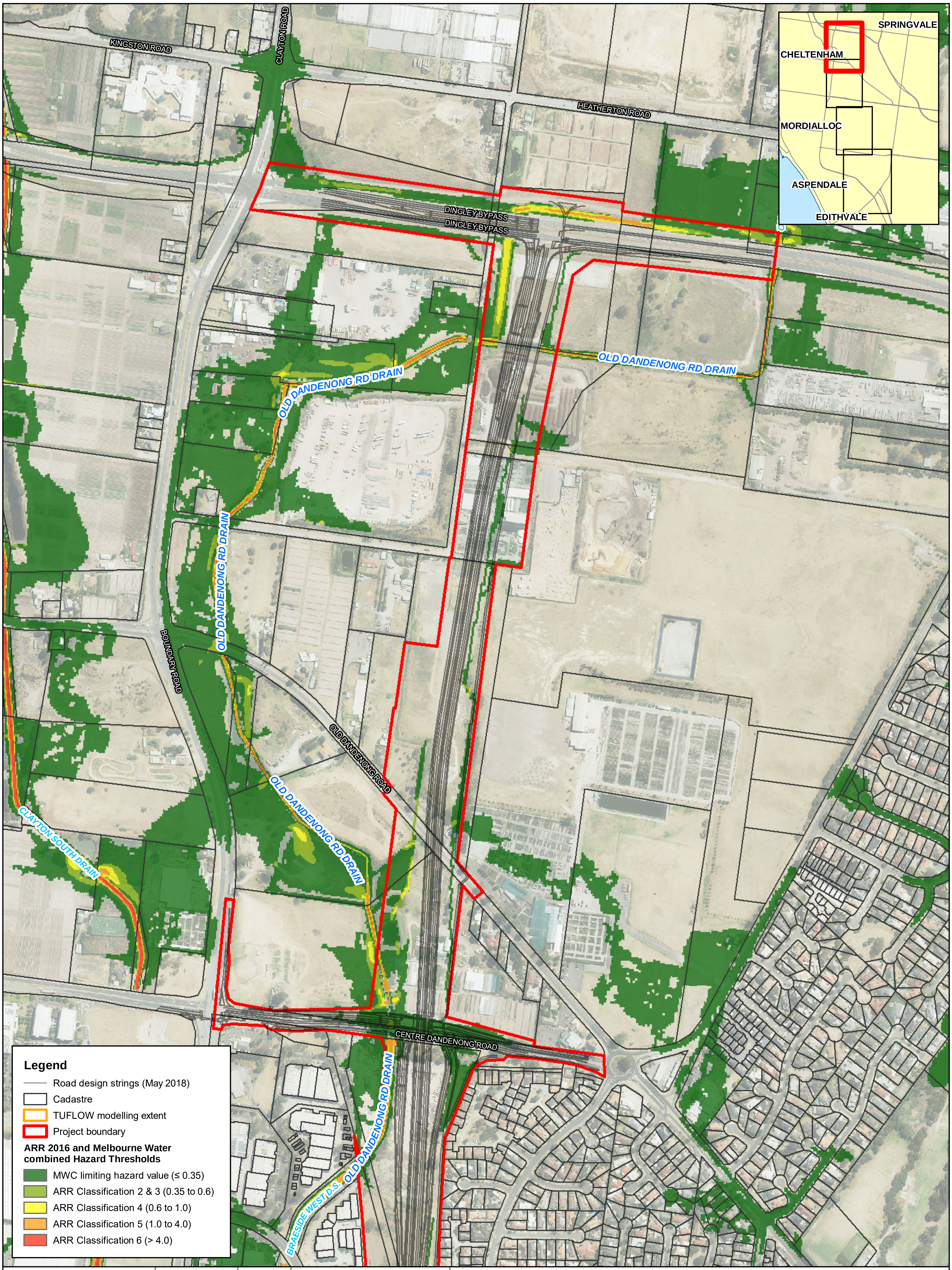
APPENDIX C-4
FLOOD HAZAD MAPPING



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Author: VD

Date: 13/08/2018

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Engineering and Technical Services for Mordialloc Freeway Upgrade

Proposed case conditions
1% AEP peak flood hazard (Velocity X Depth)
Map 1

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Engineering and Technical Services for Mordialloc Freeway Upgrade

Proposed case conditions
1% AEP peak flood hazard (Velocity X Depth)
Map 2

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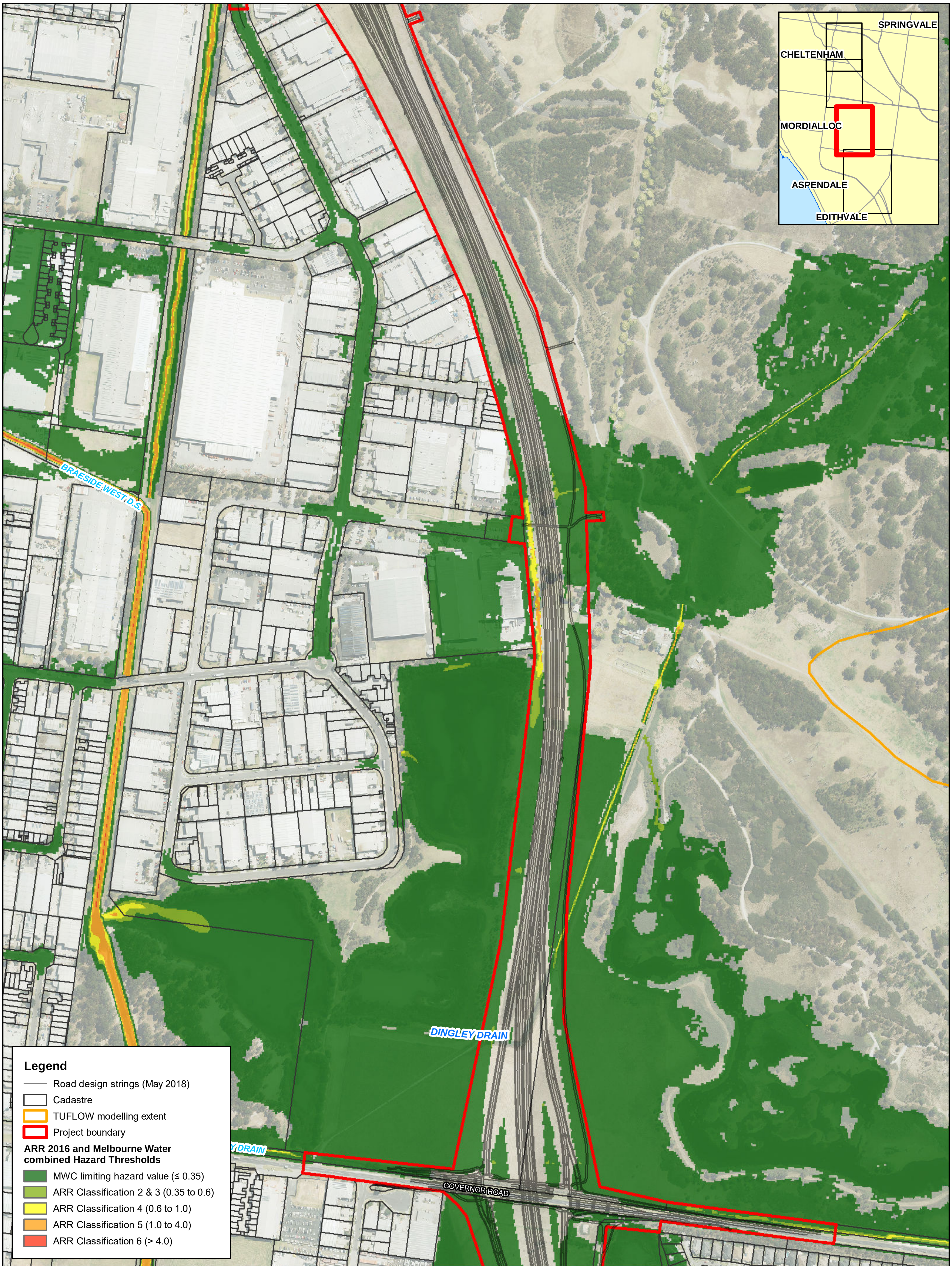

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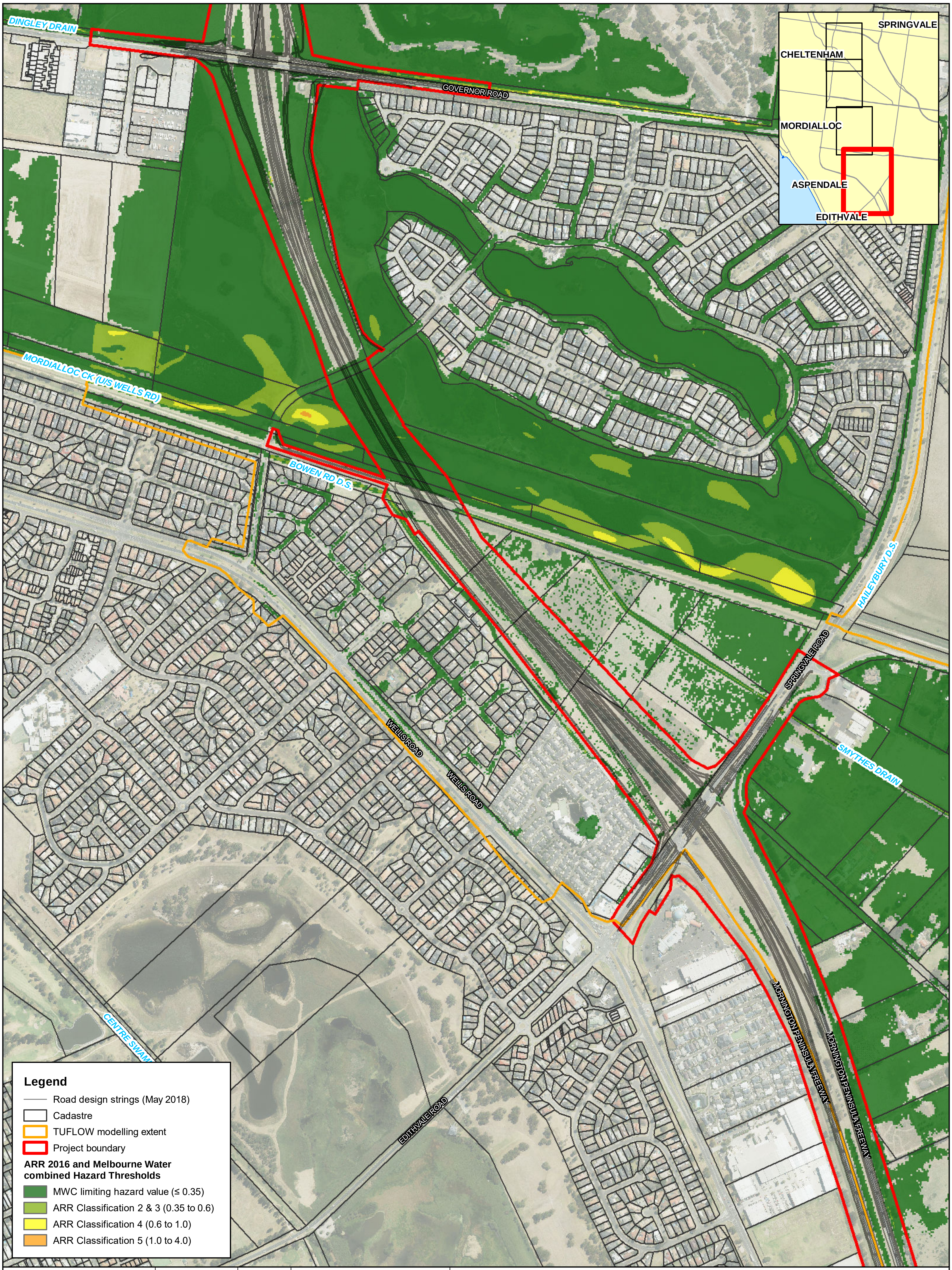
Engineering and Technical Services for Mordialloc Freeway Upgrade

Proposed case conditions
1% AEP peak flood hazard (Velocity X Depth)
Map 3



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Engineering and Technical Services for Mordialloc Freeway Upgrade

Proposed case conditions
1% AEP peak flood hazard (Velocity X Depth)
Map 4

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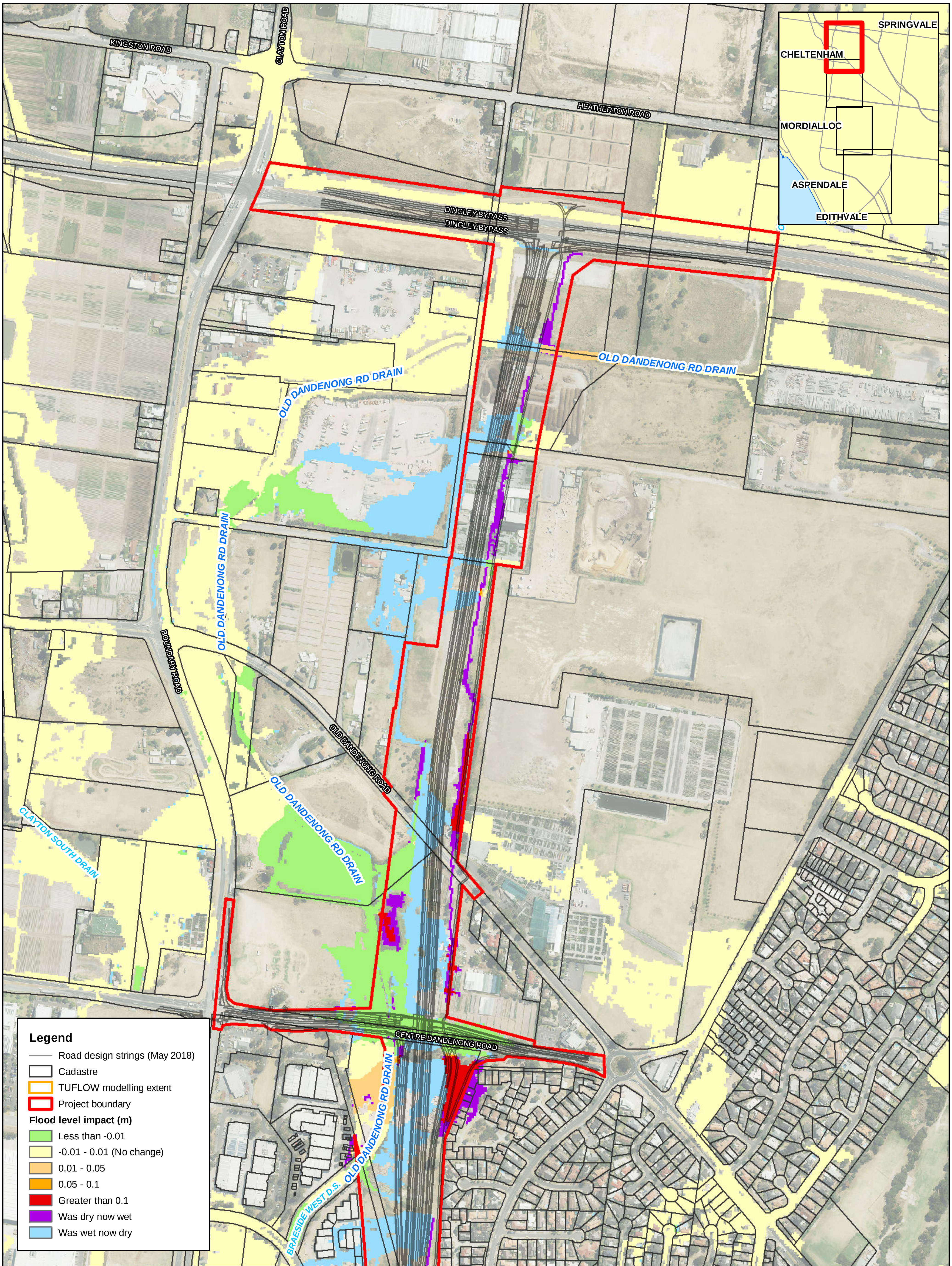
APPENDIX C-5
1% AEP AFFLUX (PROPOSED CASE – BASE-CASE) UNDER CLIMATE CHANGE



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Engineering and Technical Services for Mordialloc Freeway Upgrade
Proposed case conditions
Climate Change scenario
1% AEP peak flood level impact
Map 1

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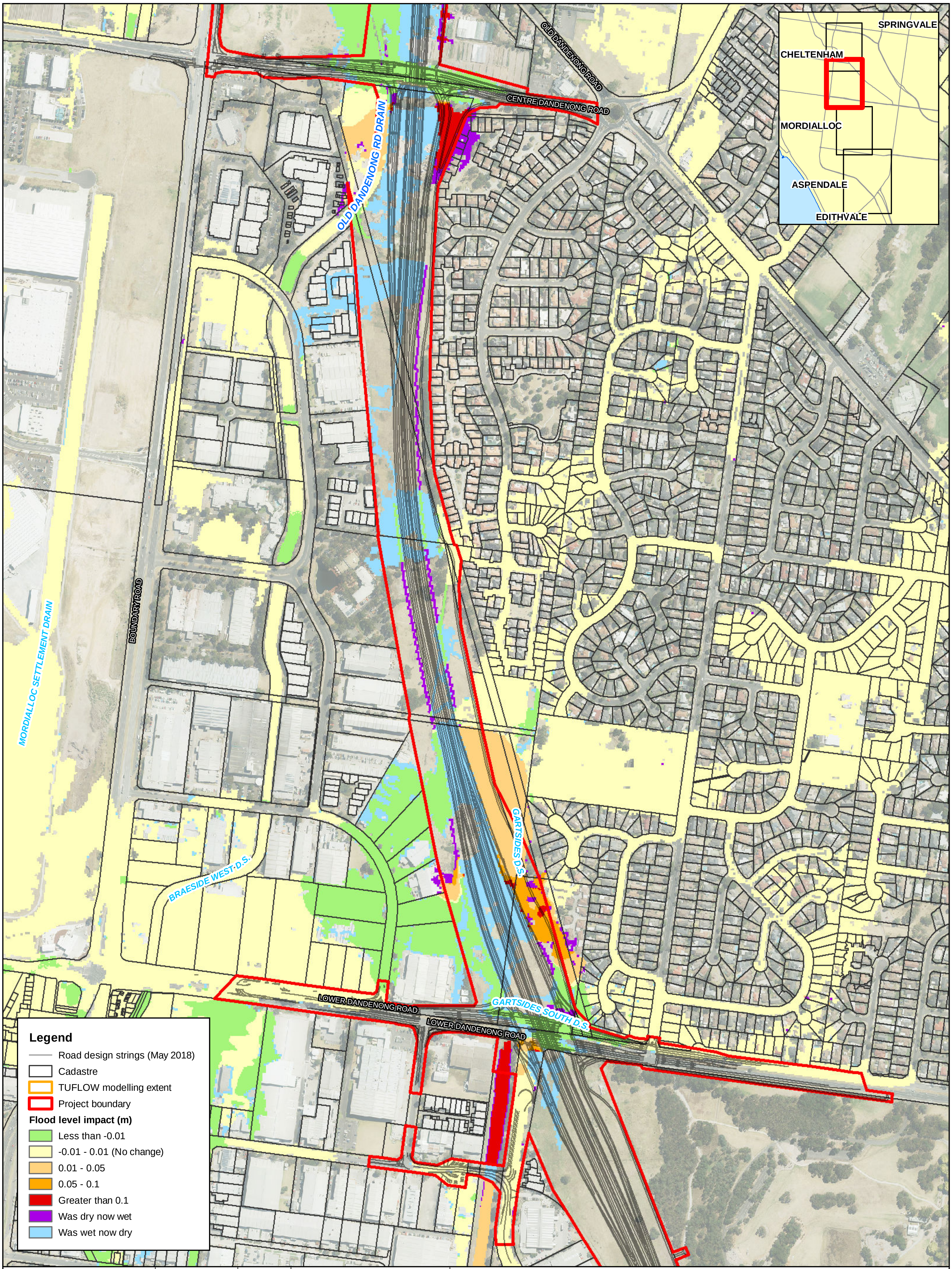

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Engineering and Technical Services for Mordialloc Freeway Upgrade
Proposed case conditions
Climate Change scenario
1% AEP peak flood level impact
Map 2

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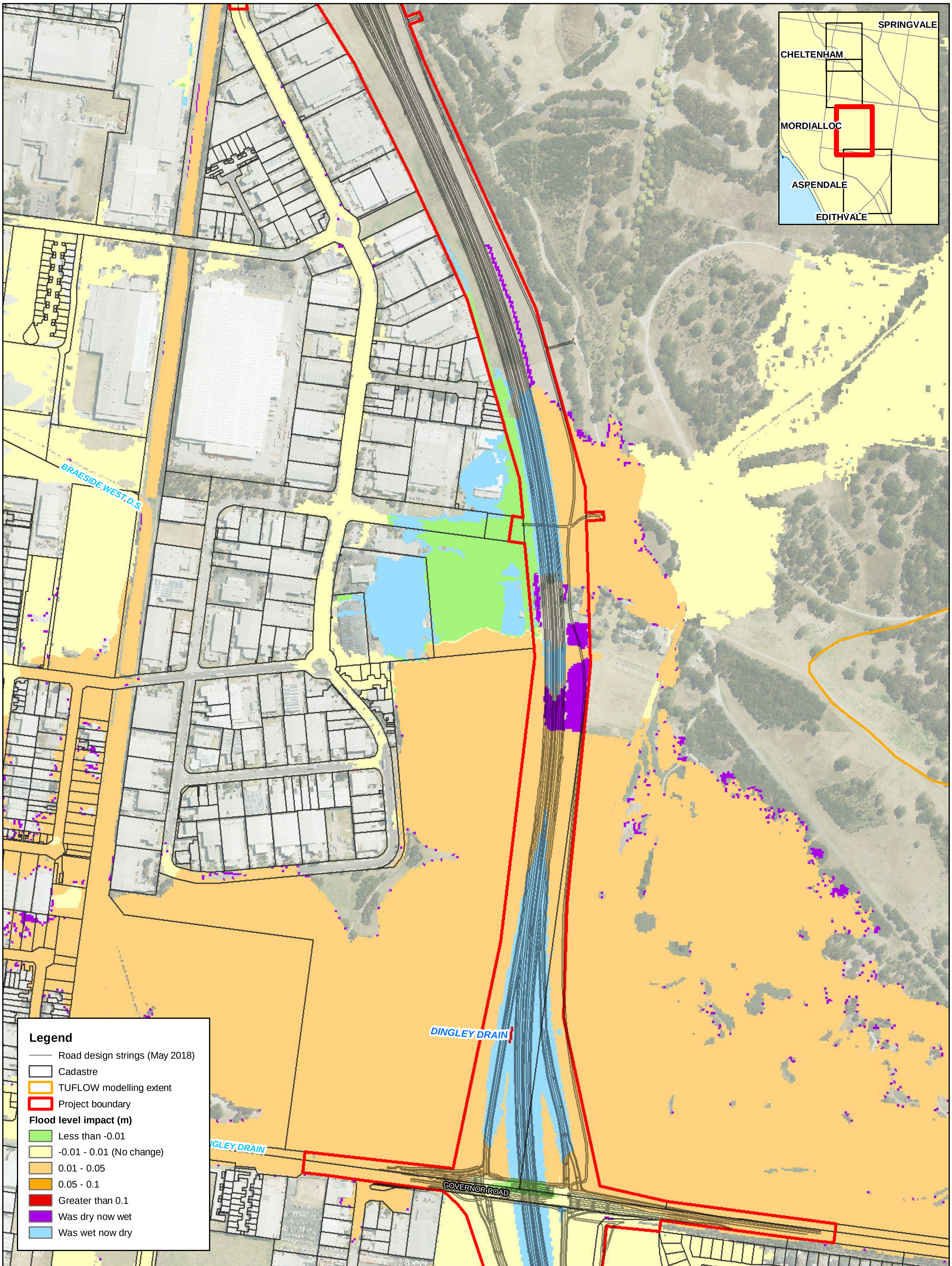

Map: 2135645A_GIS_993_B	Author: VD	
Date: 13/08/2018	Approved by: ZM	

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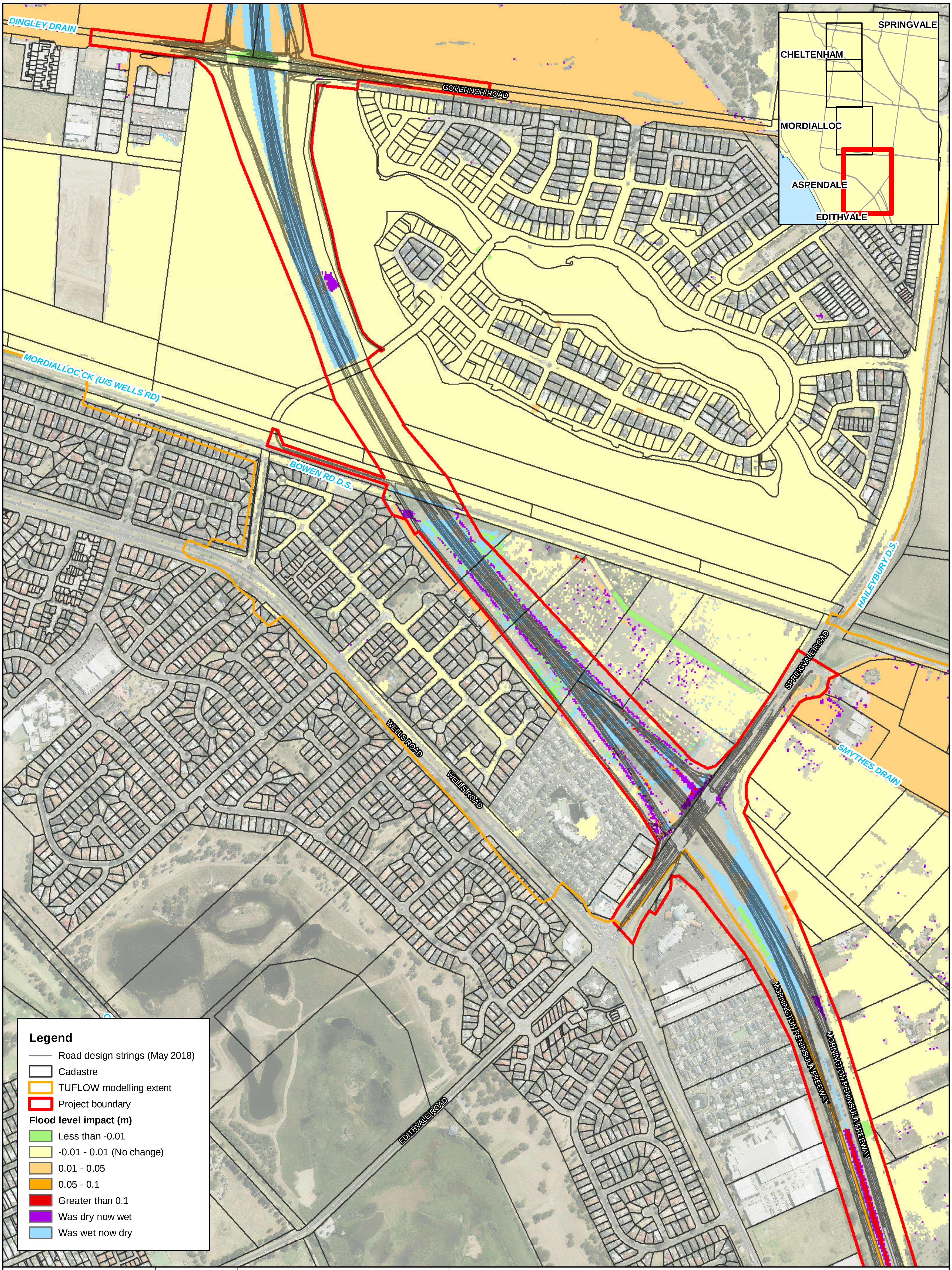
Engineering and Technical Services for Mordialloc Freeway Upgrade
Proposed case conditions
Climate Change scenario
1% AEP peak flood level impact
Map 3



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Coordinate system: GDA 1994 MGA Zone 55
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Engineering and Technical Services for Mordialloc Freeway Upgrade
Proposed case conditions
Climate Change scenario
1% AEP peak flood level impact
Map 4

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APPENDIX D

MELBOURNE WATER REQUIREMENTS

APPENDIX D-1
MODIFICATIONS TO AND PROTECTION OF MW DRAINAGE ASSETS

Protection of and Modifications of Melbourne Water Storm Water Main Drains

Performance Criteria for Major Road and Rail Projects

June 2017

Melbourne Water

Version History

Date	Version	Description	Author
30/06/2016	1.0	Draft for internal Review	D Carshalton
30/06/2016	1.1	Draft for internal Review	M Coffey
18/01/2017	1.2	Draft for internal Review	S Kelly
07/04/2017	1.3	OSAR South East issue	S Kelly
13/06/17	1.4	Mordialloc Bypass Issue	S Kelly

1. General

1.1 Purpose

Major infrastructure projects (the Project) frequently involve or impact Melbourne Water's (MW) drainage assets. To maximise community benefit of the Project, modifications of drains may be accepted provided they do not adversely impact in-situ assets and overall conveyance functions including provision for broader floodplain functions.

This document summarises the performance requirements relating particularly to major road and rail projects so as to meet need for the protection and modification of drainage assets and to ensure their safe operation.

Further general guidance principles and documents relating all classes of assets and floodplain functions can be sourced within the MW Land Development Manual: http://www.melbournewater.com.au/Planning-and-building/land-development-process/Pages/LDM-References.aspx

1.2 Limitations of Advice

The Performance Criteria provided in this document is general advice only. Melbourne Water does not warrant or guarantee that the information provided is exhaustive or without omissions or errors.

Prior to commencing any works on or near any of MW's assets the Contractor will be required to obtain MW's written consent to the works and enter into an Asset Interface Agreement with MW.

For the avoidance of doubt, nothing in this Performance Criteria document is to be taken as consent to any works being undertaken on or near MW's assets.

1.3 Wider Operational Context of Assets

Melbourne Waters drainage assets function within a wider context of floodplain management including:

- Floodplains and flood ways requiring consultation with Melbourne Water as a floodplain planning referral agency.
- Catchments which are managed either by MW or local councils.
- Council owned drainage assets (requiring engagement with the other asset owners)
- Major water courses
- Flood ways
- Development and/or Redevelopment Drainage Schemes which are administered or managed by MW, Development Agencies or Local Government where provision for

drainage services and Water Sensitive Urban Design is needed to service growing communities.(*Notes under in respect to road and rail networks within the Melbourne catchment.)

*Drainage Schemes are initiated through development planning which conceptualise drainage and flood conveyances both within the development precinct and in the wider catchment context.

An important aspect of Schemes is the creation of the funding or "contributions" systems supporting the capital works.

Where transport networks are concerned, whilst the Project initiators (Authorities) are generally exempted from participating or making financial contributions to a Development Drainage Scheme, they nonetheless are required to meet the needs of Schemes in two general ways:

1. Conveying flows across a road reserve meeting the requirements of existing and proposed Drainage Schemes as instructed by the Drainage Authority.
2. Designing and creating Water Sensitive Urban Design Water treatment works meeting Best Environmental Practice Management standards (or compensating for an impact as equivalent through offsetting.)

As the road/rail land reserves are normally 'pre-factored' in the whole-of-catchment planning sense, they are unlikely to trigger obligation for flood mitigation or attenuation work to be created within the reserve.

1.4 Communication, Review and Response Times

All correspondence with MW should initially be directed to the nominated Major Infrastructure Projects interface manager. As the project progresses, a communication protocol will be developed appropriate to the circumstance and timing of the project.

Once a communication protocol is established, MW generally meets the following response times:

- Review of design documentation – 28 working days
- Responses to minor queries, RFI's and the like– 10 working days unless otherwise advised

1.5 Melbourne Water Standard Documents

MW asset management standards shall be followed, including but not limited to, those listed in the table below.

Standards and Related Procedures / Guides
CORP AM P005 *Asset Numbering, Labelling & Data Capture*
CORP AM P006 *Preparation of Drawing Documents*
CORP AM P007 *Documenting Operation & Maintenance Manuals*
CORP AM P008 Documenting Standard Maintenance Instructions
CORP AM P031 *Asset Decommissioning*
CORP CW P062 *Safety in Design*
CORP CW P085 *Quality Plans*
MELBOURNE WATER SURVEY STANDARDS AND GUIDELINES
CORP AM S021 Handrail Standard

The above are available on request from MW

1.6 Standards

All works on MW assets shall comply with current MW's Land Development Manual, Australian Standards and Industry Codes of Practice unless otherwise agreed. All new MW underground drains and structures must comply with the Melbourne Water Standard Drawings (Dwg. 7251/08/404 to 7251/08/426). These are available on request from MW.

2. Existing Assets

2.1 Asset Information

MW has a range of information available on the drainage assets e.g.:

- GIS data (Indicative alignments only)
- CCTV footage (availability and currency varies)
- Hydraulic models
- Drawings

The accuracy of positional and condition data is not a warranty of MW. On-site investigations are required to confirm the accuracy of all information relevant to the proposed design or construction.

It should be noted that the true position of the MW underground drain will require an asset proving survey to be undertaken by the Project prior to design. This may involve MW in-drain Confined Space Entry procedures.

2.2 Ownership of assets

Drainage assets may be owned by a range of entities other than MW including local councils and road authorities. Typically ownership depends on the catchment size and type of flow (such as confined, overland or open channel). The ownership of assets impacted by a project needs to be confirmed early in the process to allow the engagement and consent of the appropriate asset owners. Any proposed modification to any MW asset will require the relevant Departments consent.

MW will not accept ownership of new drains unless part of a modification of an existing MW Main Drain asset or where it is within its Agency floodplain management responsibility. Any asset created to convey purely road reserve flows is the responsibility of the road constructor/manager.

Assets created or modified to convey overland flow across the rail and roads will become the responsibility of the applicable authority.

Where it has been agreed that the drainage structure is to be owned by MW, then it shall be structurally independent of the rail/road and operationally accessible. If it is not structurally independent of the road/rail, the drainage asset will remain under the ownership of the applicable road/rail authority (incl. Local Government for council roads). Melbourne Waters responsibilities in these cases is for with maintenance of the hydraulic capacity of the asset.

Design drawings must define the ownership of all new and modified drainage assets

2.3 Availability Requirements

No interruption to flow from any catchment may be caused by the project. (Typically there is no alternative flow path for storm water in the MW drainage network.

Construction plans shall be submitted to MW and consider the impacts to drainage and demonstrate that the risk to public and property outside the transport reserve is mitigated. Dry flow works should be planned for in ‘cut overs'.

2.4 Health and Safety

All works associated with the project shall accord with MW’s Health and Safety policies.

3. Protection of Assets

3.1 Asset Condition Investigation

An Asset Condition Investigation shall be carried out to determine the state of the MW drain.

This analysis shall include:

- Structural analysis of the assets to determine the allowable limits of any impacts.
- Hydraulic analysis to determine the limits of any impacts of the Project.
- Designing monitoring protocols and systems that will be undertaken to demonstrate that the asset is not being adversely impacted. Trigger levels and alerting means for each variable being monitored shall be determined.

3.2 Asset Protection Plan

To demonstrate the protection of assets, an Asset Protection Plan shall be prepared and submitted for review and comment by MW. This plan shall include at minimum the following:

- Pre and Post-construction condition surveys, which shall be conducted by a suitably qualified engineer.
- Construction impact assessments to consider what activities that impact the drain, including ground improvement works, changes to loading, settlement, tunnel boring, dewatering, vibration etc.
- Any strengthening works required to mitigate the risk of the asset damage or failure.
- Proof engineering of all investigations affecting the MW drains may be required
- Any works impacting on Retarding Basins will require ANCOLD (Australian National Committee on Large Dams) assessment

4. Performance Criteria for New or Modified Drainage Assets

4.1 General

These performance criteria apply to any modifications to the MW drains, including but not limited to new sections of pipework, strengthening works and temporary modifications.

The Project shall detail any modifications for which MW shall have the opportunity to review, request changes and approve prior to continuing to further design stages.

The design of any modification shall consider future network expansion if requested by MW.

Any modifications must not place additional operational or cost burden on MW. The design of the modified MW drainage asset must be to the satisfaction of MW and comply with MW's asset standards and hydraulic requirements.

4.2 Design Life and Material Requirements

- All new assets shall have a minimum design life of 100 years.
- Any remediated assets will have a minimum design life of 50 years.
- All new pipes shall be concrete Rubber Ring Jointed pipes unless otherwise agreed with MW Asset Management.

4.3 Asset Requirements

The following requirements shall be met for all new or modified assets:

- Designs must comply with the current MW standard drawings.
- Pits are to be cast-in-situ.
- No structures or foundations shall be within:
  - 0.6D + 2.0m from the outside edge of MW drainage pits, where D is the depth to pipe invert level; or
  - 0.6D + 0.5m from the outside edge of MW drainage pipelines, where D is the depth to pipe invert level; and
  - Comply with MW angle of repose requirements.
- Design of drains must allow for future access to maintain the drain and end–of-life replacement.
- Manholes are required at all changes in directions and must not exceed 250m in spacing, unless otherwise agreed to by MW
- No siphons, 'duck-under' structures or pump stations will be accepted.
- No reverse-grading in new or existing assets will be accepted.
- No trees shall be planted within 5m of MW drainage assets.
- Manholes must be a minimum of 5m outside a road reserve.

- All proposed utilities crossings running over or parallel to the MW main drain must comply with the MW publication "Utility installation Near MW Asset Guide".
- No reduction in the hydraulic performance of assets will be accepted. An assessment of the existing hydraulic performance of the assets will be required to set the hydraulic criteria for the modification of assets.
- The project shall investigate and confirm all service connections prior to works, and provide a report to MW to demonstrate that all connections are being accommodated in the new design and once construction is completed shall certify that the design has been executed completely.

4.4 Asset Abandonment Requirements

All MW drainage assets that are to be abandoned due to the realignment of the drain are to be decommissioned, removed and disposed of appropriately. The details of abandoned assets will need to be detailed on the final 'As-Built' drawings.

5.Construction Phase Requirements

5.1 Construction Phase Planning

MW requires the following Construction Phase Documentation be prepared and submitted for MW's review and comment prior to construction commencing:

1) Asset Protection Plan
2) Quality Management Plan, including Inspection and Test Plans, any commissioning requirements
3) Safety and Environmental Management Plan and, where relevant, Cultural and Heritage Management Plans.

5.2 Pre and Post Construction Asset Condition Assessment

The project shall undertake a condition assessment of MW drainage assets in the vicinity of the construction works before and after the construction phase. Any defects noted between inspections shall be remedied as part of the project at no cost to MW.

Pre and post CCTV inspections of the assets are mandatory and should be captured by correctly referencing commencement points.

Other forms of condition reporting may also be considered. The proposed condition assessment shall be submitted to MW for comment and MW may determine that further types of condition assessments are required.

5.3 Survey

All surveys shall be completed using a suitably qualified land surveyor. All survey shall comply with the requirements in the document *Melbourne Water Survey Standards and Guidelines.*

5.4 Defects liability period

The defects liability period for any works shall be 24 months from commencement of operation. At the conclusion of the defect period, the project must undertake an inspection of all new or modified Melbourne Water assets. The Inspection Report and CCTV information must be submitted to MWC to demonstrate the asset is free of defects.

6. Access, Land Ownership and Easements

6.1 Access to Existing Assets

The asset will remain available to MW for emergency management purposes during the construction phase.

In relation to the planning and availability of space, sufficient land or easements shall be provided to allow MW to safely operate and practically maintain the assets.

6.2 Land Ownership and Easements

The points below summarise the key positions from Melbourne Water:

MW does not need to own lands over a **drainage pipeline.** The following may be required to be obtained by the project:

a) Where MW pipes are located within private land, a drainage easement must be created over the asset. Easement width shall be determined by the size of the asset in consultation with MW.
b) Easements must be registered on-Title by the Project. All costs and liabilities associated with planning, design, legal dispute, land acquisition or easement acquisition are borne by the Project.

For further detail refer to the Water Act 1989 including amendments.

7. Handover Requirements

7.1 Handover

Handover acceptance will be based on the asset achieving its required drainage service function.

MW will operate all of the assets at time of handover; however any defects shall be remedied by the project. Further access to rectify defects shall be under the MW Permit to Work system.

7.2 Alteration of Existing MW Drawings

All existing as-built drawings impacted by the project shall be updated and revised as-built drawings shall be submitted for all new or rehabilitated assets.

7.3 Handover Checklist

The table of requirements below shall be completed to satisfy handover of assets to MW. Approval shall be given by the authorised MW Representative.

Requirements	**Completed Signature**
Functional design objectives have been achieved	
Third-party asset approvals and obligations completed	
Final walk through completed	
Schedule of Minor Omissions & Defects Issued	
Post Implementation Safety Audit Completed	
“As-Constructed” information and collated construction records provided by the project	
Completed equipment list	
Post completion CCTV received	
Final cost accounting based on functional components	

APPENDIX D-2
PERFORMANCE CRITERIA FOR FLOODPLAIN AND WATERWAYS

Melbourne Water standards for infrastructure projects in flood-prone areas

Purpose

Melbourne Water as the Floodplain Manager for the Port Phillip and Westernport catchments is responsible under the Water Act (1989) to oversee development works that have the potential to change the characteristics of the floodplain. This document provides the minimum requirements for any proposed project works that have the potential to impact on any flood-prone area within Melbourne Water's (MW) area of responsibility.

Melbourne Water requires a proponent to meet these standards or otherwise demonstrate why they cannot and how they have appropriately mitigated or minimised any associated flood risks.

2. Melbourne Water's Guiding Principles

Melbourne Water has five guiding principles for the assessment of development in flood-prone areas:

1. Risk to people and property must not increase as a result of the development.
2. Any development within a flood-prone area must be suitably designed for conditions that might be experienced and to reduce the reliance on emergency service personnel when flood events occur.
3. Climate change must be considered in the design.
4. Proponents must identify existing flood risk and should work with Melbourne Water to identify opportunities to reduce these risks.
5. Flood risk must be assessed at both the local and regional scale.

3. Melbourne Water's Standards

Melbourne Water uses these standards to guide its flood risk assessment.

*3.1.***Flood Flow:** *Works or structures should not affect floodwater flow capacity.*
This ensures that existing flood levels are not made worse by alterations to the flow characteristics of a floodplain or overland flow path.

*3.2.***Flood Storage:** *Works or structures should not reduce floodwater storage capacity.*
This prevents higher flood levels that may occur if the available storage volume is reduced.

*3.3.***Freeboard:** *Works or Structures should not reduce minimum freeboard*[1]*.*
This ensures there is no adverse impact on existing property and infrastructure.

3.4.Site Safety Requirements: *Works or structures should not create new hazards or increase existing hazard.*
Development will not be allowed where the depth and flow of floodwaters would create new hazard or increase existing hazards.

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[1] For new structures Melbourne Water requires 600mm and 300mm freeboard for Waterway and drainage flood extents respectively; where the structure is designed for 100 years or more, climate change must be included with freeboard.

3.5. Access Safety Requirements: *Access safety requirements should be taken into account.*

Development cannot be allowed in circumstances where the depth and flow of floodwater affecting access to the property is hazardous.

3.6. Climate Change Requirements: *Works or structures must factor in climate change:*

- **Sea-level rise** – An increase of 0.8m by the year 2100 is the current standard for sea level rise assessments.
- **Increase in rainfall intensity** - Rainfall intensity increase figure must be derived from either the AR&R 2016 Book or the AR&R Data Hub. The adopted figure must reflect the project's asset life and the project's flood protection technical performance requirements.

4. Other applicable standards & guidelines

Melbourne Water requires the proponent to consider and address where applicable any additional requirements specified in Melbourne Water and industry best practice standards and guidelines, including but not limited to:

- Australian Rainfall & Runoff 2016[2].
- MW's Land Development Manual.
- MW's Guidelines for development in flood-prone areas.
- MW's Shared user path guidelines.

5. Deliverables

5.1. Scenarios

Melbourne Water requires the proponent to model the following scenarios at all stages (reference design, detailed design and for construction):

- Pre-existing flood conditions (the 'base' case)
- Project ultimate design flood conditions (the 'proposed' case) including any variation from the 'base' case above. Mitigation Options should be presented where project works adversely impact flooding.
- Temporary construction works flood condition (inclusive of the works method steps/staging, site access, haul roads etc.).[3]

[2] Melbourne Water has adopted the information and approaches defined in the draft Australian Rainfall and Runoff 2016 (ARR2016) guidelines as current best practice for the development and analysis of hydraulic and hydrological models for the purpose of stormwater and flood flows simulations. As stated by Geoscience Australia (Commonwealth of Australia, Geoscience Australia 2016) where relevant the draft ARR2016 can be used in practice prior to finalisation.

[3] At reference design, if the staging of construction is known then model submission is expected, otherwise the risks must be identified through qualitative measures. A flood management plan will be required for any temporary works.

5.2.Parameters

The following results must be presented where the effects of the proposed design and temporary works can be assessed against the Pre-existing conditions. All pre and post assessments must be done at several locations for at least the following:

- Flows (in m^3/s)
- Velocities (in m/s)
- Product of Velocity and Depth (V x D in m^2/s)
- Flood Levels to m AHD
- Depth in metres (m)
- Any cut and fill balance information
- Clearly showing where the flooding conditions have changed and how much
- All manning's values used in modelling and assessment should be accompanied by justification in a summary modelling note.
- For ease of assessment these must be provided in three separate MapInfo tables representing each scenario.
- Site specific detailed design model should be created for the project. Melbourne Water's regional model should be updated.

5.3.Hydrology and hydraulic submission must include:

- A design model. This must include project specific and local detail.
- Melbourne Water's regional model must be updated with the design information. If the design changes during construction the model must be resubmitted incorporating the changes.
- Models must be submitted for the following AEP events (18.13%, 10%, 5%, 2% and 1% and climate change)
- An independent peer review must be undertaken.
- A log file must be submitted detailing model runs/scenarios
- Modelling assumptions and parameters must be submitted with reference to the standards.
- The submitted model must be error free and stable.
- A report outlining the modelling methodology and results must be provided in a report format.

Note: Data must be supplied in digital format; MW can provide the proponent with the file types to submit on request

6. Timeframes

Please allow the following timeframes when submitting information to MW for review

SUBMISSION	REVIEW PERIOD
Preliminary Advice	28 Business Days or Subject to number of models and size of reports
Detailed Design Reports & Models	28 Business Days
Final Detailed Designs	10 Business Days
25, 50 & 75% Detailed Designs	10 Business Days
General queries (1 – 2 pages)	5 Business Days or possibly earlier than 5 days

Melbourne Water standards for infrastructure projects in flood-prone areas

Document History

Date	Reviewed/ Actioned By	Version	Action
May 2018	Ruwan Jayasinghe, Principal Flood Modelling & Mapping	1.0	
July 2018	Jean-Michel Benier, Team Leader Flood Information	2.1	

APPENDIX D-3
PERFORMANCE CRITERIA FOR SWQ TREATMENT

Mordialloc Bypass Stormwater Quality Performance Criteria

June 2017
Melbourne Water

Version History

Date	Version	Description	Author
13.06.2017	1.1	Mordiallioc Bypass	S Kelly

Victoria

Melbourne Water

1. Stormwater Quality Treatment (SWQT)

1.1 SWQT Requirements

As part of protecting waterways from current and future contamination from road runoff, the State Environment Protection Policy (SEPP) (Waters of Victoria) (2004) classifies runoff from roads as urban stormwater. Therefore as part of its responsibilities, VicRoads must meet the SEPP for urban stormwater runoff, which requires the protection of beneficial uses and the demonstration of the application of best practice.

The SEPP (Waters of Victoria) defines ‘best practice’ as ‘the best combination of techniques, methods, processes or technology used in an industry sector or activity that demonstrably minimises the environmental impact of that sector or activity’. Best practice requires project proponents to demonstrate that the operational impacts of their project are mitigated to an appropriate level. This approach requires demonstration that the proposed road design will meet the best practice performance objectives and process outlined in Urban Stormwater: Best Practice Environmental Management Guidelines. Victorian Stormwater Committee (1999) (BPEMG).

At a minimum, these are as follows:

o 80% retention of the typical urban annual load of total suspended solids (TSS):
o 45% retention of the typical urban annual load of total phosphorus (TP):
o 45% retention of the typical urban annual load of total nitrogen (TN):
o 70% retention of the typical urban annual load of gross pollutants (GP):

2. Water Sensitive Urban Design (WSUD)

2.1 Water Sensitive Urban Design Hierarchy

The hierarchy of how stormwater quality treatment measures are implemented by the project is shown below in order of preference;

1. **WSUD at source -** Within the project corridor via passive diffuse systems implementing 'Water Sensitive Road Design' (WSRD). This includes but is not limited to swales, infiltration swales, wetlands and porous paving etc.

2. **WSUD outside of the project corridor -** WSUD with the focus on protecting sensitive receiving waters, aka "Hotspots" impacted by the project. Many waterways have been classified and identified for specific protection or management actions. The receiving water sensitivity must be understood to determine where treatment measures are focused

3. **WSUD in the wider catchment -** Construction of WSUD measures within the wider catchment. These should focus first on locations directly impacting the receiving waters within the wider catchment and elsewhere in catchment secondly.

4. **WSUD in a separate catchment –** Construction of WSUD measures to meet equivalent treatment requirements in another catchment.

5. A **combination** of the above to meet best practice requirements

6. **Offset Water Quality Treatment Contributions** - Stormwater offsets are a financial contribution for regional water quality works that are undertaken elsewhere within the wider catchment, to offset treatment that is not provided on site. Offsets funds will be levied to account for the capital and operational (recurrent) phases of the WSUD infrastructure. Offsets should only be sought as a last resort as the treatment of pollutant at source is preferable. Should the project necessitate offsets, the project should still seek to maximise the amount of on-site treatment that can be delivered.

The ultimate project aim should be a road network which has a drainage system disconnected from receiving waterways. It is understood that in some areas site constraints (e.g. topography, ground conditions, and space) can make the implementation of WSUD challenging so the above list should serve as a guide as to the available options and the order of preference for their adoption.

Acceptable methods for the design of treatment measures include the stormwater treatment modelling software package 'Model for Urban Stormwater Improvement Conceptualisation' (MUSIC), or the 'Water Sensitive Urban Design Engineering Procedures manual' available at http://www.publish.csiro.au/book/4974 which provides the procedure for design of various treatment measures.

The WSUD requirements can be investigated for implementation across the wider maintenance project extents and is not limited to the capital works boundary extents.

Resources and Further Reading:

- Melbourne Water, Stormwater Management (WSUD)
- Melbourne Water, 2016, MUSIC Guidelines: Input parameters and modelling approaches for MUSIC users in Melbourne Water's Service Area,
- Melbourne Water, Stormwater Quality Offsets
- VicRoads Integrated Water Management Guidelines 2013
- EPA Best Practice Environmental Management Guidelines (BPEMG)
- South Eastern council WSUD guidelines

APPENDIX E

WATER QUALITY DATA IN EDITHVALE WETLAND

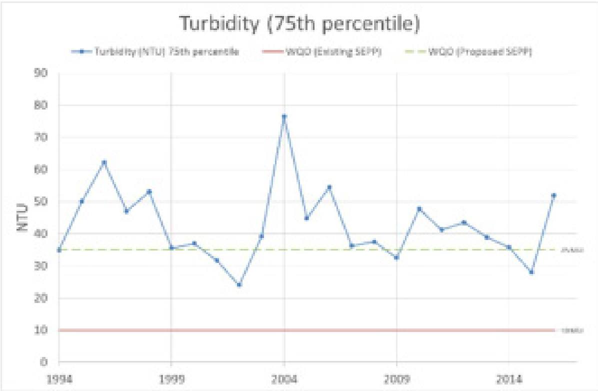
The water quality data below are cited from SKM (2011).

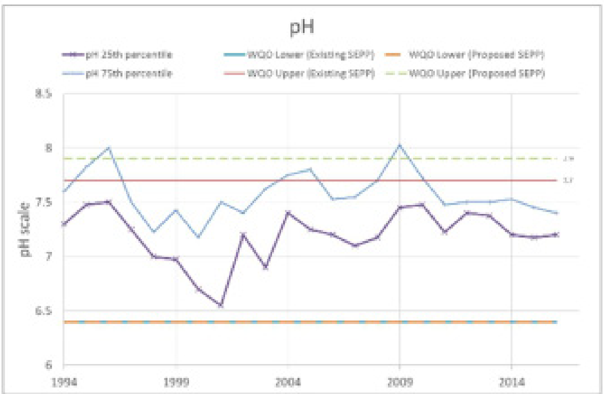
Site code	Water Source	Habitat	Current watering regime	Water quality 2009/10
EN1	- Culvert under Edithvale Road from ES1 - Weir 5 from Centre Swamp drain - Groundwater	- Fresh-Brackish	- Winter and spring inundation - Drying in summer and autumn - Desiccates every year - Moist areas in dry periods (groundwater)	No data available Likely to be similar to ES1 as this is the sole source for this cell
EN2	- From EN1 at Weir 1 - Groundwater	- Saline - Deep, permanent pond	- Draws down over summer - Maintains permanent water	- Temp = 17 ± 4°C - Turbidity = 18 ±11 NTU - pH = 8.0-8.6 - EC = 20,000 µS/cm - DO = 9.0 ± 1.0 mg/L - FRP= 0.01 ± 0.01 mg/L
EN3	- From EN2 at Weir 2 - From EN3-a at Weir 3	- Fresh-Brackish - Main open water pond - Rising salinity	- Responsive to groundwater - Deep pool that draws down in dry periods	- Temp = 15 ± 4°C - Turbidity = 10 ±3 NTU - pH = 7.4-9.0 - EC = 3485 ± 810 µS/cm - DO = 8.0 ± 2.1 mg/L - FRP= 0.01 ± 0.00 mg/L
EN3a-A	- Stormwater	- Fresh - Habitat for ducks and Australasian bittern	- Deep pool - Dries out depending on inflows vs. evaporation	- Temp = 18 ± 7°C - Turbidity = 30 ±28 NTU - pH = 7.5-8.3 - EC = 1875 ± 2015 µS/cm - DO = 7.0 ± 4.2 mg/L - FRP= 0.2 ± 0.3 mg/L
ES1	- Three drains from urban catchment - Overland flow - Overflows from Centre Swamp drain - Groundwater (ES1a)	- Shallow and deep fresh-brackish marsh - Mudflats for migratory waders during summer dry down - Supports heavy growth of marsh club-rush Bolboschenoenus cladwellii	- Normally about 0.15m deep - Winter and spring inundation - Drying in summer and autumn - Desiccates every year in late December - Excavated pools have permanent water, except in drought.	- Temp = 24 ± 6°C - Turbidity = 47 ± 20 NTU - pH = 7.2-8.9 - EC = 2240 ± 1305 µS/cm - DO = 5.0 ± 1.0 mg/L - FRP= 0.25 ± 0.2 mg/L

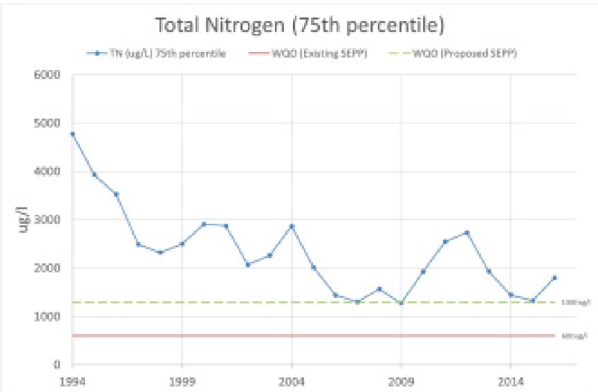
FRP – Filterable Reactive Phosphorus, EC – Electrical Conductivity, DO – Dissolved Oxygen

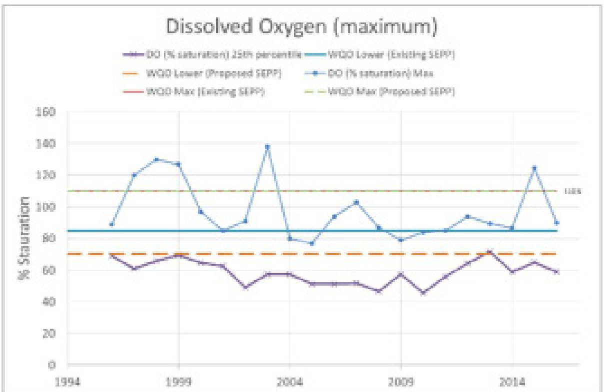
APPENDIX F

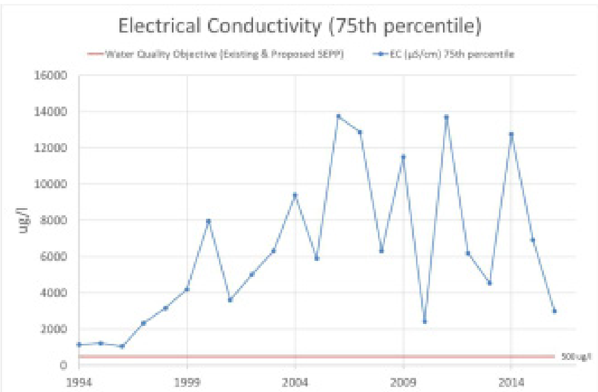
WATER QUALITY DATA IN MORDIALLOC CREEK AT WELLS ROAD

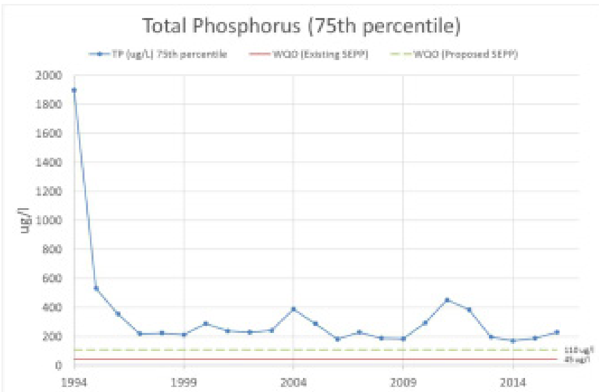

Turbidity (75th percentile)
Turbidity (NTU) 75th percentile
WQO (Existing SEPP)
WQO (Proposed SEPP)
NTU
90
80
70
60
50
40
30
20
10
0
1994
1999
2004
2009
2014

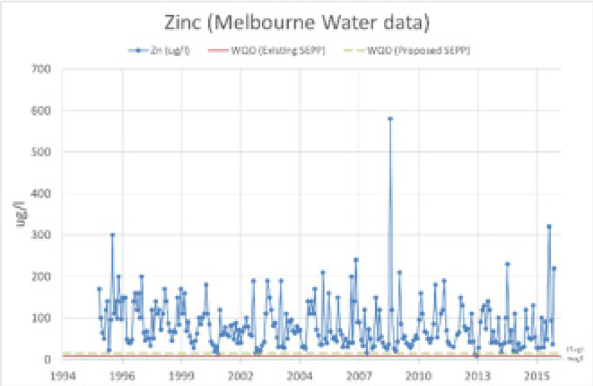

pH
pH 25th percentile
pH 75th percentile
WQO Lower (Existing SEPP)
WQO Upper (Existing SEPP)
WQO Lower (Proposed SEPP)
WQO Upper (Proposed SEPP)
pH scale
8.5
8
7.5
7
6.5
6
1994
1999
2004
2009
2014

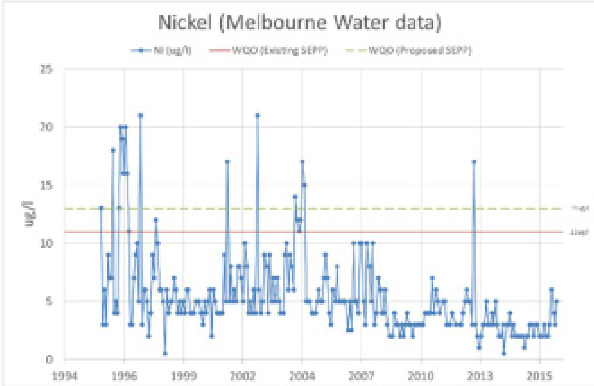

Total Nitrogen (75th percentile)
TN (ug/L) 75th percentile
WQO (Existing SEPP)
WQO (Proposed SEPP)
ug/l
6000
5000
4000
3000
2000
1000
0
1994
1999
2004
2009
2014

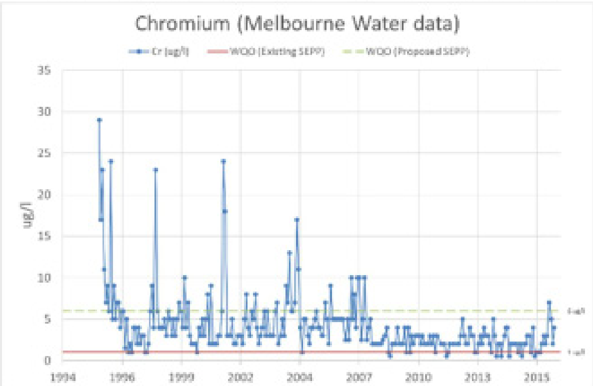

Dissolved Oxygen (maximum)
DO (% saturation) 25th percentile
WQO Lower (Existing SEPP)
WQO Lower (Proposed SEPP)
DO (% saturation) Max
WQO Max (Existing SEPP)
WQO Max (Proposed SEPP)
% Stauration
160
140
120
100
80
60
40
20
0
1994
1999
2004
2009
2014

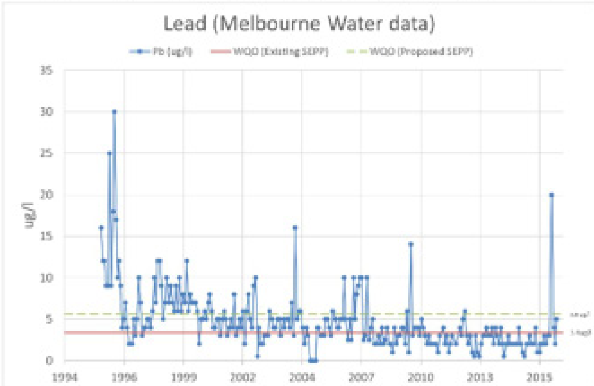

Electrical Conductivity (75th percentile)
Water Quality Objective (Existing & Proposed SEPP)
EC (µS/cm) 75th percentile
ug/l
16000
14000
12000
10000
8000
6000
4000
2000
0
1994
1999
2004
2009
2014
500 ug/l

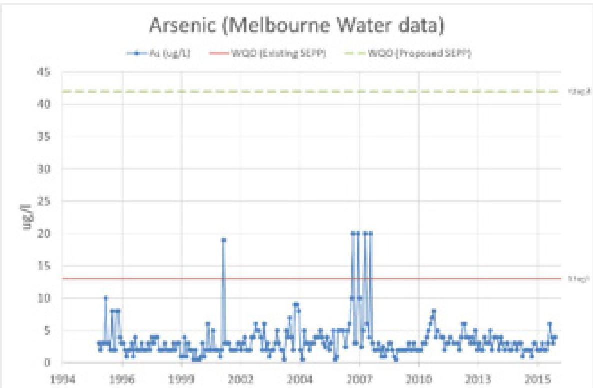

Total Phosphorus (75th percentile)
TP (ug/L) 75th percentile
WQO (Existing SEPP)
WQO (Proposed SEPP)
ug/l
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1994
1999
2004
2009
2014
110 ug/l
45 ug/l

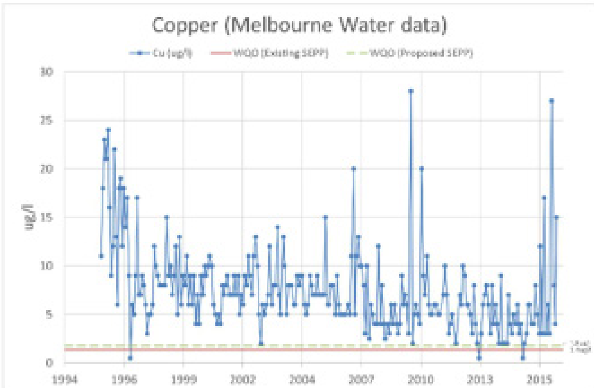

Zinc (Melbourne Water data)
Zn (ug/l)
WQO (Existing SEPP)
WQO (Proposed SEPP)
ug/l

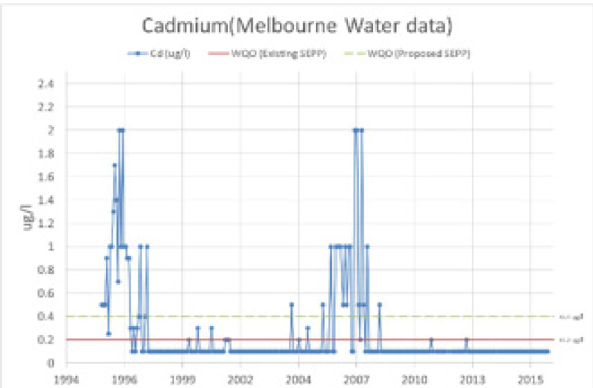

Nickel (Melbourne Water data)
Ni (ug/l)
WQO (Existing SEPP)
WQO (Proposed SEPP)
ug/l


Chromium (Melbourne Water data)
Cr (ug/l)
WQO (Existing SEPP)
WQO (Proposed SEPP)
ug/l


Lead (Melbourne Water data)
Pb (ug/l)
WQO (Existing SEPP)
WQO (Proposed SEPP)
ug/l


Arsenic (Melbourne Water data)
As (ug/L)
WQO (Existing SEPP)
WQO (Proposed SEPP)
ug/l


Copper (Melbourne Water data)
Cu (ug/l)
WQO (Existing SEPP)
WQO (Proposed SEPP)
ug/l


Cadmium(Melbourne Water data)
Cd (ug/l)
WQO (Existing SEPP)
WQO (Proposed SEPP)
ug/l

APPENDIX G

TIME SERIES FOR CLIMATE CHANGE ANALYSIS

It is the part of the score to study the effect of climate change on the environmental impact of the proposed project. Guidelines for Assessing the Impact of Climate Change on Water Supplies Final December 2016 (DELWP 2016) has provided guidance on estimation of rainfall and potential evapotranspiration rate (PET) for year 2040 and 2065. According to Figure 19 (see Figure G.1) of DELWO (2016), the project is within the Bunyip river basin. Table 2 a f Table 9 of DELWP (2016) provide 10%ile, 50%ile and 90%ile change in rainfall and PET, respectively, for years 2040 and 2065 (see Table G.1). This estimate is using 1975 to 2014 annual data as base case.

Figure 19 Victorian River Basins

Figure G.1 River Basin delineation cited from Figure 19 of DELWP (2016)

Table G.1 Change in rainfall and PET for Bunyip area (based 1975–2014)

YEAR	**2040**			**2065**		
Percentile (%)	10	50	90	10	50	90
Annual PET	2.6%	4.3%	5.7%	4.8%	7.3%	10.1%
Annual Rainfall	2.9%	-3.9%	-10.9%	2.1%	-5.0%	-16.1%

However, Music modelling is using rainfall and PET time series (6 min and daily) that it is required to translate these annual estimated changes into change in time series. The following approach has been adopted:

1. Obtain rainfall data at nearby site for a period similar to 1975–2014
2. Develop annual average rainfall duration curve for this periods
3. Fit scaling factor curve using the 10%ile, 50%ile and 90%ile as pivoting points (see Figure G.2)
4. Establish scaling factors for the full range of rainfall occurrence probability
5. For each year, look up the rainfall occurrence probability based on average annual rainfall (mm/day)
6. Look up the corresponding scaling factor based on the rainfall occurrence probability.
7. Regenerate the time series by applying the scaling factor to the time series; a factor for each year.

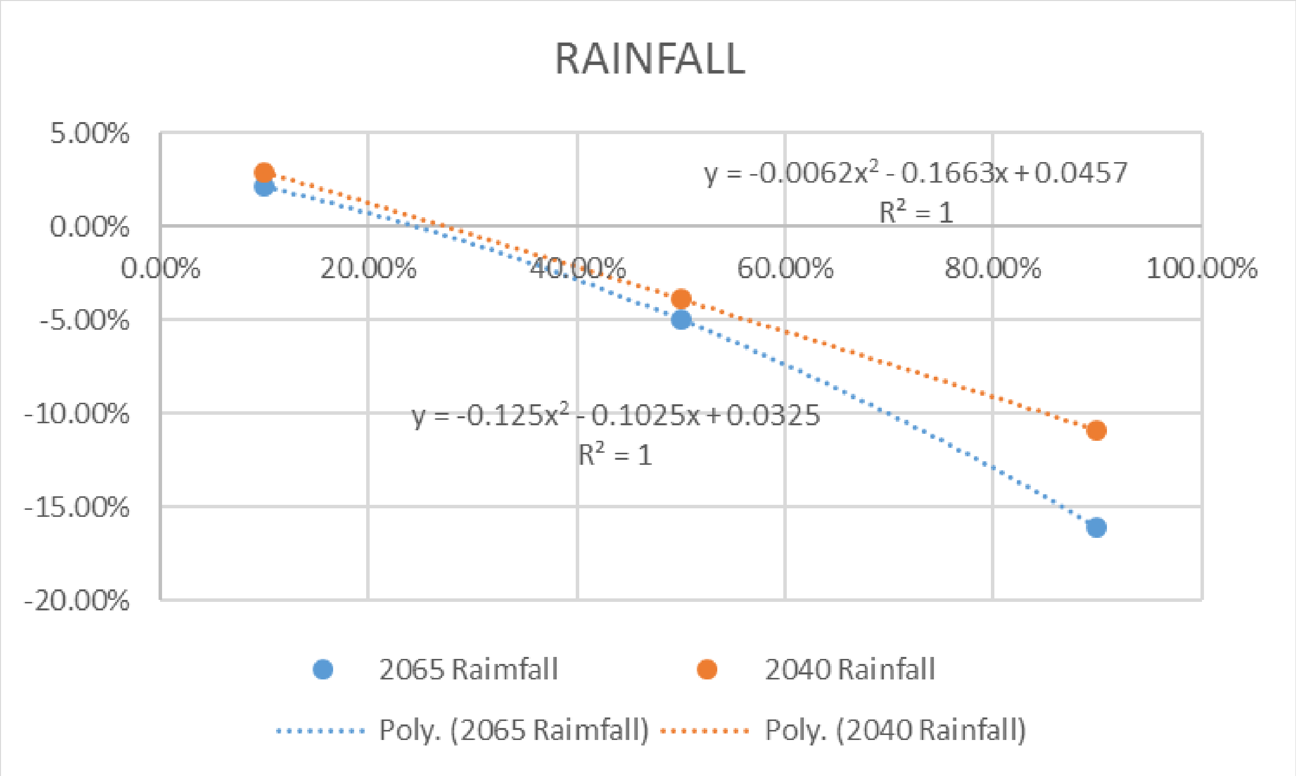


Figure G.2 Fitting of adjustment factors for 2040 and 2065 rainfalls

For PET, since it has only minor effect on the hydrological behaviour and monthly average values have been adopted in Melbourne Water recommended PET time series for this region. The PET values are adjusted based on 50%ile values.

APPENDIX H

PROPOSED OUTFALLS FOR DRAINAGE SYSTEMS OF THE BYPASS

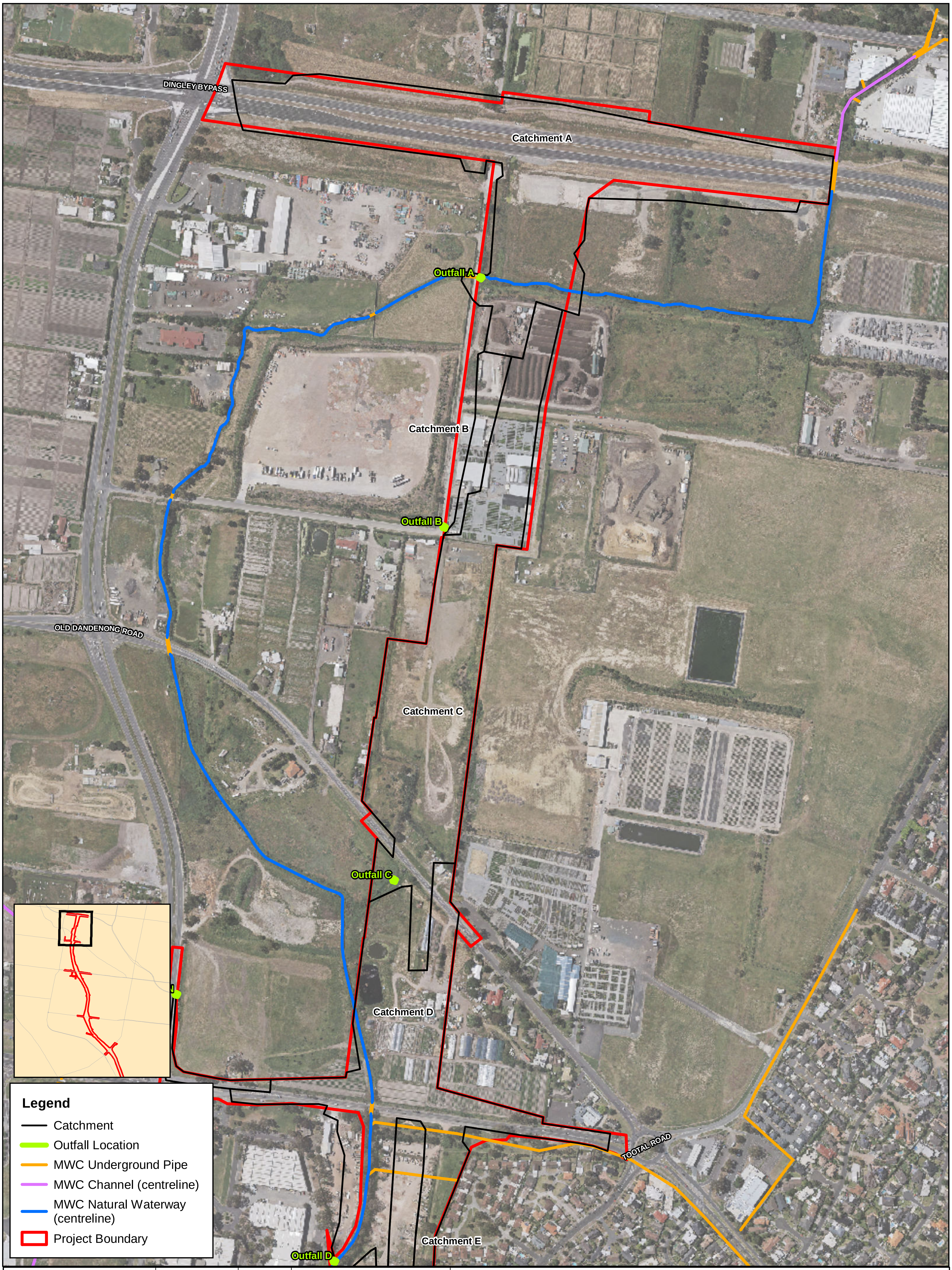
Table H.1 List of outfalls and their details

OUTFALL NAME	OUTFALL LOCATION	DESCRIPTION	SUMMARY
A	Ch23030	Outfall A is Old Dandenong Road Drain which drains to the west. The existing channel crosses the freeway via a new culvert. The road surface catchment begins with the Dingley bypass within the project boundary to the north and ends at the high point at CH23130 to the south.	Outfall asset owned by Melbourne Water Total ROW catchment area = 11.42 ha New impervious area = 1.69 ha Discharge to a major drainage system, impact due to increased runoff assessed using the flood models.
B	Ch23400	Outfall B is a 675 mm dia council pipe flowing to the west along Junction Road. The Outfall B catchment covers the northbound carriageway and road reserve of the freeway from Ch 23130 to Ch 23350. The road catchment discharges to roadside swales which connect to a grated pit connected to the existing 675 mm pipe. A detention basin has been incorporated into the design to maintain existing flow rates at the outfall.	Outfall asset owned by the City of Kingston Total ROW catchment area = 0.74 ha New impervious area = 0.11 ha Detention system to be incorporated into the drainage design. Basin volume approximately 21 m^3.
C	Ch23900 – Old Dandenong Road	Outfall C is an existing grassed channel which connects to the Old Dandenong Road Drain just west of the project boundary. The catchment area includes the southbound carriage way and road reserve from Ch23030 to Ch23900 and the northbound carriageway and road reserve from Ch23400 to Ch23900. It also includes the full carriageway from Ch23900 to the highpoint at Ch24020.	Outfall asset owned by City of Kingston (Melbourne Water asset immediately downstream) Total ROW catchment area = 8.63 ha New impervious area = 0.83 ha Discharge to a major drainage system, impact due to increased runoff assessed using the flood models.
D	Ch24400-Centre Dandenong Road	Outfall D is the Old Dandenong Road Drain at Ch24400. The drain, which flows to the south, now crosses under Centre Dandenong Road via a culvert. The catchment includes the road reserves on the east and west sides of the freeway from Ch23900 to Centre Dandenong Road and the carriageway from the highpoint at Ch24020 to the southern side of Centre Dandenong Road. It also includes all of Centre Dandenong Road to the east of the freeway, 150m of the road to the west, and both freeway ramps.	Outfall asset owned by Melbourne Water Total ROW catchment area = 7.53 ha New impervious area = 1.78 ha Discharge to a major drainage system, impact due to increased runoff assessed using the flood models.

OUTFALL NAME	OUTFALL LOCATION	DESCRIPTION	SUMMARY
E	Ch26000–Lower Dandenong Road	Outfall E is the Braeside West D.S. drain flowing to the south. The catchment area contains the carriageway and road reserve from Ch24400 to the south side of lower Dandenong road at Ch2600. It also contains the northbound freeway off-ramp.	Outfall asset owned by Melbourne Water Total ROW catchment area = 16.95 ha New impervious area = 7.11 ha Discharge to a major drainage system, impact due to increased runoff assessed using the flood models.
F	Ch27875	Outfall F is Woodlands Industrial Estate Wetland. The catchment area consists of the entire road reserve and carriageway from Ch26000 to Ch27975 and the main carriage way from Ch27975 to Ch28160.	New ROW catchment area = 24.47 ha New impervious area = 9.19 ha Bioretention swale and spill containment systems to be incorporated into the drainage design. Discharge to a major drainage system, impact due to increased runoff assessed using the flood models.
G	Ch28150	Outfall G is the Dingley Drain. The catchment area contains the road reserve on the east and west sides of the freeway from Ch28020 to Ch28275.	Outfall asset owned by Melbourne Water Total ROW catchment area = 1.11 ha New impervious area = 0.00 ha Detention not required as there is no new impervious area within the catchment
H	Ch28400	Outfall H is an existing channel running along the north side of Governor Road that connects to the outlet of the Woodlands Wetland / Dingley Drain. The catchment area contains the eastbound carriageway of Governor Road and the freeway ramps to the north of Governor Road.	Outfall asset owned by City of Kingston (Melbourne Water asset immediately downstream) Total ROW catchment area = 6.45 ha New impervious area = 1.69 ha Discharge to a major drainage system, impact due to increased runoff assessed using the flood models.

OUTFALL NAME	OUTFALL LOCATION	DESCRIPTION	SUMMARY
I	Ch28500-Governor Road	Outfall I is an existing channel which flows to the west and discharges into the Waterways Wetland. The channel has been realigned and now crosses the freeway via 3 consecutive culverts. The catchment area consists of the eastbound carriageway of Governor Road.	Outfall asset owned by Melbourne Water. Total ROW catchment area = 3.05 ha New impervious area = 0.43 ha Spill containment system to be incorporated into the drainage design. Discharge to a major drainage system, impact due to increased runoff assessed using the flood models.
J	Ch28750	Outfall J is an existing channel which connects between different cells within the Waterways Wetland. The channel now crosses under the freeway via a new culvert. The catchment area consists of the road reserve and carriage way from Ch28500 to the high point North of the Waterways bridge at Ch293075.	Outfall asset owned by Melbourne Water. Total ROW catchment area = 7.64 ha New impervious area = 3.30 ha Combined bioretention and spill containment system to be incorporated into the drainage design. Discharge to a major drainage system, impact due to increased runoff assessed using the flood models.
K	Ch29500	Outfall K is the existing Smythes Drain. The existing channel drains to the west and has been realigned behind the bridge abutment with a new culvert. The catchment consists of the road reserve and carriage way from the high point of the Waterways bridge at Ch29075 to the northern side of the Springvale Road intersection at Ch30450.0	Outfall asset owned by Melbourne Water. Total ROW catchment area = 12.63 ha New impervious area = 5.36 ha Discharge to a major drainage system, impact due to increased runoff assessed using the flood models.
L	Springvale Road	Outfall L is the existing Smythes Drain at the northern extent of the project boundary on Springvale Road. The catchment area consists of the Springvale road reserve and carriage way within the project boundary.	Outfall asset owned by Melbourne Water Total ROW catchment area = 5.44 ha New impervious area = 0.39 ha Discharge to a major drainage system, impact due to increased runoff assessed using the flood models.

OUTFALL NAME	OUTFALL LOCATION	DESCRIPTION	SUMMARY
M	Ch30875	Outfall M is an existing culvert of unknown size which eventually discharges to the Edithvale wetlands. Further investigation to be completed during detailed design to determine the condition of the outfall. The catchment area contains the road reserve and carriageway south of Springvale Road. Agreement between City of Kingston and VicRoad on the ownership and maintenance responsibility are recommended during detailed design.	Total ROW catchment area = 26.17 ha New impervious area = 2.97 ha Detention, bioretention, and spill containment systems to be incorporated into the drainage design. Detention basin volume approximately 500 m^3. Preliminary detention sizing omits Thames Promenade catchment.
N	Boundary Road	Outfall N is a 450 mm dia draining to the west across Boundary Road. This catchment contains 120m of the southbound carriage way of Boundary Road and 120 m of the eastbound carriageway of Centre Dandenong Road.	Outfall asset owned by the City of Kingston Total ROW catchment area = 0.30 ha New impervious area = 0.17 ha Detention system to be incorporated into the drainage design. Oversized pipe storage volume approximately 32 m^3.
O	Lower Dandenong Road	Outfall O is a 300 mm dia pipe (on the north side of Lower Dandenong Road) and 375 mm dia pipe (on the south side of centre Dandenong Road) draining to the west. Both pipes outlet into the Braeside West Drain 250 m away. This system drains a 320 m section of Lower Dandenong Road.	Outfall asset owned by City of Kingston Total ROW catchment area = 0.45 ha New impervious area = 0.18 ha Detention system to be incorporated into the drainage design. Oversized pipe storage volume approximately 25 m^3



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Date: 24/08/2018	Approved by: SH	

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Engineering and Technical Services for Mordialloc Bypass Upgrade

Freeway Drainage Catchments and Outfall Locations
Map 1

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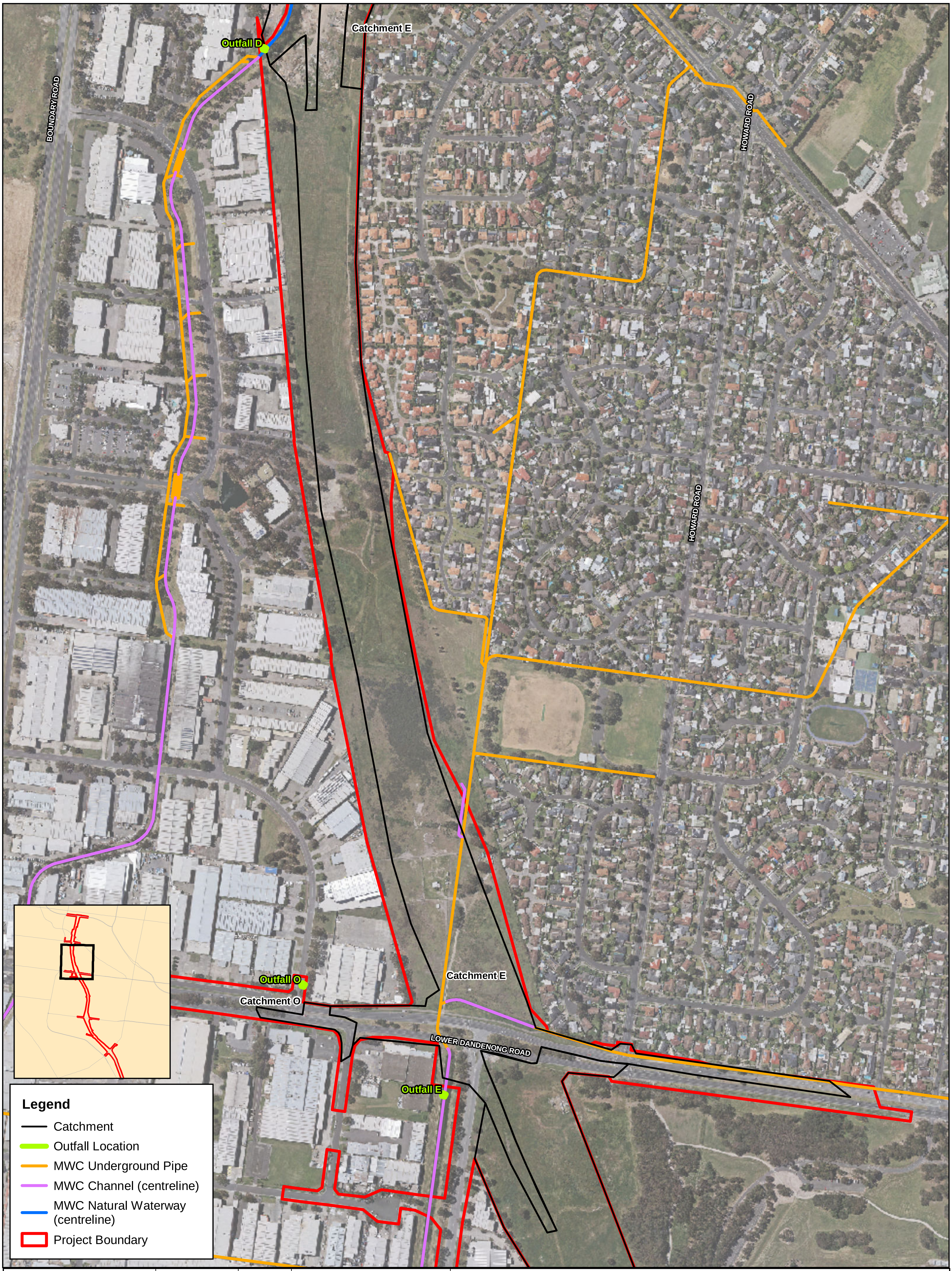

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Engineering and Technical Services for Mordialloc Bypass Upgrade

Freeway Drainage Catchments and Outfall Locations
Map 2

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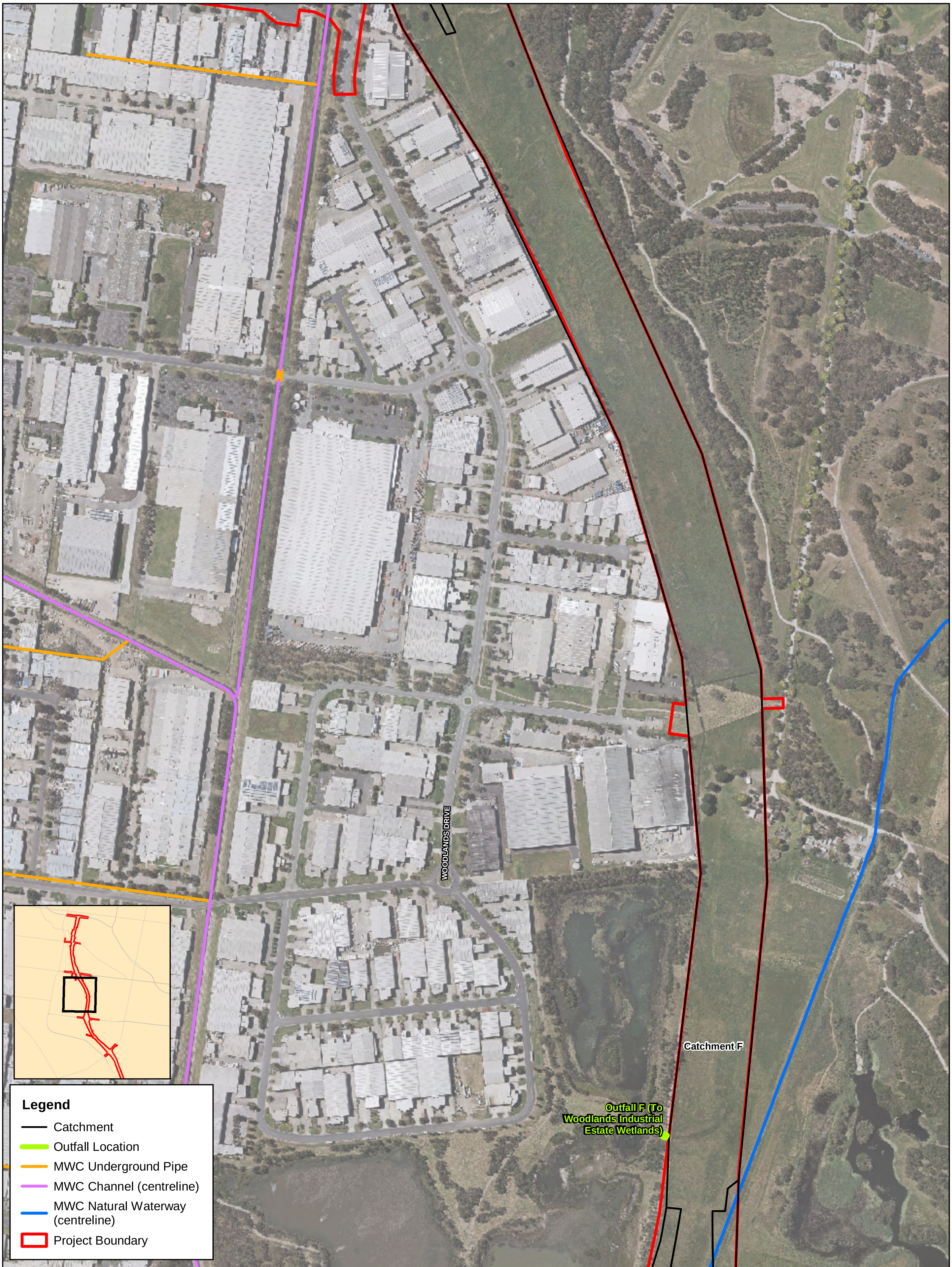

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MAJOR ROAD PROJECTS AUTHORITY

Engineering and Technical Services for Mordialloc Bypass Upgrade

Freeway Drainage Catchments and Outfall Locations

Map 3

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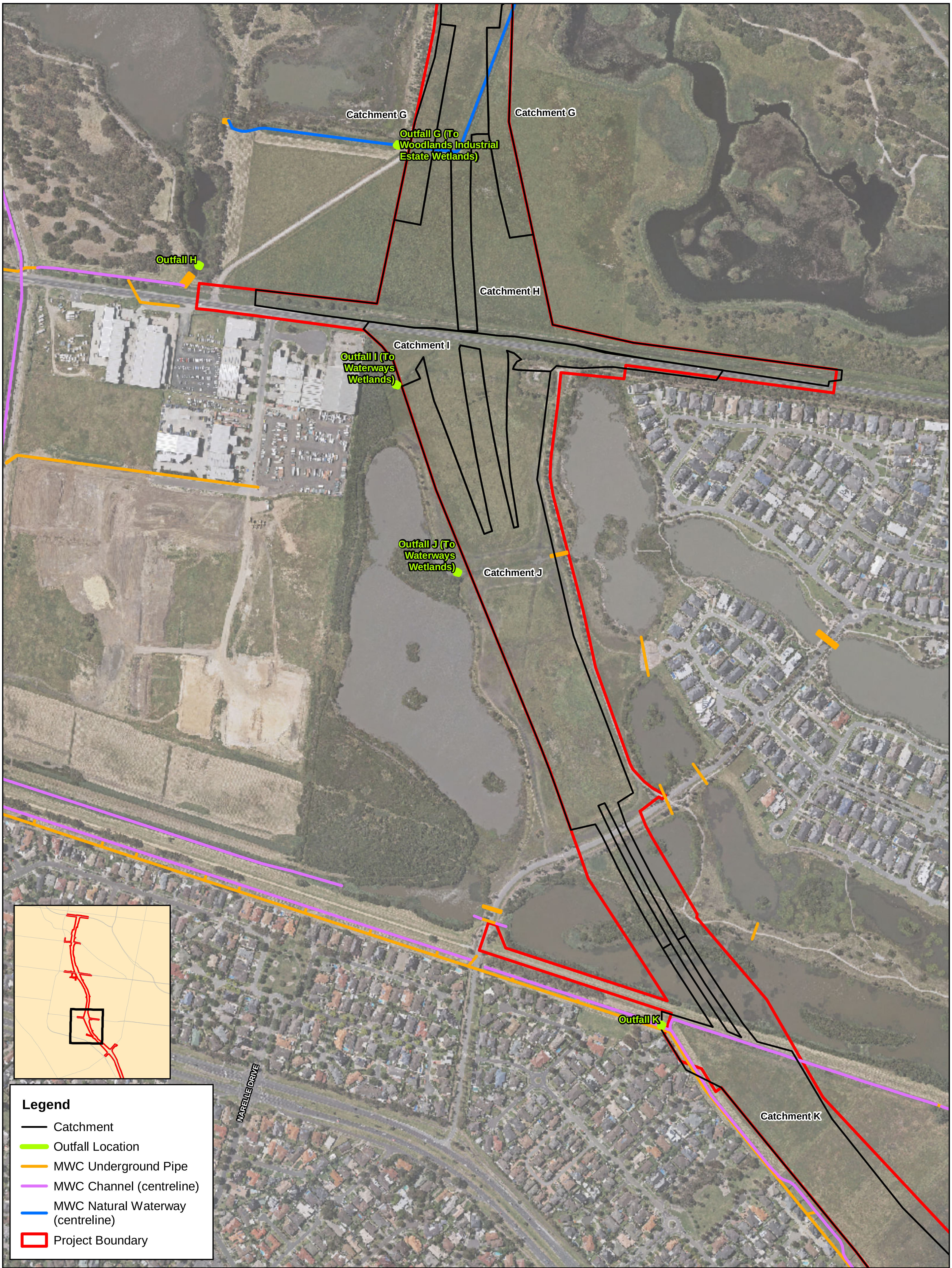

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MAJOR ROAD PROJECTS AUTHORITY

VICTORIA State Government

WSP

Engineering and Technical Services for Mordialloc Bypass Upgrade

Freeway Drainage Catchments and Outfall Locations

Map 4

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MAJOR ROAD PROJECTS AUTHORITY

VICTORIA State Government

wsp

Engineering and Technical Services for Mordialloc Bypass Upgrade

Freeway Drainage Catchments and Outfall Locations

Map 5

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APPENDIX I

PROJECTS THAT COULD FORM CUMULATIVE IMPACT WITH THE PROJECT

Table I.1 Projects, in additional to Level Crossing Removal project, that could form cumulative impact with the proposed Bypass

PROJECT	LOCATION	PROJECT DETAILS	ANY CHANGE IN LAND USES	HOW IS IT GOING TO AFFECT THE NEARBY WATERWAYS	KEY WATERWAYS / DRAINAGE FEATURES	IMPACT TO MORDIALLOC PROJECT
1 Moorabbin Airport Development	The Airport is bounded by Centre Dandenong Road to the north, Boundary Road to the east, Lower Dandenong Road to the south and Grange Road and Bundora Parade to the west.	The 2015 Master Plan is a plan that balances aviation and non-aviation objectives and land uses. In total 173 hectares (60% of the total Airport land) will be used to facilitate general aviation and 121 hectares (40% of the total Airport land) will be available for commercial, industrial, retail, office and aviation support activities. Of this, 57 hectares is serviced land, ready to accommodate new employment and business opportunities.	A range of activities are encouraged in 7 designated Airport precincts, including special purpose and mixed-use precincts including industrial, retail and commercial activity.	The 2015 Master Plan requires site discharges to be controlled to predevelopment levels. Therefore, there should be no impact on the nearby watercourses or drainage network.	Key drainage/waterways — MWC owned Mordialloc Settlement Drain — MWC owned Sibthorpe Drain — KCC network, or potentially directly to a MWC retarding basin in Voltri Street — A 175,000 m^3 dry retarding basin to the south east of the airport.	The new retarding basin has been incorporated into the project base case hydraulic model and therefore any impacts are accounted for. The impact of the Industrial, Office Retail, commercial and Aviation Support Precinct area is accounted by the WSP Q100 Base Case Flood Depth.

PROJECT	LOCATION	PROJECT DETAILS	ANY CHANGE IN LAND USES	HOW IS IT GOING TO AFFECT THE NEARBY WATERWAYS	KEY WATERWAYS / DRAINAGE FEATURES	IMPACT TO MORDIALLOC PROJECT
2 Westall Road Extension	The Westall Road Extension is proposed from the intersection of Westall Road/Princes Highway to the Monash Freeway.	The Westall Road Extension is expected to divert traffic and freight from nearby roads, improving traffic movement from Princes Highway to the Monash Freeway, and improving access to the Monash NEIC and the wider area. Due for completion in early 2018, the final business case will include the preferred design of the Westall Road Extension and will be provided to government to inform future funding priorities.	Proposed alignment to follow an existing road reserve	No details on surface water management was found in our search.	Key drainage — MW owned MILE CREEK WEST BRANCH D.S.	It is not anticipated the Westall Road Extension will impact on surface water for the Mordialloc project. The proposed project area is outside of the Mordialloc Bypass project area.

PROJECT	LOCATION	PROJECT DETAILS	ANY CHANGE IN LAND USES	HOW IS IT GOING TO AFFECT THE NEARBY WATERWAYS	KEY WATERWAYS / DRAINAGE FEATURES	IMPACT TO MORDIALLOC PROJECT
3 Monash Freeway Upgrade	The upgrade works are located between East Link Interchange and South Gippsland Freeway.	Widening from four to five lanes in each direction between East Link Interchange and South Gippsland Freeway. Widening from two to three lanes in each direction from South Gippsland Freeway to Clyde Road in Berwick.	The upgrade works will all occur within the existing central road reserve.	No details of surface water impact found in search. However, the project is anticipated to incorporate Water Sensitive Road Design (WSRD) into the design. Therefore, the proposed project should not negativity impact on the nearby watercourses or drainage network.	No anticipated impacts	It is not anticipated that the Monash Freeway Upgrade will impact on surface water for the Mordialloc project.
4 Dandenong Bypass	The project is located between the South Gippsland Highway and Perry Road, connecting to Cheltenham Road and the Mitcham Frankston Project.	The bypass is a 5 km long, four-lane duplicated road. The Bypass includes an: overpass of Cranbourne Rail Line, grade separated full diamond interchange at Mitcham-Frankston Freeway.	Project is located in the Dingley Freeway reservation.	No details of surface water impact found in search. However, the project is anticipated to incorporate Water Sensitive Road Design (WSRD) into the design. Therefore, the proposed project should not negativity impact on the nearby watercourses or drainage network.	No anticipated impacts	The Dandenong Bypass is located outside of the Mordialloc project area and is not anticipated to impact on surface water design.

PROJECT	LOCATION	PROJECT DETAILS	ANY CHANGE IN LAND USES	HOW IS IT GOING TO AFFECT THE NEARBY WATERWAYS	KEY WATERWAYS / DRAINAGE FEATURES	IMPACT TO MORDIALLOC PROJECT
5 City of Kingston development of Chadwick Reserve	Albert Place near Chadwick Reserve	Low flows diverted from main drain near the south end of Albert Place to a wetland in the north-west corner of Chadwick Reserve. Diverted flows will pass through a GPT before entering the wetland. The wetland footprint will be 7,000 m2 with an area at “normal water level” of 4,900 m^2. Treated water will be used to irrigate the two ovals at Chadwick Reserve (demand of 10 ML/yr.). Treated flows will be pumped to above ground storage. The optimal tank volume is 400 kL.	Land use change from green open space to wetland	Wetland to be located in Mordialloc Creek catchment.	GARTSIDES D.S.is located adjacent to the wetland.	The wetland located to the north-west corner of Chadwick Reserve and is within the WSP Q100 Base Case Flood Depth. The proposed wetland was not incorporated in the hydraulic model. While it is expected that this project will mitigate flood impact induced by the project, it is recommended further consideration to this project is incorporated into the detail design considering its proximity to the proposed works.

PROJECT	LOCATION	PROJECT DETAILS	ANY CHANGE IN LAND USES	HOW IS IT GOING TO AFFECT THE NEARBY WATERWAYS	KEY WATERWAYS / DRAINAGE FEATURES	IMPACT TO MORDIALLOC PROJECT
6 City of Kingston development of projects identified in Green Wedge Plan	Lands adjacent to Dingley Bypass road alignment	To investigate potential benefits that could be gained from construction of wetlands, retarding basins and storage ponds. Three options were presented for treatment of stormwater runoff from the proposed Dingley Bypass and Deals Road drainage: — Small option – 1000 m^2 sediment pond and 400 m^2 sediment pond area — Medium option – same as small option plus 2200 m^2 wetland — Large option – 8.3 ha wetland, sediment pond 0.6 ha and 1 ha storage area.	Proposed wetlands and storage ponds to be located in green open space.	Provides treatment for the proposed Dingley Bypass and proposed Deals road drain.	Dunlops Drain	The Kingston Green Wedge project is located within the model boundary. All three options are partially located within the WSP Q100 Base Case Flood Depth. These wetlands were not considered as part of the Mordialloc bypass. While it is expected that this project will mitigate flood impact induced by the project, it is recommended further consideration to this project is incorporated into the detail design considering its proximity to the proposed works.

PROJECT	LOCATION	PROJECT DETAILS	ANY CHANGE IN LAND USES	HOW IS IT GOING TO AFFECT THE NEARBY WATERWAYS	KEY WATERWAYS / DRAINAGE FEATURES	IMPACT TO MORDIALLOC PROJECT
7 Living Links Projects	Living Links is an ambitious, large scale program to retain and protect the natural values of the region in the face of continuing development, and to make this area a world-class urban ecosystem.	Living Links Corridors: — Connecting Karkarook Park to Braeside Park and Mordialloc Creek. — Connecting Dandenong Creek Corridor to the Edithvale Seaford Wetlands along Mordialloc Creek into Port Phillip Bay. Future/Proposed Shared Pathways: — Shared pathway link to the Sand Belt Parklands from Lower Dandenong Road — Mordialloc Creek Bike path Link — Mordialloc Creek Wetlands between Waterways Estate and Wells Road — Green Wedge Wetlands and Threatened Habitat Protection.	Change of land use required to accommodate a shared pathway	No details of surface water impact found in search.	Nearby key drainage features in Living Links corridor: — Clayton south drain — HAILEYBURY D.S — Braeside wetland — Edithvale Seaford Wetlands — Mordialloc Creek	The Mordialloc Corridor and Karkarook Park to Braeside Park corridor in the Living Links project intersects the Mordialloc bypass project area. In particular, the BRAESIDE PARK reserve is located within the WSP Q100 Base Case Flood Depth. While it is expected that this project will mitigate flood impact induced by the project, it is recommended further consideration of the Living Links project is included in the detail design considering its proximity to the proposed works.

PROJECT	LOCATION	PROJECT DETAILS	ANY CHANGE IN LAND USES	HOW IS IT GOING TO AFFECT THE NEARBY WATERWAYS	KEY WATERWAYS / DRAINAGE FEATURES	IMPACT TO MORDIALLOC PROJECT
8 Hawthorn Football Club development	Hawthorn Football Club, Total Road, Dingley	The planning permit allows the subdivision of land and creation of a 27.9 hectares lot to be developed and used by the Hawthorn FC. The proposed development includes: — Main training oval the size of the MCG — Multi-purpose training area with a potential running track and soccer field — To additional ovals — Pavilion with tiered seating — Change rooms, medical rooms, storage, offices and function centre (accommodating no more than 150 patrons) — Café, retail shop, museum, community education and leadership centre.	Land use could become more impervious due to construction of changing rooms, offices, cafes, etc.	No details of surface water impact found in search. However, project is located adjacent to the Mordialloc project area and depending on the layout of the proposed drainage network runoff could potentially be diverted towards the Mordialloc project area.	Nearby key drainage features: — GARTSIDES NORTH D.S.	The hawthorn football club development is located within the modelling area and adjacent to project area. Development has been approved by City of Kingston Council. Depending on the surface water managing plan proposal, this project could divert runoff towards the Mordialloc project area and impact surface water. The proposed Hawthorn Football Club is not located within the WSP Q100 Base Case Flood Depth and the potential increase in runoff is expected to be managed within the project site. It is recommended review its potential impact during the detail design stage, if further details of the water management plan are available.

PROJECT	LOCATION	PROJECT DETAILS	ANY CHANGE IN LAND USES	HOW IS IT GOING TO AFFECT THE NEARBY WATERWAYS	KEY WATERWAYS / DRAINAGE FEATURES	IMPACT TO MORDIALLOC PROJECT
9 Mordialloc Creek Tidal Waterway Restoration and Freshwater Wetland System (Melbourne Water)	Wells Road Bridge and Aspendale Gardens	Widen of Mordialloc Creek Create a large new wetland Plant native vegetation	Remove levee bank on the Braeside side of the creek. Plant native plants in and around the wetland.	Make Mordialloc Creek wider and construct new wetlands	Mordialloc Creek and wetlands	The proposed project is located within the WSP Q100 Base Case Flood Depth. This project has not been incorporated into the flood modelling. It is expected that the flood impact of this project will be mitigated as part of the project. However, considering the proximity of the effect of this proposed development should be considered at detail design stage.

APPENDIX J

HYDROLOGY CALIBRATION OF MUSIC MODEL

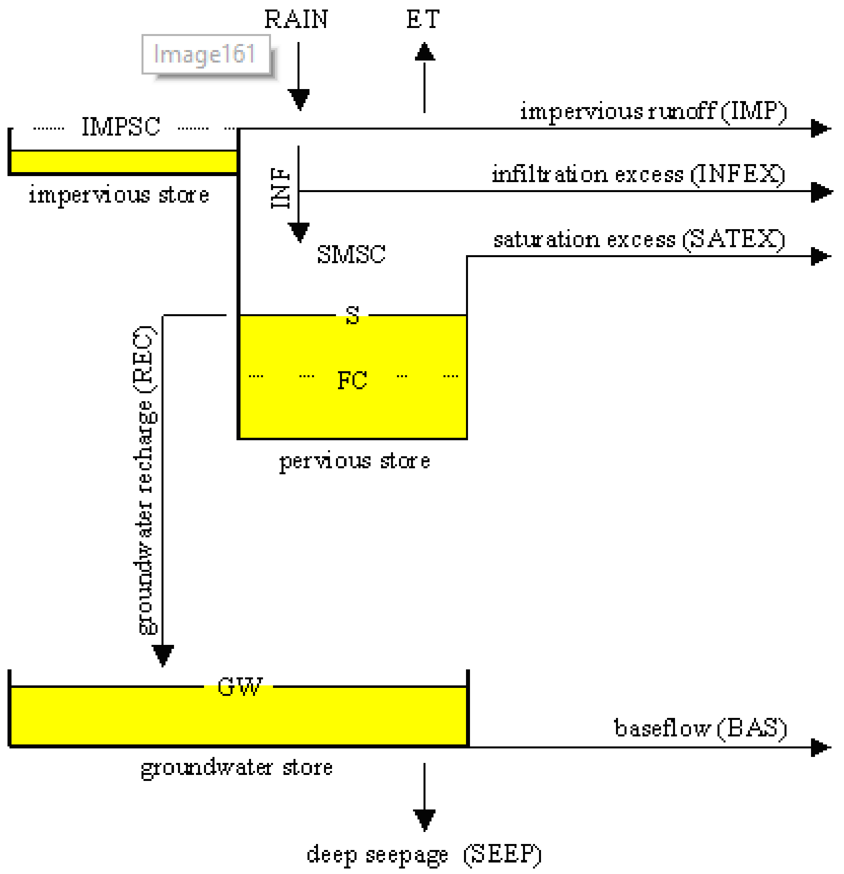
There is a flow gauge was identified within the Mordialloc Creek Catchment with available daily flow data record for the period 1975–2017. This is located on Dunlops Drain at Citus Street (228358A). This gauge covers the catchment area of the northern parts of the project and therefore is considered to provide a suitable record for flow regime analysis to inform the baseline assessment and impact assessment of the Bypass. Flow record collected at this gauge was used to calibrate the rainfall runoff parameters of MUSIC model.

Figure J.1 shows the schematic of the hydrological model adopted in MUSIC and the model parameters that can be modified during calibration. Since the MUSIC model is used to assess the impact of the proposed project on flow regime of the waterway in the catchment and flow duration curve is adopted as the indicator to represent the flow regime characteristics, the calibration based on the matching of the recorded flow duration curve. There is a number of missing flow recorded days scattering among the years that days with missing flow are ignored in the flow duration curve analyses for both recorded and MUSIC simulated data. The calibration start with parameters recommended by Melbourne Water for this region and then progressively modify the parameters to achieve the best possible fit.

Figure J.2 shows that the simulated flow duration curve matches the recorded flow duration curves reasonably. Table J.1 tabulated the MUSIC model parameters recommended by Melbourne Water in this region and the parameters found to best fit the recorded data.

Table J.1 MUCSCI Model rainfall runoff parameters

MUSIC PARAMETERS	MELBOURNE WATYER RECOMMENDED	CALIBRATED
Impervious Area		
Rainfall Threshold	1	2
Pervious Area		
Soil Storage	1.2	1.2
Initial Storage	25	25
Field Capacity	50	48
Infiltration Capacity Coef a	200	200
Infiltration Exponent b	1	1
Groundwater		
Initial Depth	5	5
Daily Recharge Rate	15	10
Daily Baseflow Rate	2.5	1.25
Daily Deep Seepage Rate	0	0



Model inputs

RAIN = daily rainfall (mm)
PET = areal potential evapotranspiration (mm)

Model parameters

IMPSC = impervious store capacity (mm)
SMSC = soil moisture store capacity (mm)
COEFF = maximum infiltration loss (mm)
SQ = infiltration loss exponent
FC = field capacity of soil moisture store (mm)
RFAC = soil moisture to groundwater recharge factor
BFAC = groundwater to baseflow factor
SFAC = groundwater to deep seepage factor

Model relationships

IMP = greater of {(RAIN - ***IMPSC***), 0}
INF = lesser of { ***COEFF*** × exp (-***SQ*** × S / ***SMSC***), RAIN}
INFEX = RAIN - INF
SATEX = greater of {(S - SMSC), 0}
REC = greater of {(***RFAC*** × (S - ***FC***)), 0}
ET = lesser of {(10 × S / ***SMSC***), PET}
BAS = ***BFAC*** × GW
SEEP = ***SFAC*** × GW

Figure J.1 Schematic and model parameters of the hydrological model used in MUSIC and the model

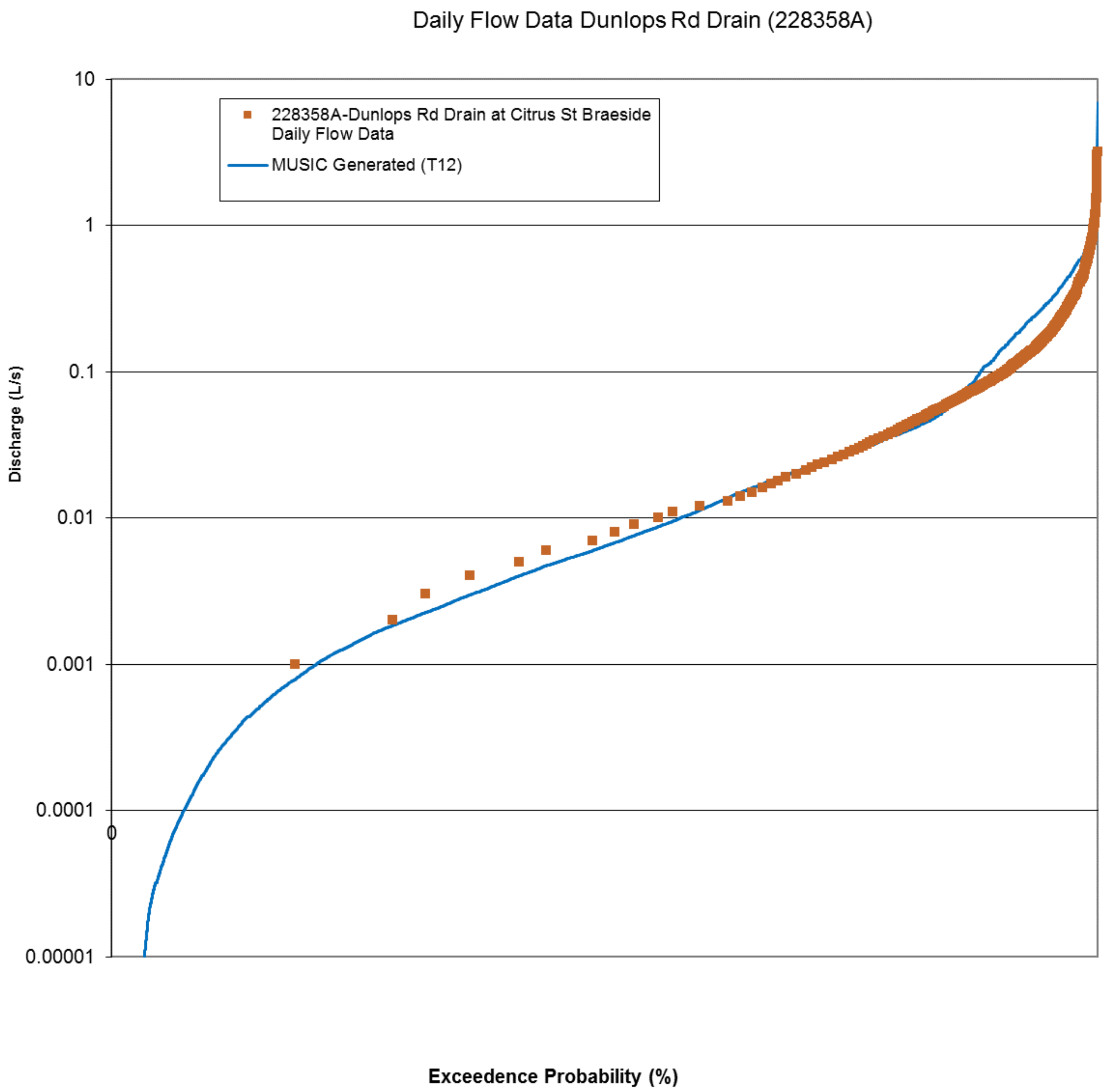


Figure J.2 Comparison of recorded and MUSIC simulated flow duration curves

APPENDIX K

MEETING MINUTES WITH CITY OF KINGSTON

MEETING NOTES

PROJECT NAME	OSAR
PROJECT NUMBER	2135645A
DATE	Friday, 19 January 2018
TIME	9:15 AM
VENUE	Phone conference
SUBJECT	Flooding and WSUD Issues related to Mordialloc Bypass
CLIENT	VicRoads
ATTENDEES	Alan West (AW) (Kingston city Council) Eric Lam (EL) (WSP
APOLOGIES	-
DISTRIBUTION	

MATTERS ARISING		ACTION
1.0	**FLOODING AND WSUD ISSUES RAISED BY AW**	
1.1	The Old Dandenong Road Drain near Dingley Bypass is known as Dunlops Drain by the council. Capacity of this drain should not be compromised by the Bypass. Some water quality information may be available at this location. AW is to confirm the availability of the data and, if available, provide the information to WSP. Also, there is Water Technology Report; related to proposed wetlands. This report could contain some water quality information. AW is to provide details to EL.	AW (extracts of Water Technology project summary was provided on 1/2/18)
1.2	The two areas marked in Map 1 of Appendix A as wetlands east of the Bypass near Junction Road are not wetlands. EL to update Map 1.	EL (to be revised in next version of the report)
1.3	AW anticipated that Swales are likely to be part of the solution. Other WSUD infrastructure need to be investigated as appropriate. Their efficiency should be evaluated using MUSIC.	
1.4	There is concern about the possible reduction of flood storage due to earthworks of the Bypass south of Centre Dandenong Road. Flood extent should be keep within the reserve and also needs to take note of the 10 year flood immunity of the bicycle way.	
1.5	The colour scheme for flood depth was suggested to be modified to a more contrasting colour scheme. AW is to provide an example of a preferred colour scheme.	AW (Example colour scheme for flood depth & hazard risk was provided on 1/2/18)

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MEETING NOTES

1.6	There are WSUD works proposed near the Chadwick Reserve area. The Bypass design should be beware of the proposed works and not adversely affect the efficiency of these works. Opportunity to integrate the proposed WSUD works with the proposed drainage design of the Bypass should be explored. AW is to send information of the proposed works.	AW (Chadwick Reserve wetland concept was provided on 1/2/18)
1.7	The Dingley Village area near Gartsides DS and Gartsides South DS, and bounded by the Bypass on the south and the west is the most concerned area. The residential area of Dingley Village between the proposed bypass and Howard Rd is known to have existing flooding problems throughout the catchment. This area was designed in the 1960's without 1 in 100 year overland flow paths and the majority of houses are on concrete slabs with minimal freeboard. The existing drainage system is operating at a service level that is less than 1 in 5 year capacity due to subsequent increased imperviousness in the catchment. Any reduction in the capacity of the Melbourne water drains (or a reduction in storage capacity within the bypass road reservation) will have negative consequences.	
1.8	The flooded area near Park Way covers a walkway which is a key pedestrian walkway linking the Woodlands Industrial area in the west and the Braeside Park on the East.	
1.9	The full length of Governor Road and the abutting land use is extremely flat. The grade of the open drain from west of Springvale Road connecting to the WC main drain is very flat. Proposed cross drainage design at this area needs to aware and take into account the potential maintenance and siltation issues.	
1.10	The flood extent in the area bounded between Smythes Drain and the Bypass west of Springvale Road seems to be less extensive than expected. This should be checked against Neil Craig's report which is detailed in Appendix B4.	EL (to investigated)
1.11	MWC has information at the location where Mordialloc Settlement Drain discharge into Mordialloc Creek (just east of Boundary Road). A proposed wetland and industrial estate half developed plans, design and testing results are available. The information might be useful to inform the present of Acid Sulphate soil. The previous contact was Graham Daff at Melbourne Water however he retired in December 2017.	

NEXT MEETING

APPENDIX L

SPILL RISK ASSESSMENT

A spills risk assessment has been carried out to identify locations where spill containment is required. The risk assessment takes into account the risk of an accident occurring on the alignment due to vehicle turning and merging movements, together with the proximity of the carriageway to a natural waterway or sensitive receiving environment. Road sections that are not located in sensitive areas and that have limited merges and favourable road geometry are likely to present a lower risk of a spill, whereas interchange areas in sensitive receiving environments would be more likely to have a higher spill risk.

An assessment matrix has been developed to assess the spill risk, as shown in Table L.1. If the matrix returns a high risk, spill containment is recommended. For a medium spill risk, separate spill containment is not recommended and a channel/swale may be available to restrict/contain any spill. i.e. swales can provide redundancy in the drainage network to assist in the delay and retention of a spill. The results of the spills risk assessment is provided in Table L.2.

Table L.1 Spills risk assessment matrix

LIKELIHOOD OF SPILL	IMPACT (DISCHARGE PROXIMITY TO A SENSITIVE RECEPTOR)		
	Minor (500 m to 2 km)	Moderate (100 m to 500 m)	Major (0 to 100 m)
Merge/diverge zones Intersections	L	M	H (provide spill containment)
Through alignment	L	L	M

Table L.2 Spills containment risk assessment

OUTLET CHAINAGE	SENSITIVE RECEPTOR	DISTANCE TO SENSITIVE RECEPTOR	OUTLET TYPE	LIKELIHOOD OF SPILL	IMPACT
26000 SB	Woodlands Industrial Estate Wetland	1930	Headwall	Intersection	Low
26315 NB	Woodlands Industrial Estate Wetland	1585	Headwall	Merge/diverge zones	Low
26350 SB	Woodlands Industrial Estate Wetland	1615	Headwall	Merge/diverge zones	Low
26500 NB	Woodlands Industrial Estate Wetland	1400	Headwall	Merge/diverge zones	Low
26500 SB	Woodlands Industrial Estate Wetland	1430	Headwall	Merge/diverge zones	Low
27075 NB	Woodlands Industrial Estate Wetland	825	Headwall/Swale	Through Alignment	Low
27075 SB	Woodlands Industrial Estate Wetland	855	Headwall/Swale	Through Alignment	Low
27375 SB	Woodlands Industrial Estate Wetland	675	Headwall	Through Alignment	Low
27900 NB	Woodlands Industrial Estate Wetland	30	Bioretention Swale	Through Alignment	Moderate

OUTLET CHAINAGE	SENSITIVE RECEPTOR	DISTANCE TO SENSITIVE RECEPTOR	OUTLET TYPE	LIKELIHOOD OF SPILL	IMPACT
27900 SB	Woodlands Industrial Estate Wetland	85	Bioretention Swale	Through Alignment	Moderate
27375 SB	Woodlands Industrial Estate Wetland	550	Headwall	Through Alignment	Low
27350 NB	Woodlands Industrial Estate Wetland	520	Headwall	Through Alignment	Low
27900 NB	Woodlands Industrial Estate Wetland	30	Headwall	Merge/diverge zones	High
27900 SB	Woodlands Industrial Estate Wetland	100	Headwall	Merge/diverge zones	Moderate
28475 NB	Waterways Wetlands	55	Headwall	Merge/diverge zones/ Intersection	High
28475 SB	Waterways Wetlands	205	Headwall	Merge/diverge zones/ Intersection	Moderate
28600 NB	Waterways Wetlands	205	Headwall	Merge/diverge zones	Moderate
28550 SB	Waterways Wetlands	330	Headwall	Merge/diverge zones	Moderate
28750 NB	Waterways Wetlands	35	Bioretention Swale	Merge/diverge zones	High
28750 SB	Waterways Wetlands	120	Bioretention Swale	Merge/diverge zones	Moderate
28825 NB	Waterways Wetlands	100	Headwall	Merge/diverge zones	Moderate
28825 SB	Waterways Wetlands	190	Headwall	Merge/diverge zones	Moderate
28850 NB	Waterways Wetlands	150	Headwall	Merge/diverge zones	Moderate
28850 SB	Waterways Wetlands	205	Headwall	Merge/diverge zones	Moderate
30760 NB	Edithvale Wetland	0	Bioretention Swale	Merge/diverge zones	High
30760 SB	Edithvale Wetland	130	Bioretention Swale	Merge/diverge zones	Moderate
30975 NB	Edithvale Wetland	185	Headwall	Merge/diverge zones	Moderate
30975 SB	Edithvale Wetland	360	Headwall	Merge/diverge zones	Moderate

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