VRC Wall & Mitigation Report for the 1% AEP 2024 Event

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Melbourne Water Corporation

Melbourne Water Lower Maribyrnong Flood Mapping Study
4 June 2024

VRC Wall & Mitigation Report for the 1% AEP 2024 Event

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Executive summary

Melbourne Water has engaged Jacobs to model and present the impacts of the Victorian Racing Club (VRC) flood wall, and associated mitigation measures, on the extent, water level, and duration of flooding experienced in the Lower Maribyrnong catchment for the 1% AEP 2024 flood event. This report has been produced to present the results of these investigations.

Previously, Jacobs has prepared and issued similar reports describing the impact of the flood wall and mitigation measures in the October 2022 flood event. Previous reports prepared by Jacobs were:

- VRC Wall & Mitigation Report presented findings of the impact of the flood wall in the October 2022 event (Jacobs, 2024b).
- Summary of Investigations – 2024 Maribyrnong River Flood Model and the VRC Flood Wall presented a summary of the findings of the impact of the flood wall and efficacy of mitigation measures in the October 2022 event (Jacobs, 2024c).
- Addendum to VRC Wall & Mitigation Report presented the findings of the efficacy of mitigation measures during the October 2022 flood (Jacobs, 2024d).

All above documents should be read in conjunction with each other, and the suggested reading order is:

- Summary of Investigations – 2024 Maribyrnong River Flood Model and the VRC Flood Wall (Jacobs, 2024c).
- VRC Wall & Mitigation Report (Jacobs, 2024b).
- Addendum to VRC Wall & Mitigation Report (Jacobs, 2024d).

This report 'VRC Wall & Mitigation Report for the 1% AEP 2024 Event' presents the findings of the impact of the VRC wall and efficacy of mitigation measures in the 1% AEP 2024 event.

Jacobs developed the 2024 Maribyrnong River Flood Model (Jacobs 2024a) and this forms the basis of the following results and reporting as well as Jacobs 2024b and Jacobs 2024d. This model is considered to produce the best available information with regards to flooding in the Lower Maribyrnong River at the time of this report. In total three hydraulic model scenarios under the 1% AEP flood event were undertaken:

- Base Case – With the VRC flood wall and with the associated mitigation measures. This represents the current catchment conditions.
- Scenario 1 – Without the VRC flood wall and associated mitigation measures.
- Scenario 2 – With the VRC flood wall but without the associated mitigation measures.

The scenarios have the same naming convention as reported in Jacobs 2024b as these represent the same catchment conditions. The only change is the magnitude of the flood event, in Jacobs 2024b the flood event applied to the model was the October 2022 event whereas in this report the flood event is the 1% AEP event.

The mitigation measures are:

- Footscray Rail Culverts (Northern Railway Culverts) – Approximately 70 m of earth roadway embankment removed downstream of the rail culverts lowering levels from 0.8 m AHD to 0.5 m AHD.
- Footscray Road Bridge – Removal of bluestone abutment located on the eastern edge of the channel.
- Footscray Road Bridge – Flow training wall constructed on the eastern embankment upstream and downstream of the bridge. Fargue spiral design to minimise the energy losses through the bridge.
    - While the training wall is understood to have been installed as designed, the cladding has fallen into disrepair over time and may not be functioning as designed.

Performance of the VRC Flood Wall

As designed, the VRC flood wall was intended to protect Flemington Racecourse under events more frequent than the 1% AEP event. Under the 1% AEP event modelled for this report, floodwaters enter the VRC during the peak of the event leading to minor inundation of the racecourse. The 1% AEP event is not large enough however to fully utilise the racecourse for flood storage, so the flooding does not extend through the entire site as it does in the scenario without the wall.

Impact on Flood Extent

Under the 1% AEP event, the flood extends from the steep 'walls' of either side of the floodplain which results in negligible changes in extent under Scenario 1 and Scenario 2.

The flood extent (area) in the Base Case is increased by <1%, when compared to Scenario 1. In Scenario 2 the flood extent (area) is increased also by <1% when compared to Base Case.

Impact on Flood Level

As a result of the VRC flood wall and the associated mitigation measures (Base Case compared to Scenario 1), there is a moderate increase in flood depths across the wider area, including:

- An average water level increase of approximately 38 mm within the residential parcels of Maribyrnong Township off an average depth of 1.31 m (3%).
- An average water level increase of approximately 12 mm within the industrial parcels along Hobsons Road and Kensington Road in Kensington off an average depth of 0.86 m (1%).
- In the residential parcels within Kensington Banks, there is a benefit of approximately 52mm from the VRC wall and mitigation measures.

The mitigation measures also provide minor benefits under the 1% AEP event (Base Case compared to Scenario 2), including:

- An average decrease in water level of approximately 1mm within the residential parcels of Maribyrnong Township.
- An average decrease in water level of approximately 4mm within the industrial parcels along Hobsons Road and Kensington Road in Kensington.
- An average decrease in water level of approximately 3mm within the residential parcels in Kensington Banks.

Impact on Flood Duration

The comparison of Base Case to Scenario 1 shows that the VRC wall (and associated mitigation measures) extended the duration of the flood peak by up to 4.5 hours. At Chifley Drive gauge, the Base Case peak level of 4.71 m AHD is exceeded by up to 30 mm for approximately 4.5 hours under Scenario 1.

In Scenario 2 there was no impact on flood duration at Chifley Drive gauge. At Footscray Road Bridge where the bulk of the mitigation is located, the Base Case peak level of 1.77mAHD is exceeded by up to 10mm for approximately 3 hours.

Efficacy of the mitigation measures

The outcome of the modelling indicates that, under a 1% AEP flood event, when the mitigation works are removed (Scenario 2), there is a moderate impact to peak flood levels, a minor impact to flood peak duration and a negligible impact on the extent of the flood peak. Removing the mitigation measures were found to have a small increase in peak water levels except for a localised increase of up to10 mm in the vicinity of Footscray Road bridge which exceeded the Base Case level for approximately 3 hours.

To definitively assess the efficacy of the mitigation measures, it is necessary to compare the pre-flood wall conditions to the current conditions (base case). This would allow the determination of whether the mitigation measures are meeting the intended purpose of matching the conditions without the flood wall. However, this was not considered to be feasible as available pre-wall information was not commensurate with the information available for current conditions; in particular, the floodplain topographic levels and bathymetry available pre-wall are far sparser the current conditions.

In reaching these conclusions Jacobs notes the following:

- The modelling methodology and software which has assessed the mitigations measures differs to the methodology adopted at the time of the 2003 assessment.
- The representation of the mitigation works at Footscray Road Bridge within the current modelling software differs to the representation in the assessment completed at the time that it was approved in 2003. This is due to the different modelling techniques undertaken 20 years apart. The earlier work was completed using a 1D steady state model whereas the current model was a 2D unsteady model which used up to date data and had fewer assumptions.
- There have been changes to the floodplain in the last 20 years that may have contributed to flood changes in flood behaviour in the Maribyrnong River including the construction of Regional Rail Link, Ascot Chase Development, changes to Smithfield Road Bridge (Lynch's Bridge) and minor changes to landscaping and works on the banks of the Maribyrnong.

Future 2100 conditions including an allowance for climate change

A preliminary assessment of the potential impacts of the VRC wall including the associated mitigation measures under 2100 conditions for the 1% AEP indicates that the wall is significantly overtopped. In essence the wall is drowned out and flood levels are only minimally affected. The 'shielding' effect of the VRC wall on Kensington Banks is also present under this scenario.

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Abbreviations and definitions

1D Hydraulic Model	1-Dimensional hydraulic model where flood levels are determined by cross sections perpendicular to the flow path.
2D Hydraulic Model	2-Dimensional hydraulic model based on terrain/elevation data at a specified grid size. Capable of modelling floods across a floodplain where flow direction varies in space and time.
1D/2D Hydraulic Model	Coupled 1D/2D modelling, typically the floodplain would be represented in 2D and the main flow paths in 1D together with small scale hydraulic structures.
12d	A civil design software package that is use can be used to create a 3-dimensional surface from 3d data points
ARR 2019	2019 release of Australian Rainfall & Runoff Guidelines.
AEP	Annual Exceedance Probability. The probability that an event of a given size will be equalled or exceeded in a given year.
ARI	Average Recurrence Interval. The inverse of the AEP expressed as a return period. For instance, the 1% AEP is equivalent to the 100-year ARI event.
Afflux	Typically referred to as a change in a water level due to an obstruction.
Attenuation	The reduction in the peak flow and shape of a hydrograph due dissipation, friction and changes in the storage characteristics within a waterway.
Bathymetry	Survey representing the underwater terrain (elevation).
Conveyance	The capacity of a waterway to carry flows and is a function of geometry and bed resistance typically expressed as Manning's values.
FFA	Flood Frequency Analysis.
Floodplain storage	The area in a floodplain which is capable of storing flood waters during a flood event.
Freeboard	Freeboard is the difference between the floor level of a building and the 100-year ARI flood level
Hydrograph	A time series of flow which changes at each timestep and naturally captures the peak flood flow.
LiDAR	Light Detection and Ranging is a remote sensing method that uses light in the form of a pulsed laser to distance to the Earth.
M AHD	Meters Australian Height Datum.
m/s	Metres per second (a measure of speed / velocity).
M^3/s	Cubic metres per second (a measure of flow).
Manning's "n" value	A coefficient which represents the roughness of terrain on which water flows over.
MW	Melbourne Water Corporation.
Steady State	A modelling method where a constant flow is applied to a hydraulic model which then determines hydraulic properties such as water level and velocity.
Total Energy Line	The level to which the WSL rises if it were stationary. The TEL is always above the water surface and decreasing in a downstream direction. The difference between the WSL and the TEL is the velocity head which is the square of the velocity divided by twice the acceleration due to gravity. Sometime referred to as the Total Energy Level, Energy Grade Line or Gradient Line.
Unsteady State	A hydraulic modelling methodology where flows are applied that vary with time.

Water Surface Elevation	Water Surface Elevation, the surface of the water at a given point.
VRC	Victoria Racing Club

Terminology between ARI and AEP

When describing the magnitude of flood events, this report uses both Average Recurrence Interval (ARI) and Annual Exceedance Probability (AEP). The ARI terminology has generally been preferred to remain consistent with the work completed in the early 2000's and to avoid confusion when cross-referencing information.

Australian Rainfall and Runoff (ARR) 2019, recommends that rare events should be expressed as an Annual Exceedance Probability (AEP). AEP is the probability of an event being equalled or exceeded within a year and may be expressed as either a percentage (%) or 1 in X. For example, a 1% AEP event or 1 in 100 AEP has a 1% chance of being equalled or exceeded in any year.

Average Recurrence Interval (ARI) was a term commonly used in the past (ARR, 1987) and was defined as the average period between occurrences equalling or exceeding a given value. The use of terms such as "recurrence interval" and "return period" are no longer recommended as they imply that a given event magnitude is only exceeded at regular intervals, such as every 100 years. The term ARI has only been applied when referencing documents developed prior to the release of ARR 2019.

1. Introduction

Jacobs was approached in March 2023 and then commissioned by Melbourne Water in April 2023 to undertake flood modelling of the Lower Maribyrnong River for provision of updated flood information for the Lower Maribyrnong River. As part of this provision of updated flood information in the Lower Maribyrnong Flood Mapping project a new TUFLOW model (along with updated hydrological models) was developed that is reflective of current catchment conditions, 2023 survey and terrain data, revised guidance from the introduction of ARR2019 (Australian Rainfall and Runoff 2019), modelled climate change scenarios, Melbourne Water Flood Mapping Project Specifications (Melbourne Water 2023) and developments in modelling methodology. This model is hereafter referred to as the 2024 Maribyrnong River Flood Model and will replace previous 2003 1D HEC-RAS models for the Lower and Mid Maribyrnong River.

For the purposes of this report, Jacobs used the 2024 Maribyrnong River Flood Model developed for the Lower Maribyrnong Flood Mapping Project to assess the impact of the Flemington Racecourse flood protection wall (hereafter referred to as the VRC (Victorian Racing Club) flood wall) and associated mitigation measures, on the Lower Maribyrnong catchment, in the 1% AEP 2024 flood event.

1.1 Purpose of this report

Previously, Jacobs has prepared and issued a VRC Wall & Mitigation Report V002 (Jacobs, 2024b) issued to Melbourne Water on 14 March 2024 and Addendum to VRC Wall & Mitigation Report V002 (Jacobs, 2024c) issued to Melbourne Water on 25 March 2024, which detailed the impact of the VRC flood wall and mitigation measures in the October 2022 flood event.

The flood modelling for the Lower Maribyrnong Flood Mapping study has been completed and Jacobs has been requested to provide additional information on the impact of the VRC flood wall and efficacy of mitigation measures in the 1% Annual Exceedance Probability Event (AEP) 2024 event. This report has been prepared to detail the findings of the assessment.

Previous reports prepared by Jacobs, and the suggested reading order is:

- Summary of Investigations – 2024 Maribyrnong River Flood Model and the VRC Flood Wall (Jacobs, 2024c).
- VRC Wall & Mitigation Report (Jacobs, 2024b).
- Addendum to VRC Wall & Mitigation Report (Jacobs, 2024d).
- VRC Wall & Mitigation Report for the 1% AEP 2024 Event (this report).

The 2024 Maribyrnong River Flood Model is completed and is calibrated to the October 2022 event and validated to an additional three historic events. This calibrated model forms the basis of this report. Details on the model setup and the calibration can be found in:

- A summary in Appendix A of VRC Wall & Mitigation Report (Jacobs 2024b).
- The 2024 Maribyrnong River Flood Model Report (Jacobs, 2024a).

1.2 Background

The VRC flood wall was constructed in 2007 with the purpose of mitigating flooding to Flemington Racecourse assets from the Maribyrnong River for events up to the 1% Annual Exceedance Probability event (GHD, 2003b). As part of the package of works associated with the VRC flood wall, mitigation measures were also delivered with the aim of not increasing flood depth, in the lower Maribyrnong River floodplain, due to the addition of the VRC flood wall for events up to the 1% AEP event. Details of these infrastructure changes and information on how they are represented within a 1D HEC-RAS model is contained in GHD's 2003 report on the Flemington Racecourse (GHD, 2003b). These changes in the GHD 2003 report can be summarised as:

- Works to lower the access track immediately downstream of the Footscray Rail culverts.
- Removal of the bluestone abutment on the eastern bank of Footscray Road Bridge.
- Construction of a flow 'training wall' on the eastern abutment at Footscray Road Bridge.

These measures were implemented to meet Melbourne Water flood criteria and permit conditions by mitigating the effect that the VRC flood wall may have on water levels along the Maribyrnong River. The mitigation measures aim to offset any increase in flood depth by allowing the flood wave to move through the bridge and culvert locations more effectively thereby enabling water to flow more easily down the lower reach of the Maribyrnong River.

1.3 Modelling Approach

The purpose of the wider study is to produce flood mapping products to support a variety of Melbourne Water business functions and these flood mapping products will be produced from a flood model, that is, the flood model will underpin all the wider study outcomes.

The flood model of the Lower Maribyrnong, known as the 2024 Maribyrnong River Flood Model, is a combination of an event-based rainfall runoff model (RORB) and hydraulic model (TUFLOW). The purpose of the rainfall-runoff model is to calculate the catchment's response to runoff for observed events and to calculate the runoff for a given probability of occurrence. The runoff is then applied to the hydraulic model which calculates the flood extent, level, depth, velocity, and other hydraulic outputs. These modelling activities are augmented by empirical analysis of other flood forming variables such as tidal levels and baseflow and verification of key input datasets such as rainfall, topographic data, and rating curves.

A 2D TUFLOW hydraulic model with embedded 1D elements was developed for the Lower Maribyrnong River and extends from the Keilor gauge to downstream of Footscray Road near the confluence with the Yarra River. This extent covers the Lower Maribyrnong River and its floodplain including Maribyrnong Township, Ascot Vale, Kensington, Footscray, and the surrounding areas. The Maribyrnong River flow is applied to the upstream extent of the model with a downstream boundary set as a tidal level. The 2024 Maribyrnong River Flood Model incorporates 2023 catchment conditions and the more recent data available (including rainfall data, topographic and bathymetric). The modelling has been undertaken in alignment with the guidance in ARR2019, Melbourne Water Flood Mapping Project Specifications (Melbourne Water 2023) along with recent developments in modelling methodology.

The 2024 approach differs from the previous 2003 1D HEC-RAS model approach in several respects. Key differences are summarised in Table 1-1.

Table 1-1: Key differences between 2003 1D HEC-RAS model and 2024 Maribyrnong River Flood Model

	2003 1D HEC-RAS Model	2024 Maribyrnong River Flood Model
Software	1D HEC-RAS Model	1D/2D linked TUFLOW Model
Survey Data	1m contour maps, 2000 bathymetry and photogrammetry.	2023 0.5m floodplain LiDAR and river bathymetric data.
Model Representation of Floodplain and Inundation	Interpolated data between 1D cross sections of the Maribyrnong River and the floodplain.	Comprehensive Digital Elevation Model (DEM) representation of Maribyrnong River and the floodplain topography.

Model Representation of River Channel	River channel roughness applied at 1D cross section locations at approximately 50m intervals.	2D roughness maps applied throughout the extents of the river channel.
Losses at Bridge Structures	Contraction and expansion losses estimated and applied at 1D bridge structures.	Macro Contraction and Expansion losses captured explicitly within 2D domain. Micro energy losses due to piers estimated and applied at bridge structure.
Numerical Method	1D Steady Flow.	2D Unsteady Flow.
Upstream hydrograph	Adopted a 1991 Melbourne Water 100 ARI design hydrograph at Maribyrnong Village.	October 2022 Event at Keilor Gauge.
Applicable industry Guidance	Australian Rainfall and Runoff 1987 Melbourne Water guidance for flood mapping at the time	Australian Rainfall and Runoff 2019 Melbourne Water Flood Mapping Project Specifications (2023)

2. Methodology

The assessment methodology was to compare three hydraulic model runs or scenarios using the calibrated 2024 Maribyrnong River Flood Model for the 1% AEP 2024 event to understand the impact of the wall and mitigation measures in this event. The full set of model runs performed for the purposes of this report are:

- Base Case – with the VRC flood wall and mitigation measures.
- Scenario 1 – without the VRC flood wall and removal of associated mitigation from the model that were present in 2022. Various assumptions have been made about representation within the model:
  - Terrain around the VRC flood wall was modified to represent the landform pre-VRC flood wall construction.
  - The eastern bluestone abutment at Footscray Road bridge was added back into the model.
  - The access track downstream of the Footscray Rail culverts was reinstated to its original level.
  - As there is limited data from this period, with respect to the flow 'training wall', there are several assumptions regarding alterations to the DEM to represent a pre-flow 'training wall' condition of the banks upstream and downstream of the eastern abutment of the Footscray Road bridge.
- Scenario 2 –with the VRC flood wall but with removal of the associated mitigation from the model that was present in 2022.

The differences between the model runs described above were then investigated in terms of changes to flood extent, flood depth and duration of flooding.

With respect to the VRC flood wall, the 2024 Maribyrnong River Flood Model had incorporated the details of the VRC flood wall modifications and associated mitigation.

Figure 2-1 shows the 2024 Maribyrnong River Flood Model extent, locations of boundary conditions and the location of the VRC flood wall and the associated mitigation measures. Further information is available in Appendix A of Jacobs 2024b. Note that the hydraulic model extent presented in Figure 2-1 differs from the mapping extent as discussed in Jacobs 2024a.

Keilor Park Drive
Keilor Road
Bulla Road
Milleara Road
Mt Alexander Road
ALLAN RESERVE
Aberfeldie
Essendon
LOWER MARIBYRNONG RIVER LAND
ABERFELDIE PARK
Avondale Heights
Military Road
RIVERSIDE PARK
Moonee Ponds
CANNING RESERVE
Cordite Avenue
Maribyrnong
Raleigh Road
Canning Street
Wests Road
HIGHPOINT SHOPPING CENTRE
Maribyrnong Road
Van Ness Avenue
FAIRBAIRN PARK
Ascot Vale
LOWER MARIBYRNONG VALLEY PARKLANDS (COM)
VICTORIA UNIVERSITY STUDENT VILLAGE
MEDWAY GOLF CLUB
WALTER ST RESERVE
CRANWELL PARK
Hampstead Road
ORICA AUSTRALIA LABORATORIES
RIVERSIDE GOLF COURSE
Braybrook
Ballarat Road
Gordon Street
RAS SHOWGROUNDS
BURNDAP PARK
FLEMINGTON RACECOURSE
QUARRY PARK
HENRY TURNER MEMORIAL RESERVE (SOUTH)
FOOTSCRAY PARK
Smithfield Road
NEWELLS PADDOCK WETLANDS RESERVE
J J HOLLAND PARK
Princes Highway
Moore Street
Footscray
Hopkins Street
Dynon Road
Buckley Street
Seddon
Paramount Road
Tottenham
Somerville Road
Whitehall Street
Yarraville
Francis Street

Flemington Racecourse

Footscray Road bridge

Footscray rail bridge

Legend

- Mapping extent
- DEM (terrain) adjustments
- Flow training walls adjustment
- Bluestone abutments
- VRC floodwall
- Minor balancing culverts
- Maribyrnong River

MGA Zone 55

0 0.5 1

Figure 2-1: Location of VRC wall and mitigation works

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3. Base Case Model Setup

The Base Case scenario represents a model with the VRC flood wall and with associated mitigation measures. Details of this scenario are presented in Jacobs (2024b) and the key features with respect to this assessment are:

- The VRC flood wall was incorporated into the flood model with details for the wall being sourced from the recent 2023 survey in combination with information from 2013 survey plans.
- Ensuring that the access track immediately downstream of the Footscray Rail culverts was set at 0.5m AHD or below in the Digital Elevation Model.
- Confirming that the eastern bluestone abutment under the Footscray Road bridge was not represented in the flood model.
- The flow 'training wall' on the upstream and downstream banks of the eastern abutment of Footscray Road bridge was represented albeit not as per the design intent due to the poor condition at the time of the 2022 flood.

3.1 VRC Flood Wall

The VRC flood wall is the wall that was erected around the Flemington Racecourse in 2007 with the intent to ensure that the racecourse is protected from floodwaters of events more frequent than the 1% AEP event. LiDAR and survey produced in 2023, along with available survey plans were used to develop a Digital Elevation Model (DEM) that includes the VRC flood wall. The VRC flood wall varies in height from 3.04m AHD to over 5.28m AHD along its alignment. Figure 3-1 is a photograph of the VRC flood wall.

Figure 3-1: Picture of the VRC flood wall taken at the southern edge of the wall, along Chiquita Drive, looking north.

3.2 Access track downstream of Footscray Rail culverts

The LiDAR (2023), that formed the basis of the 2024 Maribyrnong River Flood Model, captured the levels downstream of the Footscray Rail culverts and confirmed that the access track was 0.5m AHD or below. The LiDAR confirmed the access track in this location generally varies from 0.4-0.5m AHD. Small 'balancing' culverts under the access track are also incorporated into the model. Figure 3-2 and Figure 3-3 are photos taken in 2023 of this area.

Figure 3-2: Access Track (gravel) downstream of the Footscray Rail culverts (photo taken in 2023).

Figure 3-3: Downstream of the Footscray Rail culverts: facing west (left) and east (right). Balancing culverts under the access track circled in red (photos taken in 2023).

3.3 Footscray Road Bridge

The Footscray Road bridge was surveyed as part of the bridges and structures survey in the data collection phase of the 2024 Maribyrnong River Flood Model build (Jacobs, 2024a). Using an empirical method contained within a publication by the US Division of Hydraulic Research (Bradley,1978) the losses at the bridge were calculated taking into account the two (2) existing piers at this bridge, the existing pier's oblong 'strip' shape (visible on Figure 3-5) and the cross sectional area the piers represent as a percentage of the overall waterway cross sectional area, the pier loss factor was set at 0.11 and blockage factor set as 6% for the Base Case.

The presence of a bluestone abutment on the western abutment was represented within the 2D domain of the model as water levels did not overtop this.

Additionally, a flow 'training wall' on the upstream and downstream banks of the eastern abutment of Footscray Road bridge has been represented within the 2D domain of the model. This can be seen on Figure

3-6 and Figure 3-7. These figures clearly demonstrate that the flow 'training wall' is in poor condition and will not currently be functioning as designed or intended. As such, an assumption has been made in the model that the flow 'training wall' is represented in the 2D DEM.

Figure 3-4: Bluestone abutment under Footscray Road bridge on the eastern bank removed as mitigation works (left) (GHD, 2003b) and the abutment that remains on the western bank (right) (photo taken in 2023).

Figure 3-5: Footscray Road bridge from the western bank, facing east towards the eastern bank (photo taken in 2023)

Figure 3-6: Footscray Road bridge from the western bank, facing east where the downstream 'training wall' is visible (photo taken in 2023).

Figure 3-7: Footscray Road bridge from the western bank, facing east where the upstream flow 'training wall' is visible (photo taken in 2023).

4. Scenario 1 Model Setup

Scenario 1 represents a model without the VRC flood wall and associated mitigation measures. This scenario was the same as the Base Case with the only difference being the wall and mitigation measures removed, specifically:

- The VRC flood wall was removed and the terrain that replaced this area is an interpolation of the ground levels on either side of the wall. No other terrain modifications were made.
- The access track immediately downstream of the Footscray Rail culverts was reinstated at a level of 0.8 m AHD and this was reinforced in the hydraulic model.
- The eastern bluestone abutment under the Footscray Road bridge was reinstated and areas of adjacent fill, both upstream and downstream, were removed. As there was a lack of available data for these mitigation measures, assumptions about the abutment and terrain modifications have been made.
- The training wall and associated fill was removed terrain.

4.1 VRC Flood Wall removal

The LiDAR that was used to develop the Digital Elevation Model (DEM) was flown in 2023 (Jacobs 2023f) and contains elevation data points representing the flood wall. Modifications were necessary to remove this for the scenarios without the wall in place. These modifications were implemented by removing the area of the DEM where the wall influenced flow behaviour in the 2024 event and interpolating the ground level between either side of the wall. As no information about the ground levels in 2003 was available this was considered a reasonable assumption.

4.2 Access track downstream of Footscray Rail culverts

The LiDAR adopted in the model captured the levels downstream of the culverts in 2023. GHD, 2003b reported that the pre-mitigation landform downstream of the Footscray Rail culverts included a road embankment at 0.8m AHD. Modifications to the current conditions terrain were necessary to increase the level of the access track for Scenario 2. A photograph with levels of the access track can be seen in Figure 4-1. The balancing culverts within the model during the Base Case have also been removed from Scenario 2 as it is assumed these were constructed as part of the reduction in level of the access track.

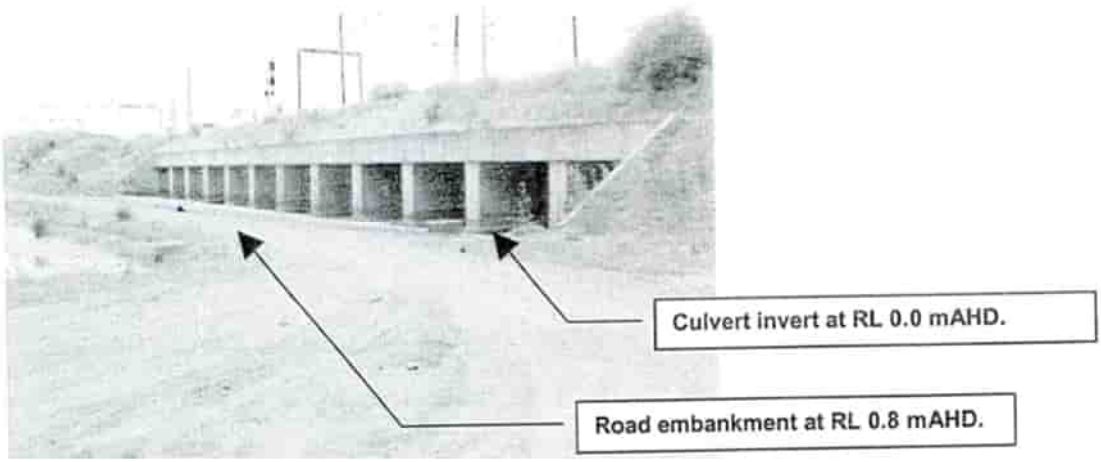


Figure 4-1: Annotated photo of downstream of the Footscray rail culverts showing the pre-mitigation elevations (GHD, 2003b).

4.3 Footscray Road Bridge

The Footscray Road bridge mitigation measures involved the removal of a bluestone abutment and the construction of a flow 'training wall' on the eastern embankment upstream and downstream of Footscray Road bridge (Fargue spiral design to minimise the energy losses through the bridge). The aim of these measures was to improve hydraulic performance in this area which was documented in GHD's report on the Flemington Racecourse (GHD, 2003b).

As detailed of the pre-wall conditions were limited, various assumptions were needed to be made. Scenario 3 included:

- The insertion into the DEM of a 2 m wide bluestone abutment on the eastern abutment of the Footscray Road bridge (in red in Figure 4-2). As no details of the dimensions of this bluestone abutment were available it was assumed to that the dimensions of this abutment were the same as the bluestone abutment on the opposite bank.
- Removal of a section of bank upstream of the eastern abutment. The upstream removal is based on Figure 4-2 which shows a receded bank on the left of the photograph (purple). The DEM modifications are assumed to represent the removal of a flow 'training wall' that was constructed in this location as part of VRC flood wall associated mitigation measures.
- The lowering of a section of bank downstream of the eastern abutment. The downstream removal is based on Figure 4-3 which shows a constructed bank (purple). The DEM modifications are assumed to represent the removal of a 'training wall' that was constructed in this location as part of VRC flood wall associated mitigation measures.

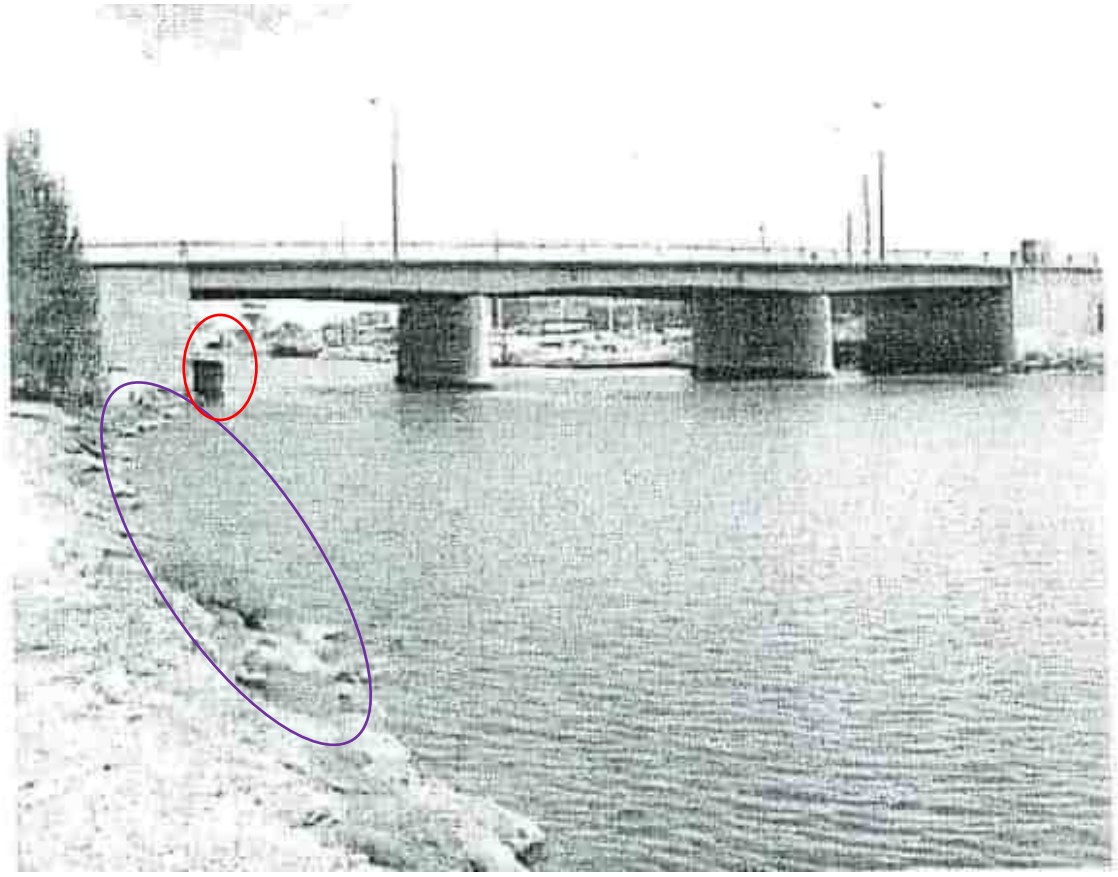


Figure 4-2: Photograph taken from the eastern bank looking downstream at the Footscray Road bridge. Eastern bluestone abutment circled in red and receded bank in purple (photograph taken pre-2003).

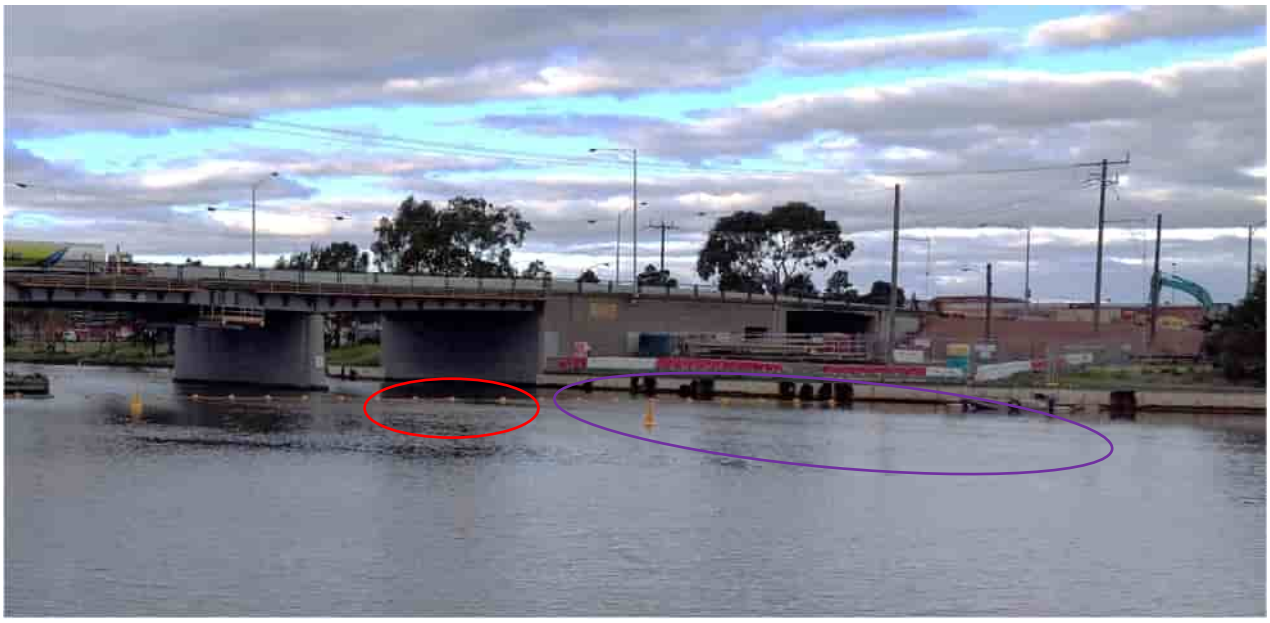


Figure 4-3: Photograph taken from the western bank of the eastern bank, upstream, at the Footscray Road bridge. Eastern bluestone abutment (removed) circled in red and 'training wall' bank in purple (photograph 11 September 2016).

5. Scenario 2 Model Setup

Scenario 2 represents a model with the VRC flood wall but without the associated mitigation measures. This scenario was the same as the Base Case with the only difference being the mitigation measures removed, specifically:

- The access track immediately downstream of the Footscray Rail culverts was reinstated at a level of 0.8 m AHD and this was reinforced this in the hydraulic model.
- The eastern bluestone abutment under the Footscray Road bridge was reinstated and areas of adjacent fill, both upstream and downstream, were removed. As there was a lack of available data for these mitigation measures, assumptions about the abutment and terrain modifications have been made.
- The training wall and associated fill was removed terrain.

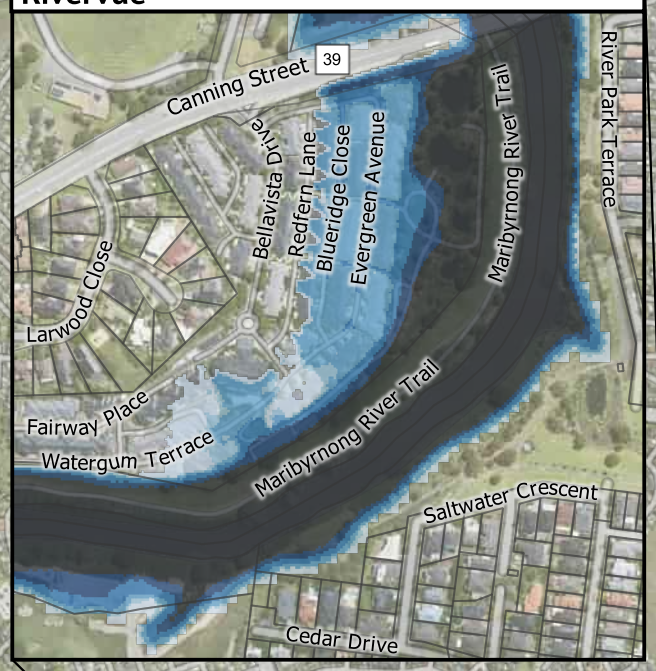
6. Results

The results of the scenario analysis with the 1% AEP event are presented in Figure 6-1 to Figure 6-17 with the details below:

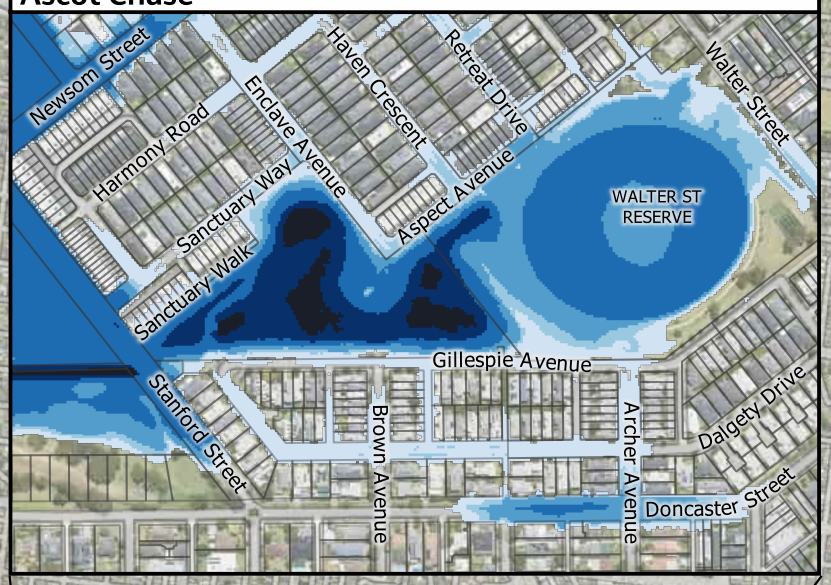
- Figure 6-1 presents the peak flood extent and depth for the Base Case which has the VRC flood wall and mitigations included.
- Figure 6-2 shows the peak flood extent and depth for Scenario 1 (i.e. without the flood wall and associated mitigation measures).
- Figure 6-3 shows the peak flood extent and depth for Scenario 2 (i.e. with the flood wall but without the mitigation measures).
- Figure 6-4 presents the difference in modelled peak flood extents of the Base Case and Scenario 1, for the 1% AEP 2024 event .
- Figure 6-5 presents the difference in modelled flood levels between the Base Case and Scenario 1 for the 1% AEP 2024 event. In this figure the increases in water levels represent the increases due to the flood wall.
- Figure 6-6 presents several river cross sections to contextualises the difference in flood levels along several roads within Maribyrnong Township. The three cross sections show the topography (DEM) and modelled flood levels for both the Base Case and Scenario 1 during the 1% AEP 2024 event. Cross sections 1 and 2 are orientated from South to North and cross section 3 west to east.
- Figure 6-7 presents time series of modelled flood levels at selected locations for Base Case and Scenario 1, during the 1% AEP 2024 event, at selected locations.
- Figure 6-8 presents the difference in modelled peak flood extents of the Base Case and Scenario 2 for the 1% AEP 2024 event.
- Figure 6-9 presents the difference in flood levels between the Base Case and Scenario 2 for the 1% AEP 2024 event. In this figure increases in water levels indicates the increase that would occur if the mitigation measure were not in place.
- Figure 6-10 presents several cross sections of the peak flood levels along selected roads within Maribyrnong township. The three cross sections show the topography (DEM) and modelled flood levels for both the Base Case and Scenario 2 during the 1% AEP 2024 event. Cross sections 1 and 2 are orientated from South to North and cross section 3 west to east.
- Figure 6-11 presents time series of flood levels at selected locations along the Maribyrnong River for the Base Case and Scenario 2 in the 1% AEP 2024 event. These time series are to assess a potential change in duration of the peak of the flood.
- Figure 6-12 presents the chainage (in metres) along the Maribyrnong River from the upstream boundary of the model (chainage = 0m) to the downstream boundary.
- Figure 6-13 shows the location of the two areas discussed in Section 7.2.142.
- Figure 6-14 presents longitudinal sections along the Maribyrnong River showing peak flood levels of Base Case and Scenario 1 for the 1% AEP 2024 event.
- Figure 6-15 presents longitudinal sections along the Maribyrnong River showing the difference in peak flood levels between Base Case and Scenario 1 for the 1% AEP 2024 event.
- Figure 6-16 presents longitudinal sections along the Maribyrnong River showing peak flood levels of Base Case and Scenario 2 for the 1% AEP 2024 event.
- Figure 6-17 presents longitudinal sections along the Maribyrnong River showing the difference in peak flood levels between Base Case and Scenario 2 for the 1% AEP 2024 event.

These maps have used unprocessed raw model results which are slightly different to the final mapping deliverables completed as part, since the 'no wall' scenarios haven't been run through the GIS deliverable tool

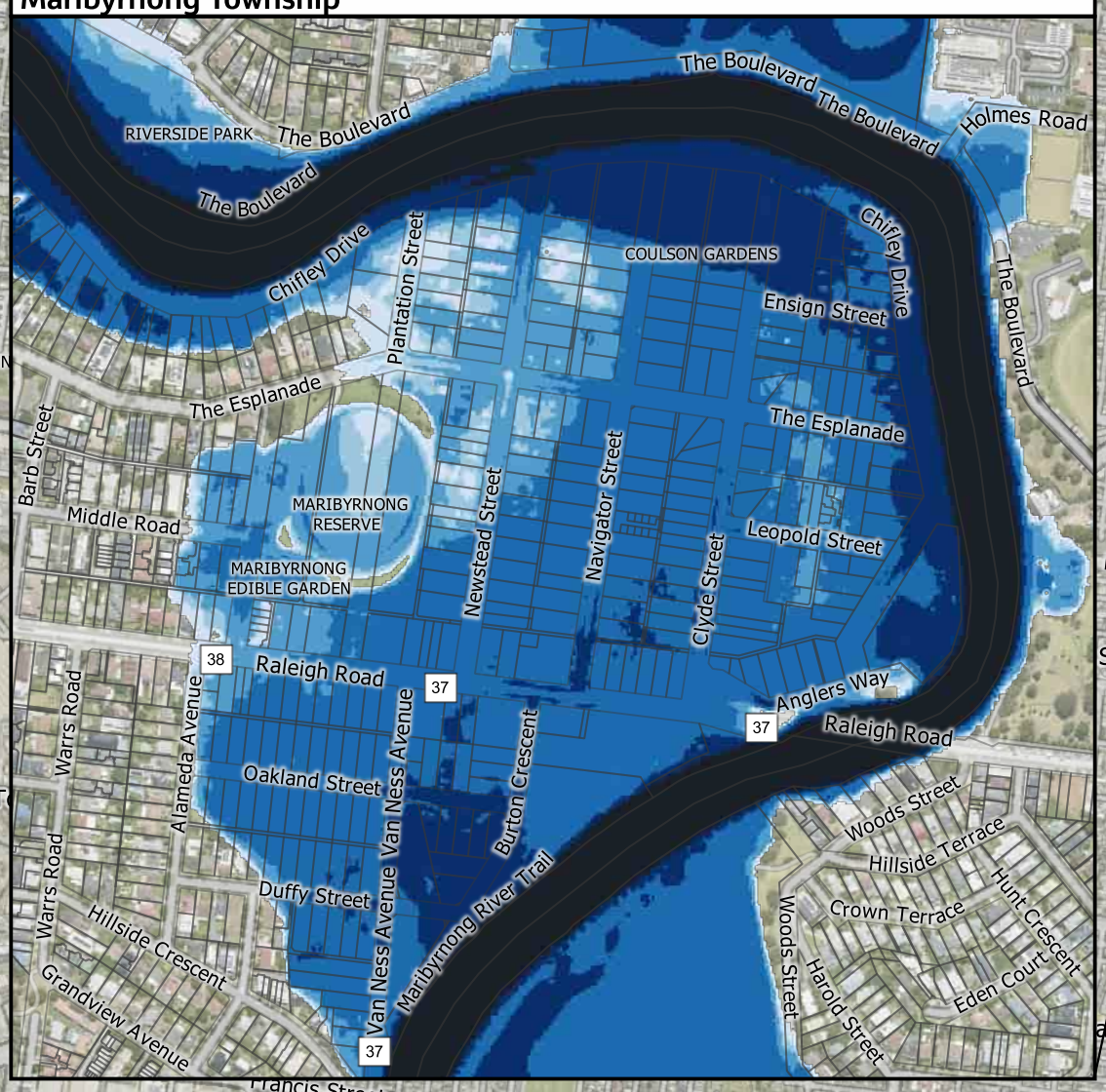
Rivervue



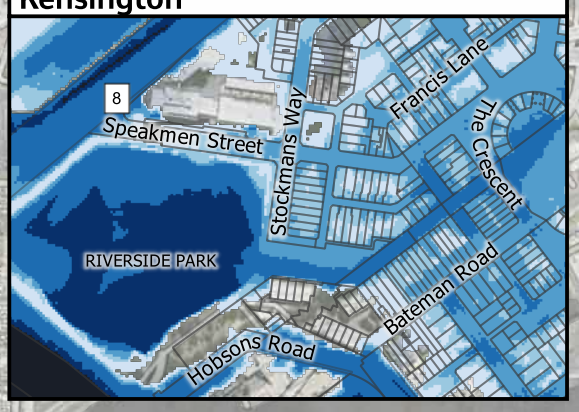
Ascot Chase



Maribyrnong Township



Kensington



Legend

Depth (m)

- <= 0.3 m
- 0.3 - 0.5 m
- 0.5 - 1.0 m
- 1.0 - 2.0 m
- 2.0 - 3.0 m
- >3.0 m

MGA Zone 55

Jacobs

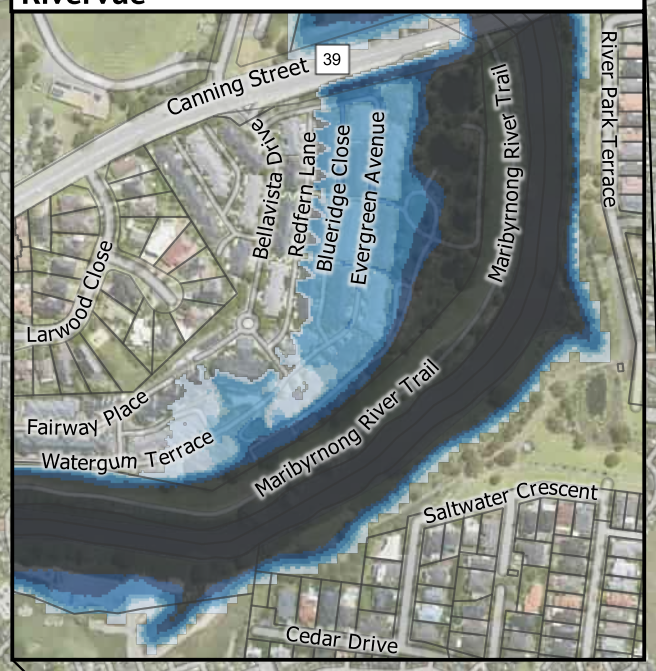
0 0.5 1 km

Figure 6-1: Flood Depth and Extent during the 1% AEP 2024 event - Base Case

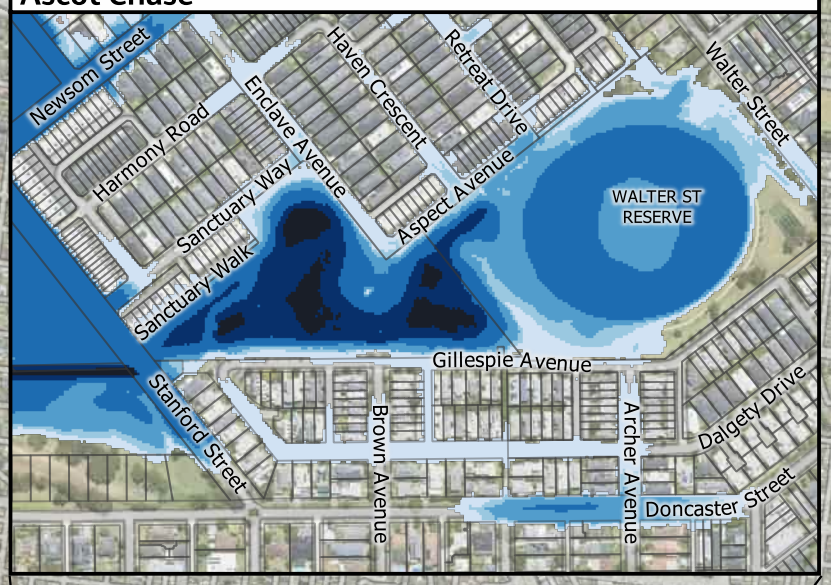
Project Number: IA5000NN

FINAL

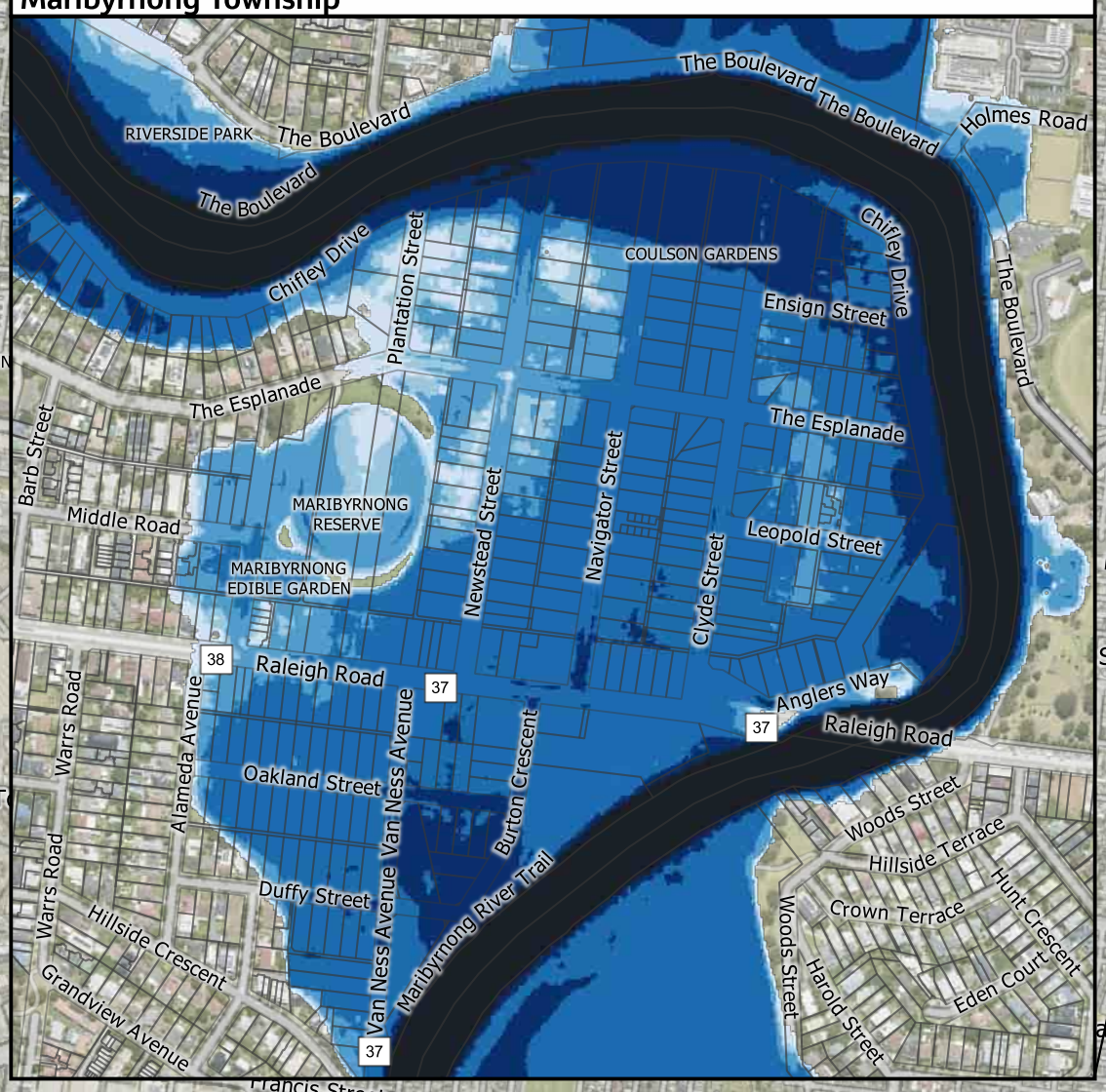
Rivervue



Ascot Chase



Maribyrnong Township



Kensington

Legend

Depth (m)

- <= 0.3 m
- 0.3 - 0.5 m
- 0.5 - 1.0 m
- 1.0 - 2.0 m
- 2.0 - 3.0 m
- >3.0 m

MGA Zone 55

Jacobs

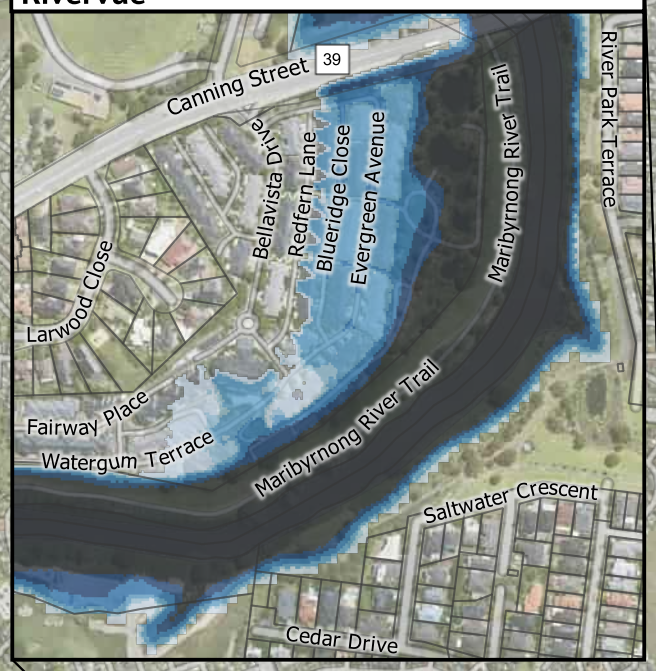
0 0.5 1 km

Figure 6-2: Flood Depth and Extent during the 1% AEP 2024 event - Scenario 1

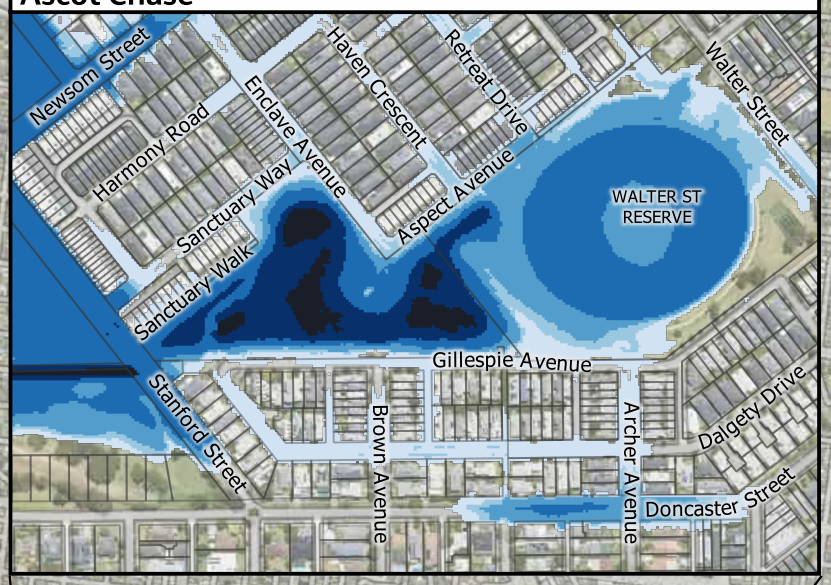
Project Number: IA5000NN

FINAL

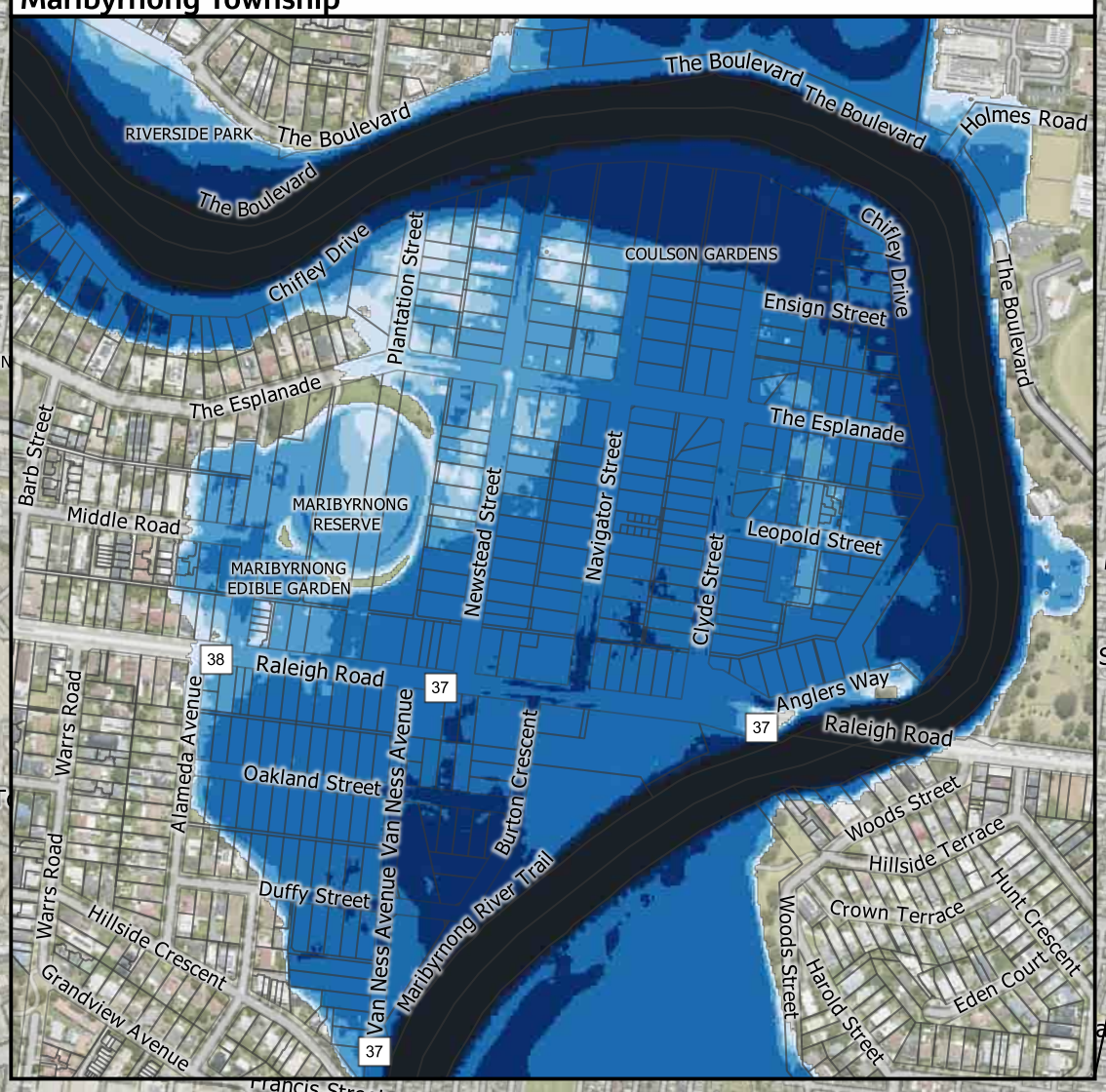
Rivervue



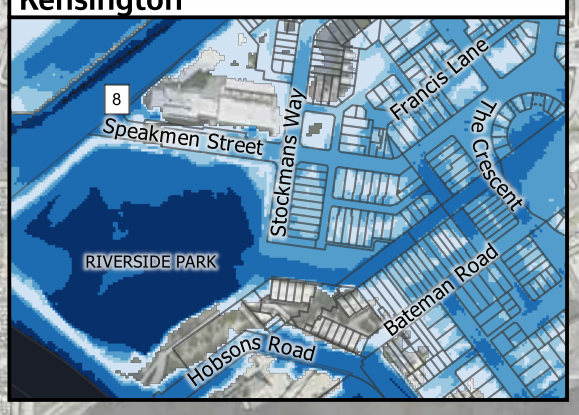
Ascot Chase



Maribyrnong Township



Kensington



Legend

Depth (m)

- <= 0.3 m
- 0.3 - 0.5 m
- 0.5 - 1.0 m
- 1.0 - 2.0 m
- 2.0 - 3.0 m
- >3.0 m

MGA Zone 55

Jacobs

0 0.5 1 km

Figure 6-3: Flood Depth and Extent during the 1% AEP 2024 event - Scenario 2

This map should be read in conjunction with Lower Maribyrnong Flood Model Report
Background imagery from Metromap (Jan 2024) and ESRI.

Project Number: IA5000NN

FINAL

Rivervue

Canning Street
River Park Terrace
Maribyrnong River Trail
Bellavista Drive
Redfern Lane
Blueridge Close
Evergreen Avenue
Larwood Close
Fairway Place
Watergum Terrace
Saltwater Crescent
Cedar Drive

Ascot Chase

Newsom Street
Haven Crescent
Retreat Drive
Walter Street
Harmony Road
Enclave Avenue
Sanctuary Way
Sanctuary Walk
Aspect Avenue
WALTER ST RESERVE
Gillespie Avenue
Stanford Street
Brown Avenue
Archer Avenue
Dalgety Drive
Doncaster Street

Maribyrnong Township

RIVERSIDE PARK
The Boulevard
Holmes Road
Chifley Drive
Plantation Street
COULSON GARDENS
Ensign Street
The Esplanade
Barb Street
Middle Road
MARIBYRNONG RESERVE
MARIBYRNONG EDIBLE GARDEN
Newstead Street
Navigator Street
Clyde Street
Leopold Street
Raleigh Road
Anglers Way
Warrs Road
Alameda Avenue
Oakland Street
Van Ness Avenue
Burton Crescent
Maribyrnong River Trail
Duffy Street
Hillside Crescent
Grandview Avenue
Francis Street
Woods Street
Hillside Terrace
Crown Terrace
Hunt Crescent
Eden Court
Harold Street

Kensington

Speakmen Street
Stockmans Way
Francis Lane
The Crescent
RIVERSIDE PARK
Bateman Road
Hobsons Road

Aberfeldie
LOWER MARIBYRNONG RIVER LAND
ABERFELDIE PARK
Avondale Heights
Military Road
CANNING RESERVE
Cordite Avenue
Maribyrnong
Canning Street
Wests Road
HIGHPOINT SHOPPING CENTRE
LOWER MARIBYRNONG VALLEY PARKLANDS (COM)
MEDWAY GOLF CLUB
VICTORIA UNIVERSITY STUDENT VILLAGE
CRANWELL PARK
Hampstead Road
Braybrook
Ballarat Road
Gordon Street
Van Ness Avenue
FAIRBAIRN PARK
WALTER ST RESERVE
ORICA AUSTRALIA LABORATORIES
RIVERSIDE GOLF COURSE
Mt Alexander Road
Moonee Ponds
Raleigh Road
Maribyrnong Road
Ascot Vale
BURNDAP PARK
RAS SHOWGROUNDS
QUARRY PARK
HENRY TURNER MEMORIAL RESERVE (SOUTH)
FLEMINGTON RACECOURSE
Smithfield Road
FOOTSCRAY PARK
Ballarat Road
RIVERSIDE PARK
NEWELLS PADDOCK WETLANDS RESERVE
J J HOLLAND PARK
Princes Highway
Moore Street
Footscray
Hopkins Street
Dynon Road
Buckley Street
Seddon
Whitehall Street

Legend

- Mapping extent
- Waterway outlines
- Flood extents common between base case & scenario 1
- Flooded locations in base case only
- Flooded locations in scenario 1 only

MGA Zone 55

Jacobs

0 0.5 1 km

Figure 6-4: Comparison of Flood Extents between Base Case and Scenario 1 during the 1% AEP 2024 event

Project Number: IA5000NN

FINAL

Ascot Chase

VRC Flood Wall

Maribyrnong Township

Kensington

Legend

- Wet only in Scn1
- Wet only in Base
- Waterway outlines
- Mapping extent

Difference

- >300mm lower
- 100 - 300mm
- 50 - 100mm
- 10 - 50mm lower
- +/- 10mm
- 10 - 50mm higher
- 50 - 100mm
- 100 - 300mm
- >300mm higher

MGA Zone 55

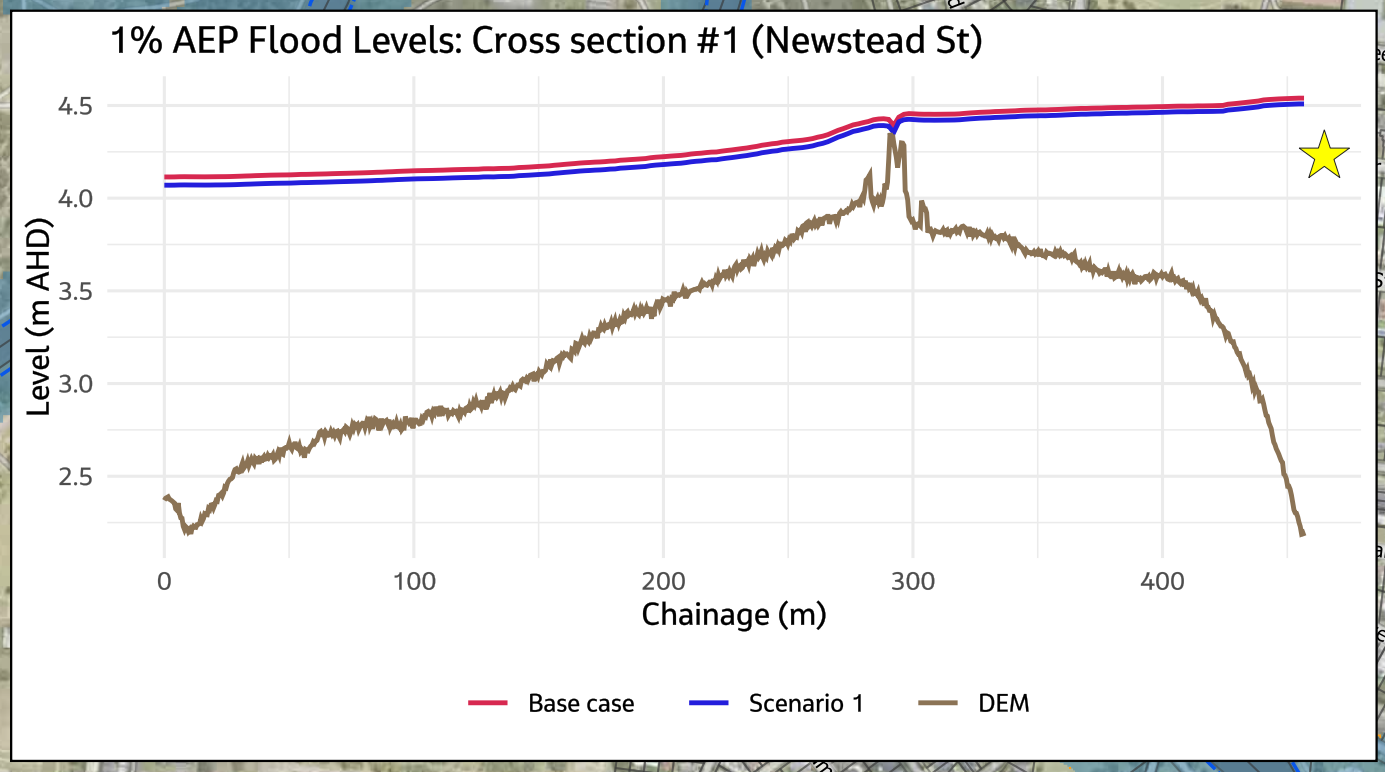
Jacobs

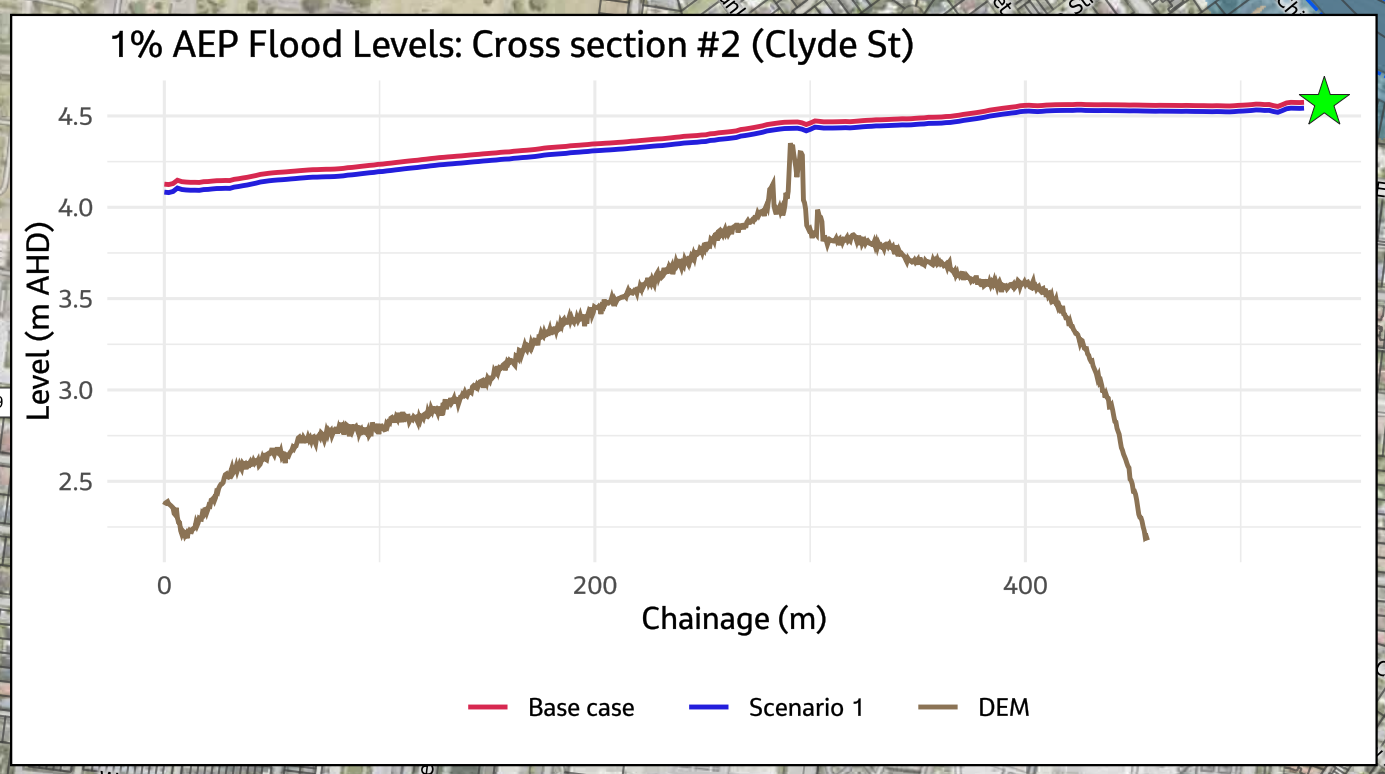
0 0.5 1 km

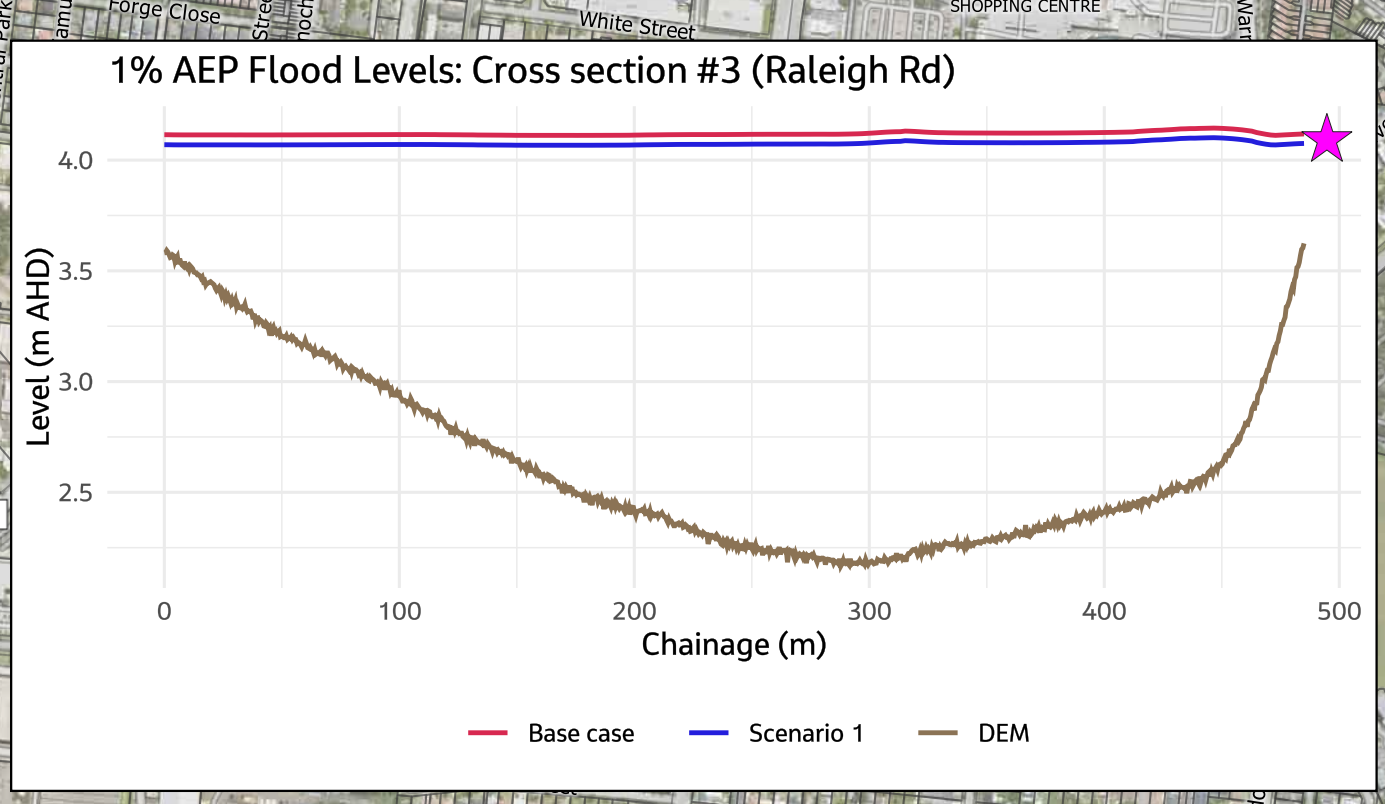
Figure 6-5: Comparison of the difference in flood level during the 1% AEP event between Base Case and Scn 1

Project Number: IA5000NN

FINAL







Legend

- Waterway outlines
- Cross sections
- Flooded locations in base case only
- Flooded locations in scenario 1 only
- Flood extents common between base case & scenario 1

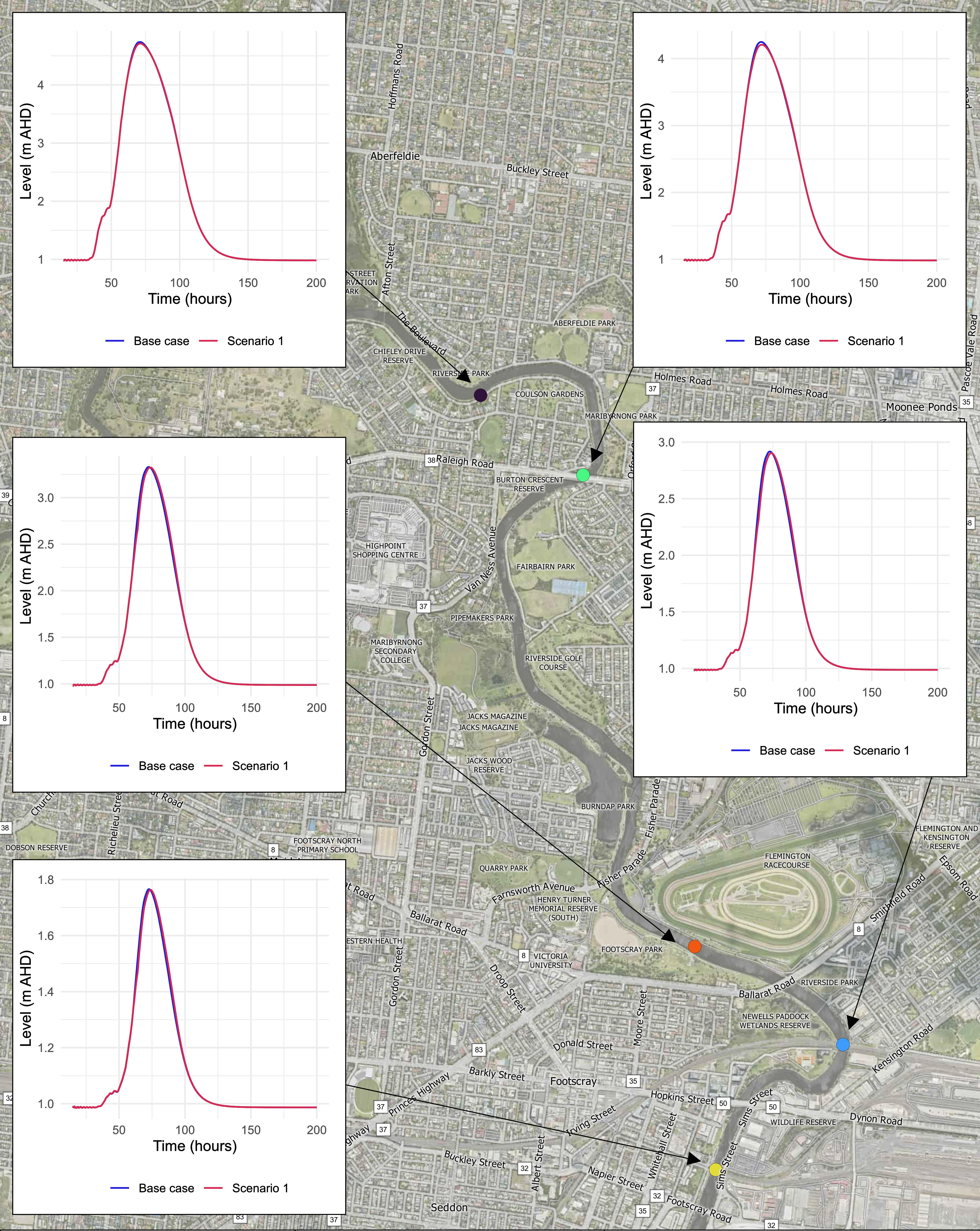
MGA Zone 55

Jacobs

0 100 200 300 m

Figure 6-6: Cross-sections of flood levels along roads within Maribyrnong Township - 1% AEP Base Case & Scn 1

Project Number: IA5000NN	FINAL



Legend

Flood levels: modelled levels at select gauges. Base case & scenario 1

- Chifley Street gauge
- Footscray rail bridge
- U/S Raleigh Road bridge
- U/S Footscray Road bridge
- Victorian Racing Club (VRC)

MGA Zone 55

Jacobs

0 250 500 750 m

Figure 6-7: Timeseries of flood levels at selected locations during the 1% AEP (2024) event – Base Case & Scenario 1

Project Number: IA5000NN

FINAL

Ascot Chase

Kensington

Maribyrnong Township

Footscray Rd Bridge

Aberfeldie
Essendon
Keilor Road
LOWER MARIBYRNONG RIVER LAND
ABERFELDIE PARK
RIVERSIDE PARK
Avondale Heights
Military Road
CANNING RESERVE
Cordite Avenue
Maribyrnong
Canning Street
Raleigh Road
Wests Road
HIGHPOINT SHOPPING CENTRE
Maribyrnong Road
Mt Alexander Road
Moonee Ponds
Ascot Vale
FAIRBAIRN PARK
Van Ness Avenue
WALTER ST RESERVE
ORICA AUSTRALIA LABORATORIES
LOWER MARIBYRNONG VALLEY PARKLANDS (COM)
MEDWAY GOLF CLUB
VICTORIA UNIVERSITY STUDENT VILLAGE
CRANWELL PARK
Hampstead Road
RIVERSIDE GOLF COURSE
Braybrook
Ballarat Road
Gordon Street
RAS SHOWGROUNDS
BURNDAP PARK
QUARRY PARK
FLEMINGTON RACECOURSE
HENRY TURNER MEMORIAL RESERVE (SOUTH)
FOOTSCRAY PARK
Smithfield Road
NEWELLS PADDOCK WETLANDS RESERVE
J J HOLLAND PARK
Princes Highway
Moore Street
Footscray
Hopkins Street
Dynon Road
Buckley Street
Seddon
Whitehall Street
MELBOURNE
Footscray Road
Sims Street
Maribyrnong River Trail
32
Speakmen Street
Stockmans Way
Francis Lane
The Crescent
RIVERSIDE PARK
Bateman Road
Hobsons Road
8
Newsom Street
Harmony Road
Haven Crescent
Retreat Drive
Walter Street
Enclave Avenue
Aspect Avenue
Sanctuary Way
Sanctuary Walk
WALTER ST RESERVE
Gillespie Avenue
Stanford Street
Brown Avenue
Archer Avenue
Dalgety Drive
Doncaster Street
RIVERSIDE PARK
The Boulevard
Holmes Road
Chifley Drive
Plantation Street
COULSON GARDENS
Ensign Street
The Esplanade
Barb Street
Middle Road
MARIBYRNONG RESERVE
MARIBYRNONG EDIBLE GARDEN
Leopold Street
Clyde Street
Newstead Street
Navigator Street
38
37
Raleigh Road
Anglers Way
Warrs Road
Alameda Avenue
Van Ness Avenue
Burton Crescent
Oakland Street
Duffy Street
Hillside Crescent
Grandview Avenue
Francis Street
Maribyrnong River Trail
Woods Street
Hillside Terrace
Crown Terrace
Hunt Crescent
Eden Court
Harold Street

Legend

- Mapping extent
- Waterway outlines
- Flood extents common between base case & scenario 2
- Flooded locations in base case only
- Flooded locations in scenario 2 only

MGA Zone 55

0 0.5 1 km

Jacobs

Figure 6-8: Comparison of Flood Extents during the 1% AEP event (2024) - Base Case & Scenario 2

Project Number: IA5000NN

FINAL

Ascot Chase

Kensington

Maribyrnong Township

Footscray Rd Bridge

Legend

- Wet only in Scn2
- Wet only in Base
- Waterway outlines
- Mapping extent

Difference

- >15 mm lower
- 10 - 15 mm
- 5 - 10 mm
- <5 mm lower
- no change
- <5 mm higher
- 5 - 10 mm
- 10 - 15 mm
- >15 mm higher

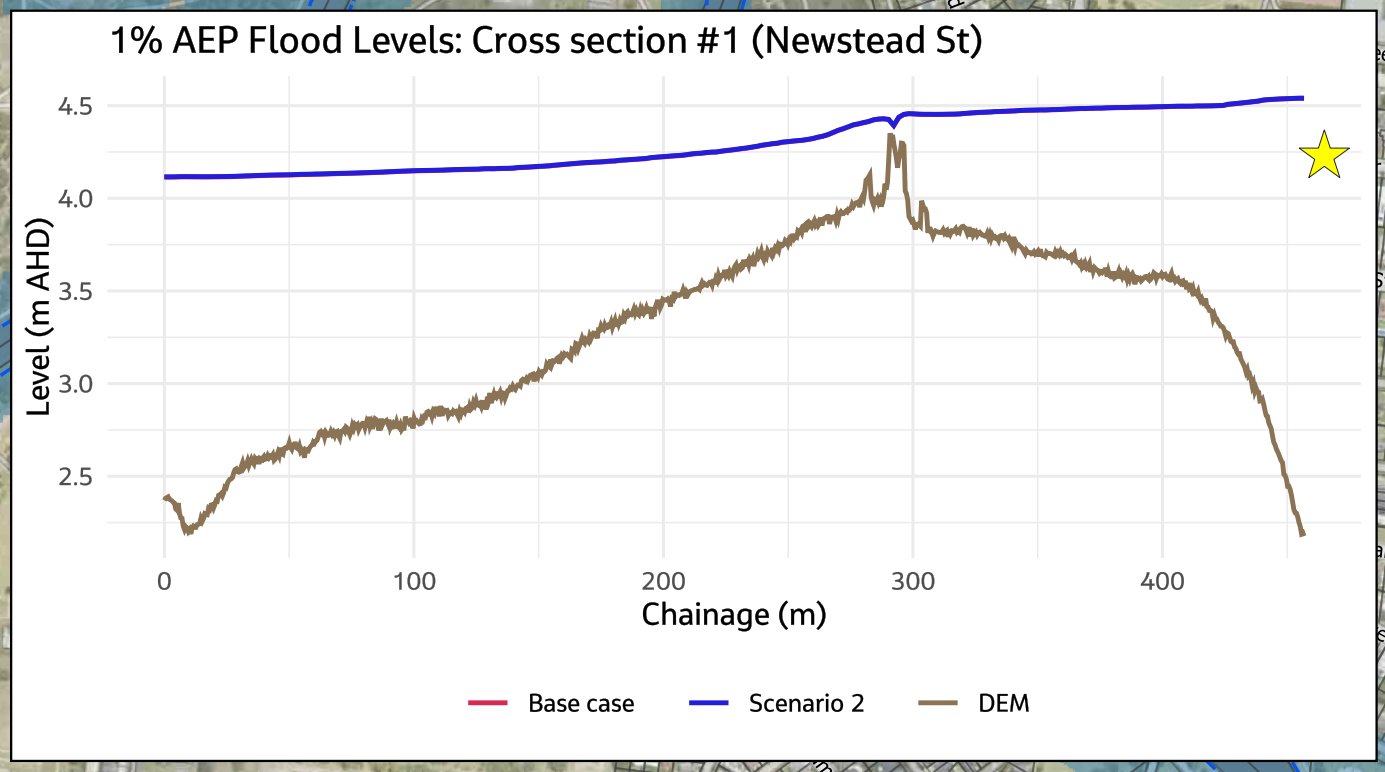
MGA Zone 55

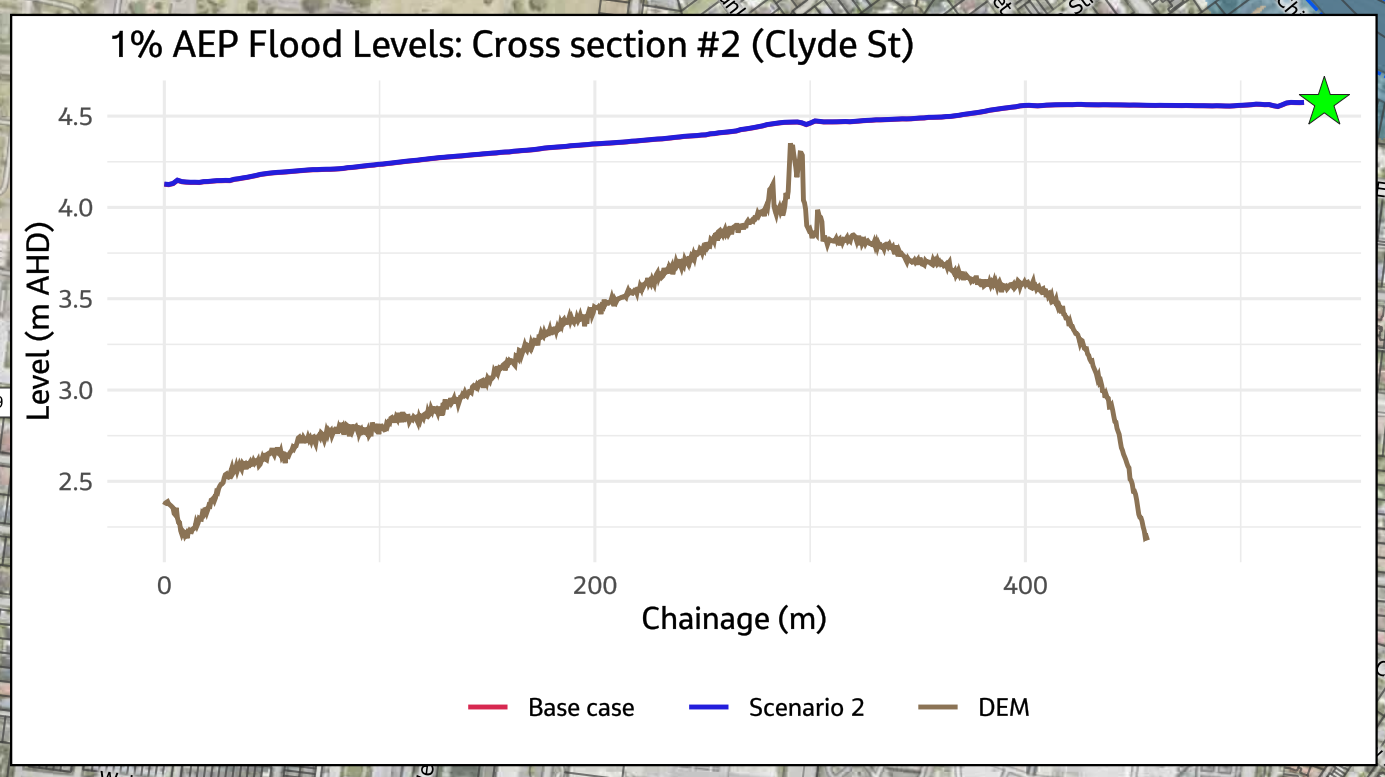
0 0.5 1 km

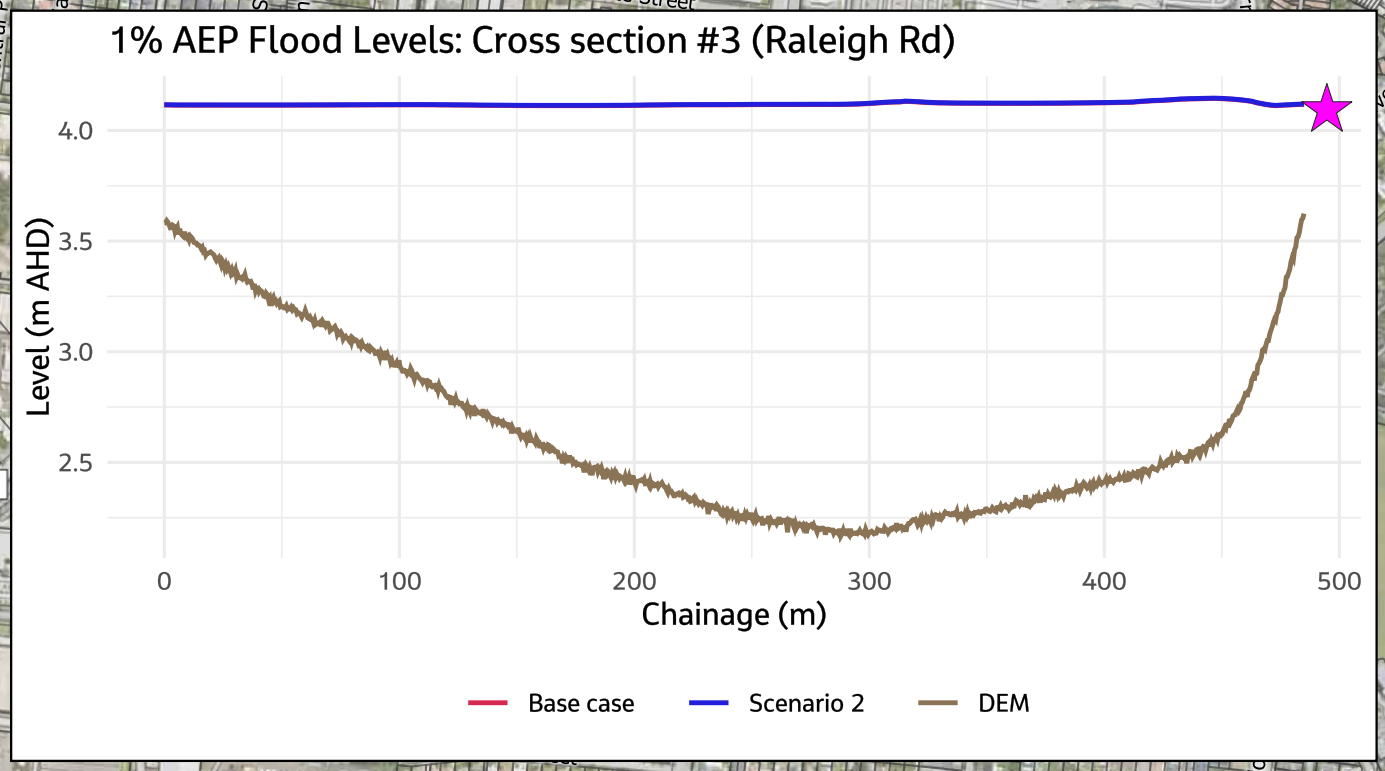
Figure 6-9: Comparison of the difference in flood level during the 1% AEP event between Base Case and Scn 2

Project Number: IA5000NN

FINAL







Legend

- Waterway outlines
- Cross sections
- Flooded locations in base case only
- Flooded locations in scenario 2 only
- Flood extents common between base case & scenario 2

MGA Zone 55

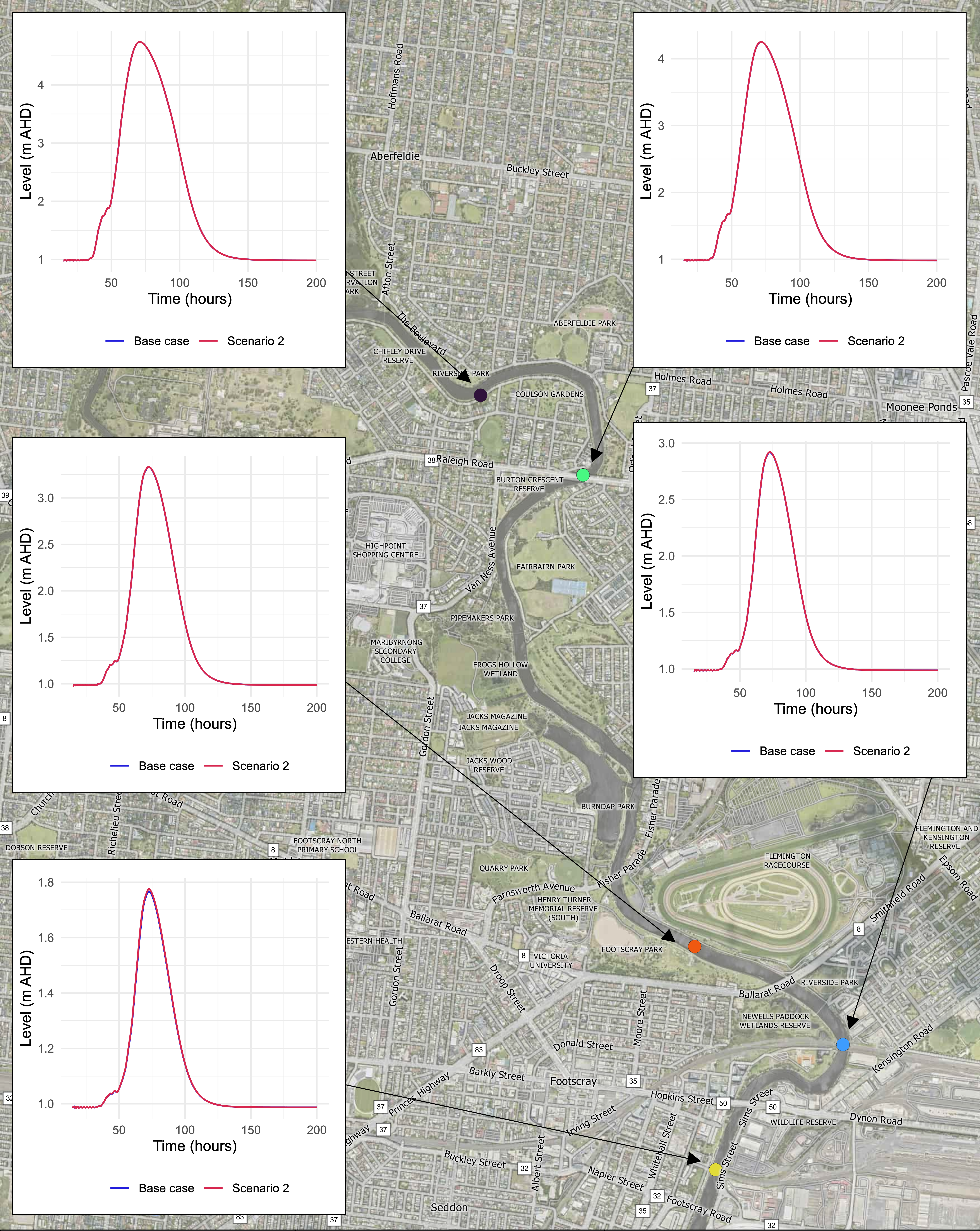
Jacobs

0 100 200 300 m

Figure 6-10: Cross-sections of flood levels along roads within Maribyrnong Township - 1% AEP Base Case & Scn 2

Project Number: IA5000NN

FINAL



Legend

Flood levels: modelled levels at select gauges. Base case & scenario 2

- Chifley Street gauge
- Footscray rail bridge
- U/S Raleigh Road bridge
- U/S Footscray Road bridge
- Victorian Racing Club (VRC)

MGA Zone 55

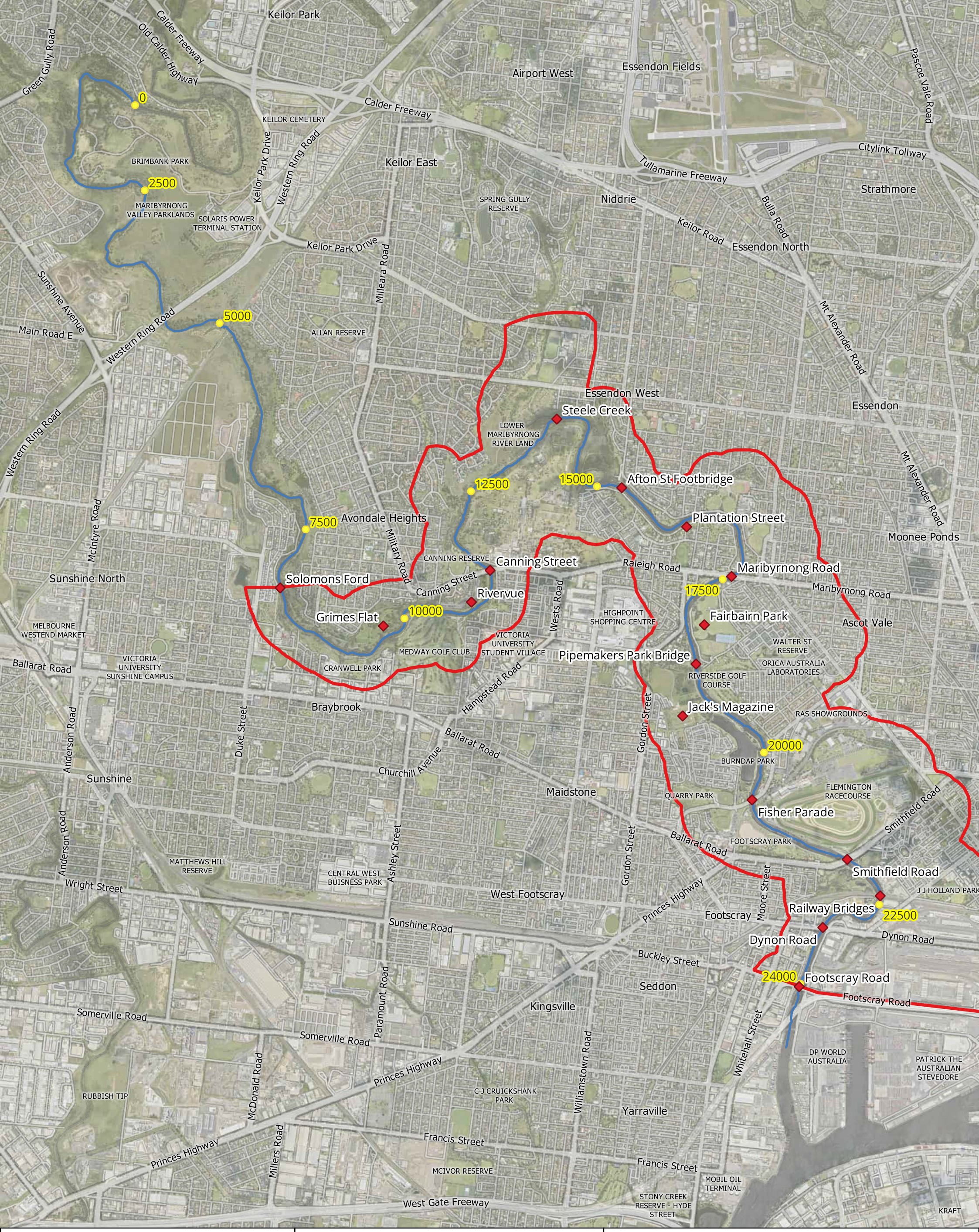
Jacobs

0 250 500 750 m

Figure 6-11: Timeseries of flood levels at selected locations during the 1% (2024) event - Base Case & Scn 2

Project Number: IA5000NN

FINAL



Legend

- Mapping extent
- Maribyrnong River
- Key landmarks
- Chainage

MGA Zone 55

Jacobs

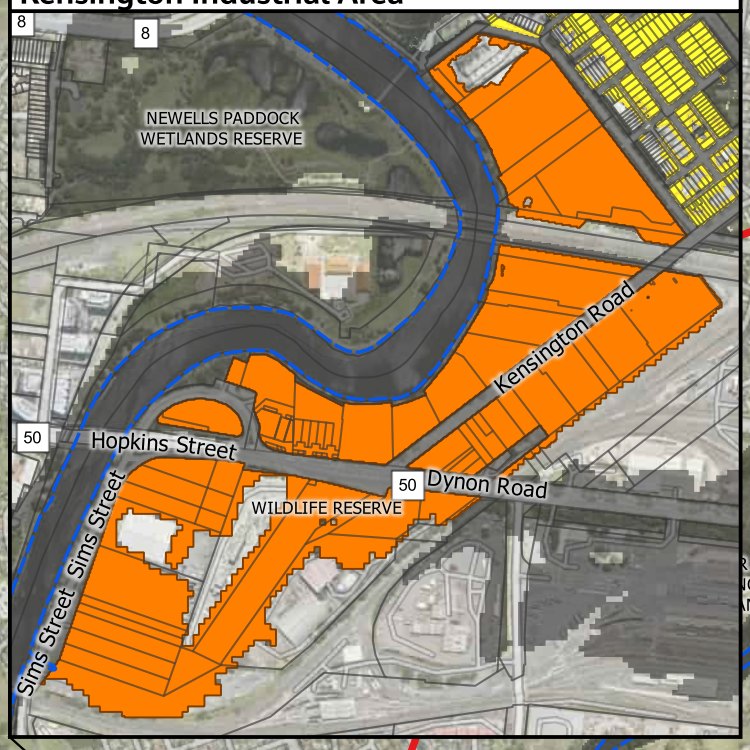
0 0.5 1 1.5 km

Figure 6-12: Chainage along Maribyrnong River used in Longitudinal Sections and key landmarks

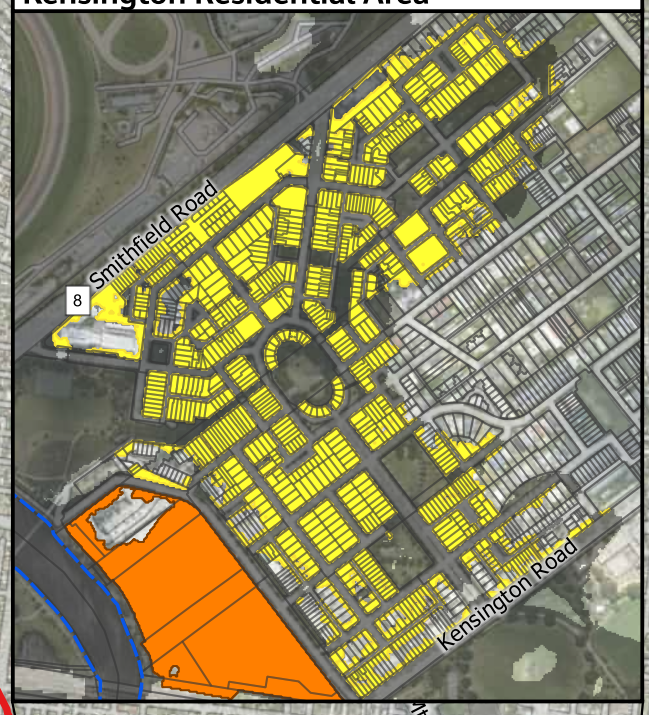
Project Number: IA5000NN

FINAL

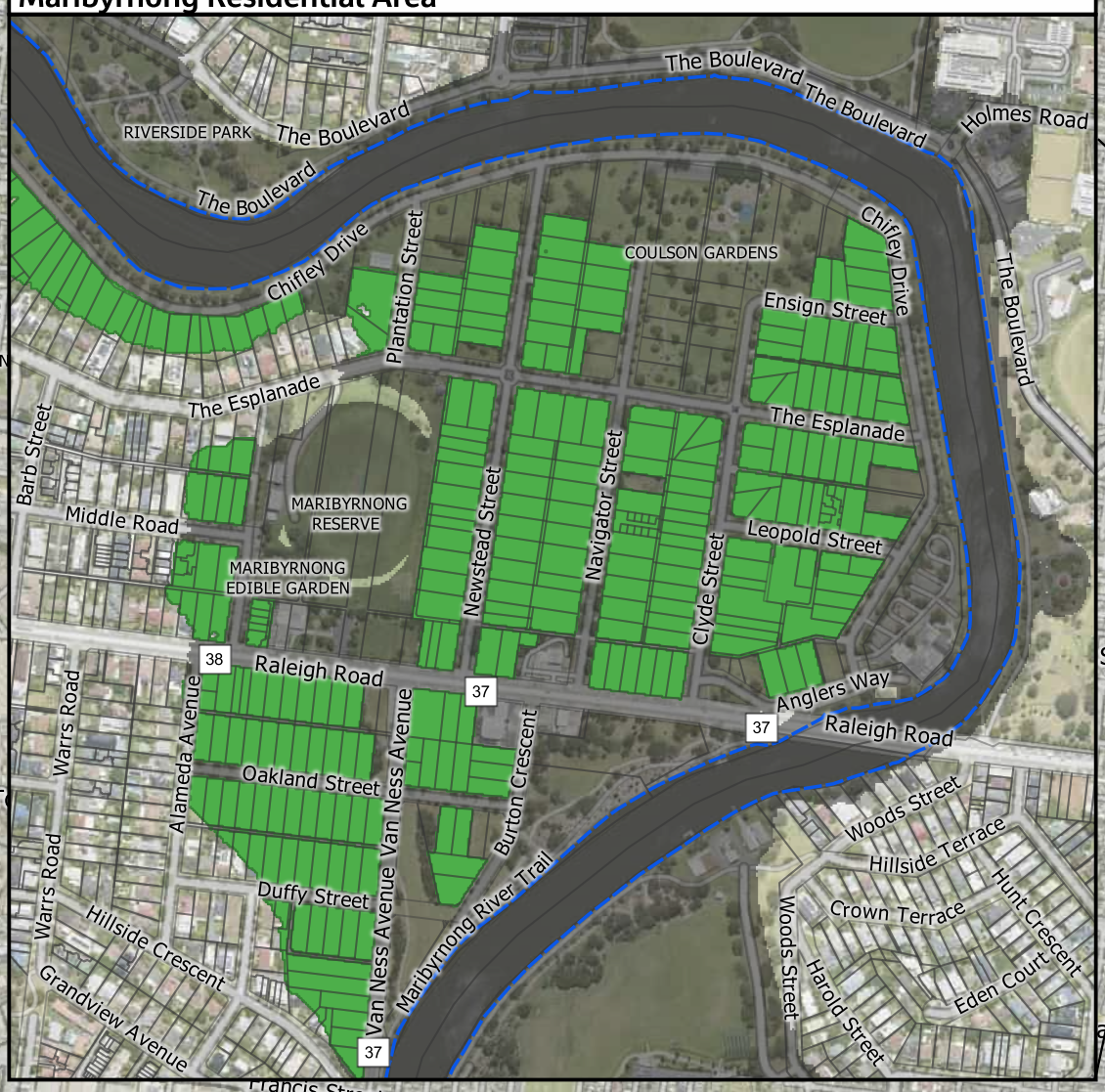
Kensington Industrial Area



Kensington Residential Area



Maribyrnong Residential Area



Maribyrnong Residential Area

Legend

- Mapping extent
- Waterway outlines
- Maribyrnong residential area
- Kensington industrial area
- Kensington residential area
- 'Non-impacted' land use types

MGA Zone 55

0 0.5 1 km

Figure 6-13: Location of 'affected' land use areas in Maribyrnong and Kensington

Project Number: IA5000NN

FINAL

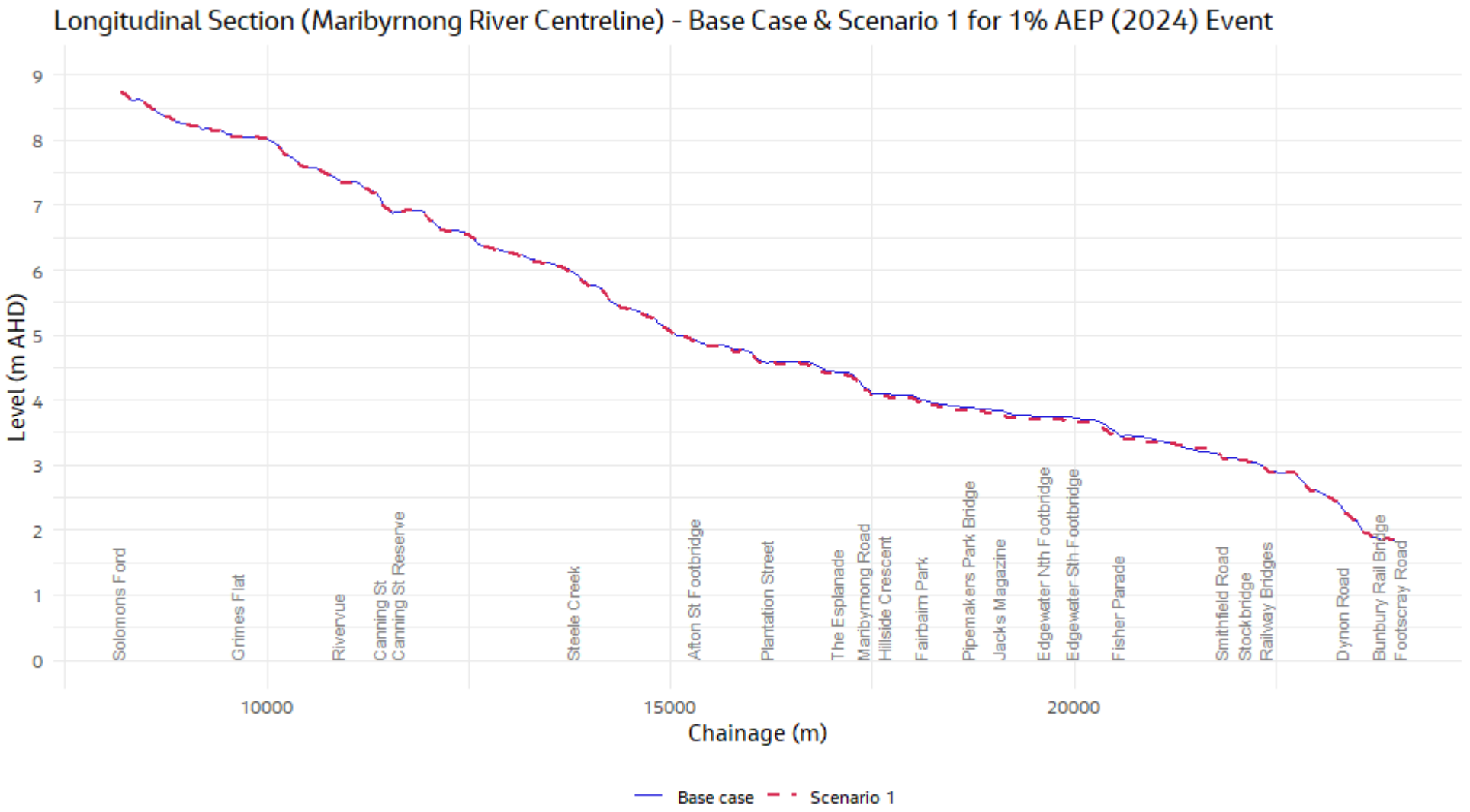


Figure 6-14. Longitudinal Section of Maribyrnong River showing modelled flood levels of the Base Case and Scenario 1 for the 1% AEP 2024 event

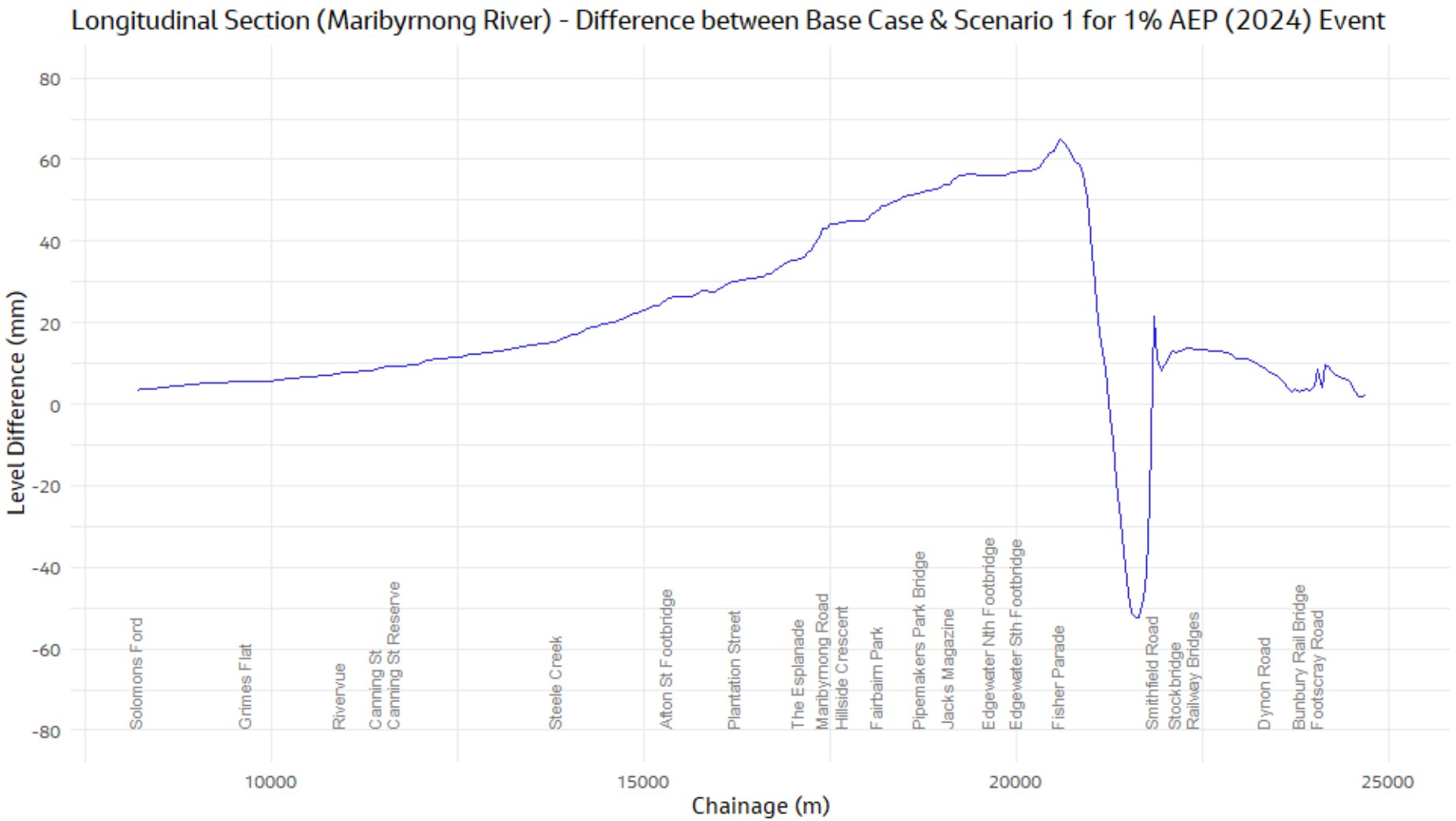


Figure 6-15. Longitudinal Section of Maribyrnong River showing the difference in modelled peak flood levels between the Base Case and Scenario 1 for the 1% AEP 2024 event (where Scenario 2 is lower than Base Case everywhere except in the vicinity of the VRC i.e. Smithfield Road)

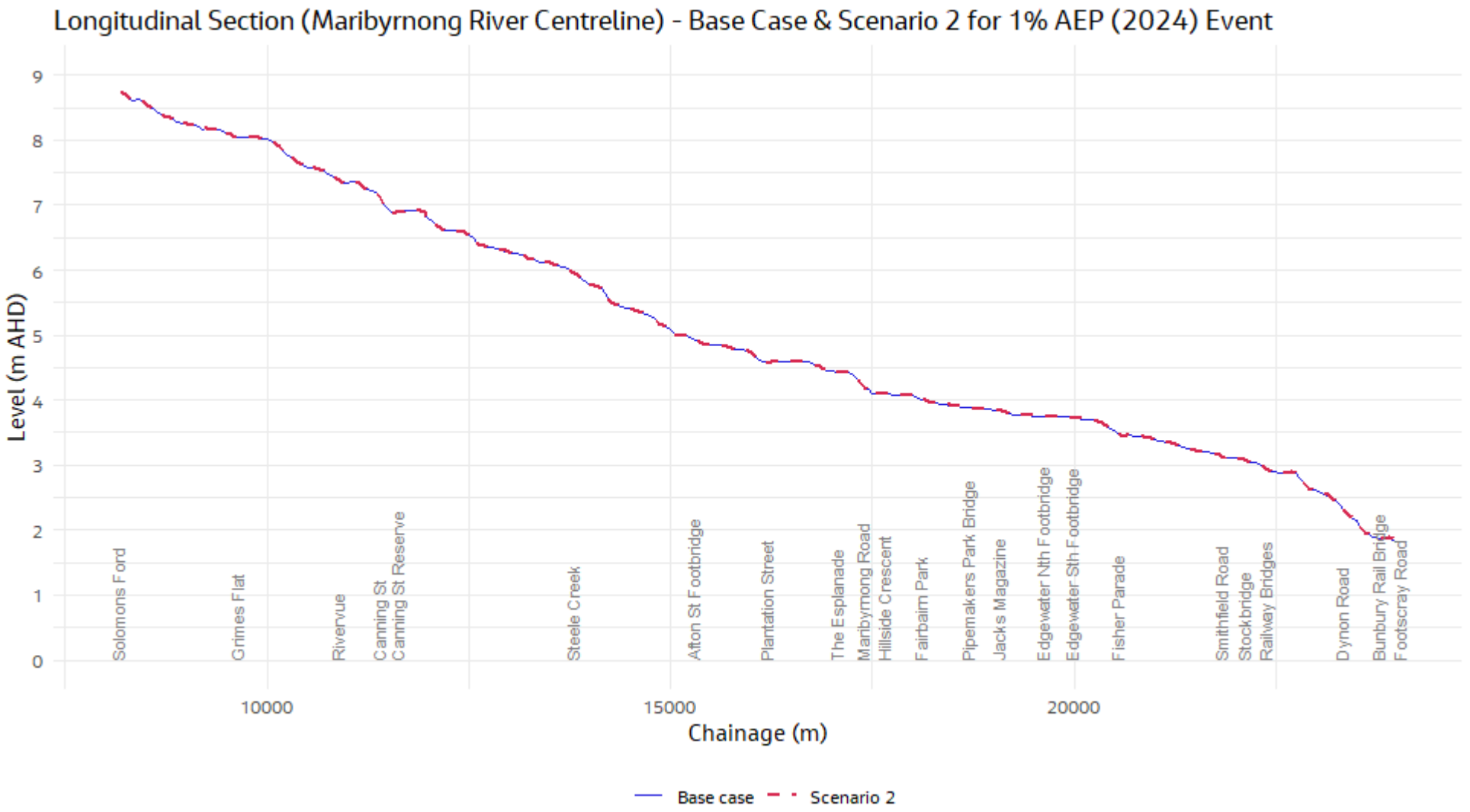


Figure 6-16. Longitudinal Section of Maribyrnong River showing modelled flood levels of the Base Case and Scenario 2 for the 1% AEP 2024 event

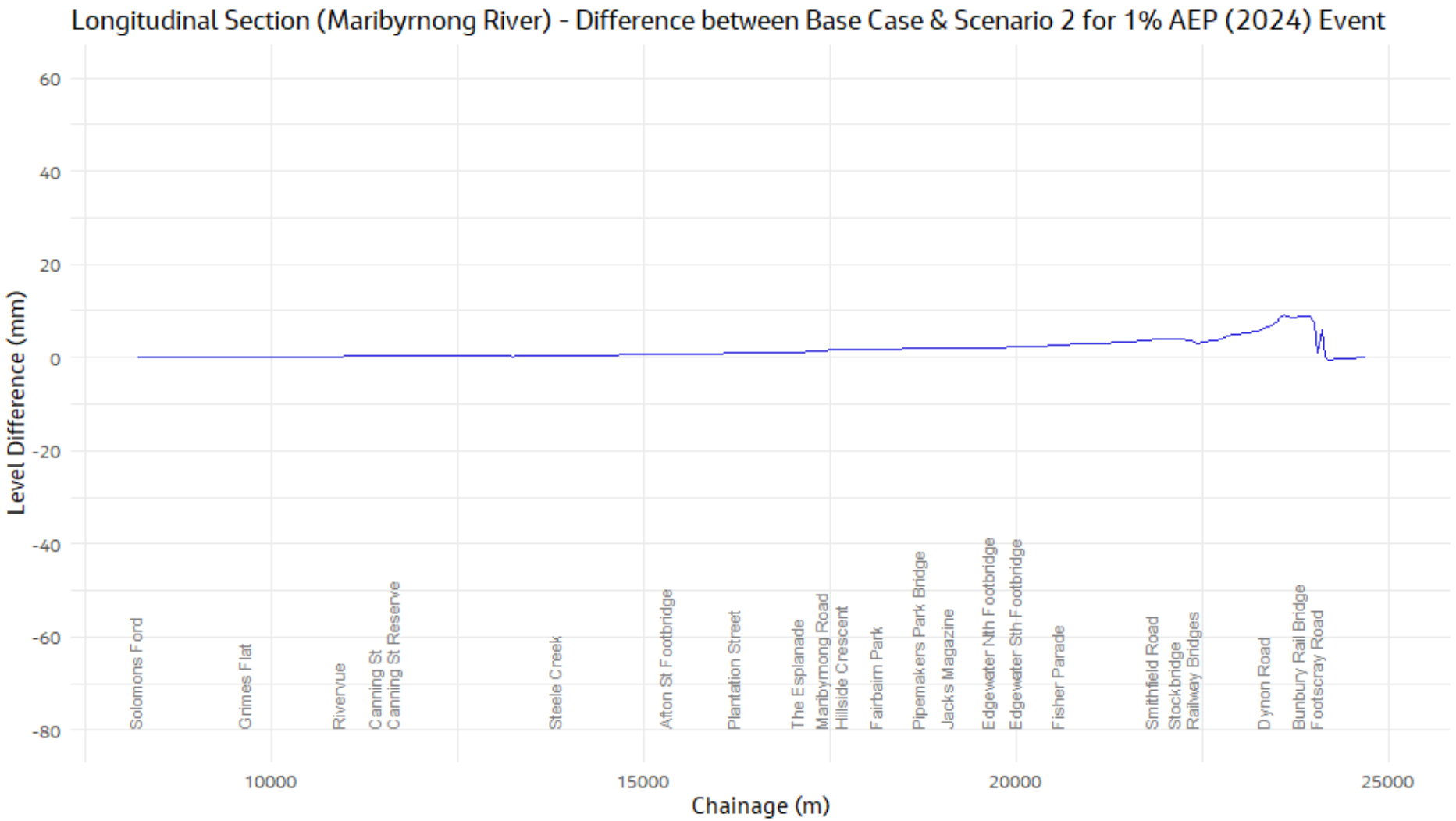


Figure 6-17. Longitudinal Section of Maribyrnong River showing the difference in modelled peak flood levels between the Base Case and Scenario 2 for the 1% AEP 2024 event (where Scenario 2 is higher than Base Case upstream of Footscray Road bridge)

7. Analysis & Discussion

Using the 2024 Maribyrnong River Flood Model to compare the Base Case with Scenario 1 and Scenario 2 under the 1% AEP (2024) event, extents, flood levels, flood impacts by land use at certain locations and flood durations have been analysed.

7.1 Flood Extents

The difference in flood extents is shown in the following figures:

- For Base Case vs. Scenario 1 see Figure 6-4. Outside the VRC the extent difference is generally negligible. At Ascot Chase there is more flooding along the affected roads and into the affected properties at the Woods St-Newsom St-Bettina Court corner of the model extent. For the Base Case under the 1% AEP event there is only partial flooding of the VRC. The VRC is much more significantly flooded for Scenario 1 due to the removal of the VRC wall.
- For Base Case vs. Scenario 2 see Figure 6-8. The differences in extents are negligible.

There are various model and data nuances that influence the ability to make conclusions at the lot-level about variations in extents in a catchment scale model. These include:

- Model cell size, sub-grid sampling, results smoothing and edge effects. These are captured in detail in Jacobs 2024a.
- Input LiDAR survey has a Root Mean Square Error (RMSE) of 0.027m in the vertical. This is consistent with a generally accepted vertical accuracy of Global Positioning System (GPS) land survey.
- Small scale infrastructure or subtle variations in ground conditions such as kerbs, steps, fences, and other obstructions may not be represented in the model.

As a result, an expected limitation of the 2024 Maribyrnong River Flood Model is the ability to draw conclusions at the lot scale at the edge of the model. Nevertheless, the modelled flood extents do indicate that the Base Case has a larger model extent than Scenario 1. Table 7-1 presents the total area of flood extent for both scenarios. This difference is largely a result of small amounts of water spilling into neighbouring model cells based on the topographic survey. The total area would likely be revised in post-processing of the results after lot-level considerations, but this is outside the scope of this report and would not change the findings that extents have only increased by a small margin.

Table 7-1: Estimated areas of flood extents

Flood Extents	1% AEP Area (m^2)
Base Case	4,679,000
Scenario 1	4,682,000
Increase due to VRC wall	25,000 (<1%)
Scenario 2	4,700,000
Decrease due to mitigation only	6,000 (<1%)

Note: The area calculations in this table exclude the VRC precinct and the areas outside the mapping extent

Table 7-1 indicates that, excluding the VRC precinct, flood extents increase by less than 1% as a result of the VRC flood wall.

7.2 Flood Levels

The differences in peak flood levels between Scenario 1 (without wall and without mitigation) and the Base Case (2022 conditions) under the 1% AEP (2024) event are presented in Figure 6-5. In this figure increases in water levels are represented by the orange and red colours and these increases due to the presence of the wall and mitigation. Conversely, areas coloured green represents areas with lower water levels. A long section of the difference between these two events is presented Figure 6-15. The following is noted:

- The greatest increase in flood levels is in line with the western, upstream, end of the VRC wall where, excluding edge effects, the increase under Scenario 1 is approximately 60 mm near Fisher Parade.
- Along the embankment protecting Edgewater the level increase is a consistent 57 mm.
- In Walter Reserve and along the roads in Ascot Chase affected by inundation, the increase in level is approximately 50 mm.
- In Maribyrnong Township south of Maribyrnong Road the increase in level is approximately 45 mm. This reduces to approximately 30 mm at the north end of the township in the vicinity of Chifley Drive gauge.
- Between Chifley Drive gauge and Canning Street bridge the level differences gradually reduce to 9 mm. Through Rivervue the impact is 7 – 9 mm.
- At the upstream boundary of the mapping extent the impact is 3 mm.
- In the VRC with the wall removed flood levels increase by approximately 1.2 m. This number is particularly high as in the Base Case 1% AEP event, the wall is only overtopped for a few hours at the peak of the storm event, leaving the VRC protected from floodwaters for the majority of the modelled event and only shallow inundation behind the wall.
- The wall appears to provide a 'shielding' effect through Kensington Banks. Under the Base Case, with the VRC wall and mitigation present, flood levels decrease by approximately 47 mm in Riverside Park, and 50 – 55 mm within the flood-affected streets of Kensington Banks.
- In the industrial part of Kensington along Hobsons Road levels are 12 mm higher under the Base Case (i.e. with the wall in-place).

The difference in peak flood levels between Scenario 2 (with wall and without mitigation) and the Base Case (2022 catchment and infrastructure conditions) are presented in Figure 6-9. The purpose of this comparison was to investigate the effectiveness of the mitigation measures. A long section is presented in **Figure 6-17**. The following is noted:

- The removal of the mitigation measures creates localised impact of up to 60 mm at the location of the upstream flow training wall on the bank. However, in the channel this impact is less: 10 mm at Footscray Road bridge, reducing to 3 mm at Kensington rail bridge.
- The removal of the mitigation works along the vehicular access track create a localised increase of 5 – 7 mm immediately upstream and downstream of the Kensington Rail culverts. In the channel upstream and downstream of the culverts, the difference is lower at between 3 and 4 mm.
- At Smithfield Road the impact of the mitigation in the channel is a reduction in levels of approximately 4 mm.
- By Chifley Drive gauge and for the remainder of the model extent to the upstream boundary the impact is negligible.

7.2.1 Land Use Considerations

Whilst there are varying differences in flood levels between Base Case, Scenario 1 and Scenario 2 under the 1% AEP event, it is important to contextualise where these increases are located. For the purposes of further

consideration in this section of the report, increases in flood levels have been characterised by land use in two areas:

- Kensington industrial area, located along Kensington Road and Hobsons Road immediately north and south of Kensington Rail bridge.
- Maribyrnong Township residential area, consisting of the residential parcels from Hillside Crescent in the south to the corner of Chicago Street and Chifley Drive in the north-west.

Table 7-2 presents the increase in flood levels within these two areas when comparing Base Case with Scenario 1 under the 1% AEP event and when comparing Base Case with Scenario 2 under the 1% AEP event. Figure 6-13 shows the location of these impacted areas.

Table 7-2: Average impact on modelled flood levels in Kensington & Maribyrnong

Scenario	Average impact on modelled flood level under 1% AEP (2024) event		
	Kensington industrial area	Maribyrnong residential parcels	Kensington residential parcels
Scenario 1 vs. Base Case	11 mm (increase due to wall)	38 mm (increase due to wall)	52 mm (decrease due to wall)
Scenario 2 vs. Base Case	3 mm (decrease due to mitigation)	1 mm (decrease due to mitigation)	4 mm (decrease due to mitigation)

7.3 Flood Duration

Figure 6-7 shows that in Scenario 1 (without the VRC Wall & associated mitigation) under the 1% AEP event there is a negligible impact on flood duration in relation to the overall event length at the five locations shown. Specifically, at the Chifley Drive gauge the impact is an increase in the peak flood level of approximately 30mm (4.71 m AHD to 4.74 m AHD). The duration under Scenario 1 above the Base Case peak level of 4.71 m AHD is approximately 4.5 hours.

In Scenario 2 under the 1% AEP event there is no discernible impact on flood duration at Chifley Drive gauge or at any point shown in Figure 6-11. At Footscray Road Bridge the impact of removal of the mitigation is an increase in the peak flood level of up to 10mm for approximately 3 hours.

7.4 Discussion

The outcomes of the modelling indicate there was some benefit from the mitigation works at the key flood-affected locations (Scenario 2 vs. Base Case). The removal of the abutment on the eastern side of Footscray Road Bridge likely has the most significant influence on the flood levels in the river with the removal of this blockage improving conveyance. The training wall has been modelled in its current state which is not consistent with its design, and it is expected that benefit of this would have been reduced given the current condition of the training wall. The potential additional benefit has not been investigated further.

Although there is a measurable increase in flood levels due to the increase in the access track level the benefit in terms of reduced flood levels was small for the simulated 1% AEP event. The hydraulic model estimates the peak flow through the Footscray Rail Culverts during this event was approximately 135 m^3/s, flowing approximately 89 % full. The peak flow in the Maribyrnong River at Kensington Rail bridge, that is the portion of the flow that was not directed through the culverts, was 750 m^3/s. Hence, the culverts were servicing approximately 15% of the flow associated with the flood.

In reaching the outcomes of this assessment Jacobs note the following:

- To definitively assess the efficacy of the mitigation measures, its necessary to compare the pre-flood wall conditions to the current conditions (Base Case). In many instances, this information was not available, such as the high-quality terrain data like LiDAR, details of the pre-mitigation works bank conditions around Footscray Road, river bathymetry, etc. This would allow the determination of whether the mitigation measures are meeting the intended purpose of matching the conditions without the flood wall. However, given the passage of time the exact conditions in 2003 are not able to be replicated to the same level of detail as the 2022 conditions.
- The modelling methodology and software which has assessed the mitigations measures in this assessment differs to the methodology adopted in 2003 and when the permit for the VRC flood wall was approved. The conclusion in this report does not infer that there were any shortcomings in the 2003 assessment of the VRC flood wall.
- The representation of the mitigation works at Footscray Road Bridge within the adopted software used in this study, differs to the representation in the assessment completed by GHD (2003b). This includes the assumed hydraulic performance of the training wall and the contraction and expansion coefficients, variables which are not explicitly represented in the 2024 Maribyrnong River Flood Model. Jacobs has not investigated these differences further as the required data was not available but note that they are not like-for-like.
- There have been changes to the floodplain in the last 20 years that may have contributed to flood impacts in the Maribyrnong River including the construction of the Regional Rail Link bridge over Maribyrnong River, Ascot Chase Development, changes to Smithfield Road Bridge and minor changes to landscaping and works on the banks of the Maribyrnong. No comparison has been made of the terrain data used in this model compared to the GHD (2003b) study.
- The training wall has deteriorated over time and this deterioration may have affected its performance as a mitigation measure.

7.4.1 Future 2100 conditions including an allowance for climate change

A preliminary assessment of the potential impacts of the VRC wall including the associated mitigation measures under 2100 conditions for the 1% AEP indicates that the wall is significantly overtopped. In essence the wall is drowned out and flood levels are only minimally affected. The 'shielding' effect of the VRC wall on Kensington Banks is also present under this scenario.

8. Limitations and Exclusions

The sole purpose of the modelling presented in this report and associated services performed by Jacobs was to investigate the impact of the Victoria Racing Club (VRC) flood wall and associated mitigations on the extent, depth, and duration of flooding for the current conditions 1% AEP event, in the vicinity of the Maribyrnong River, in accordance with the scope of services set out in the contract between Jacobs and Melbourne Water ("MW"; the Client).

This report has been prepared on behalf of, and for the exclusive use of, Melbourne Water, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and Melbourne Water. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by Melbourne Water and/or from other sources. Except as otherwise stated in the report and other associated Jacobs reports, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate, or incomplete, then it is possible that our observations and conclusions, as expressed in this report, may change.

Jacobs derived the data in this report from information sourced from Melbourne Water, third parties, and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations, and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures, and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full, in conjunction with the final reporting of the 2024 Maribyrnong River Flood Model. and no excerpts are to be taken as representative of the final findings. Jacobs accepts no responsibility for using any part of this report in any other context.

The 2024 Maribyrnong River Flood Model, developed as part of the Lower Maribyrnong Flood Mapping Project has been used as the basis for the modelling presented in this report, and is considered the best available information at the time of this request. The study is documented in the 2024 Lower Maribyrnong Flood Model Report (Jacobs 2024a).

Processing of flood depths and extents has not been carried out on the results presented in this memorandum, rather this memorandum contains an assessment of raw model results. Post-processed extents and depths are presented in the final report for the 2024 Maribyrnong River Flood Model.

The sole purpose of the flood modelling undertaken for this report is to define flood behaviour in the vicinity of the project sites. Flood extents and flood behaviour around the boundary of the TUFLOW hydraulic model domain should be interpreted with caution. The model should be reviewed in detail prior to being used for any other purpose.

9. References

Bradley, J (1978), Hydraulics of Bridge Waterways. Hydraulics Branch Bridge Division, Office of Engineering, U.S. Department of Transportation/Federal Highway Administration. March 1978.

GHD (2003a) Maribyrnong River Hydraulic Model: Final Report. Report for Melbourne Water Corporation. February 2003.

GHD (2003b) Flemington Racecourse Flood Protection: Investigation of Maribyrnong River Flood Protection. Report for Victoria Racing Club. May 2003.

Jacobs (2023a) Maribyrnong Flood Event October 2022- Post Event Analysis. Final. IA5000LI. March 2023.

Jacobs (2023b) Lower Maribyrnong Hec Ras Model Verification. Rev C. IA5000LI. 18 May 2023.

Jacobs (2023c) Mid Maribyrnong HEC-RAS Model Verification. Rev B. IA5000LI. 4 July 2023.

Jacobs (2023d) Maribyrnong River Changes. IA5000NN_MEM_001_Bath_Comparison_001. July 2023.

Jacobs (2023e) Model Schematisation Report, Lower Maribyrnong Flood Mapping. IA5000NN_MEM_002_Schematisation_001. August 2023.

Jacobs (2023f) Comparison of Flood Frequency Analysis Software Flike and Best-Fit IA5000NN_MEM_004_Comp_Flike_Best_Fit_001. September 2023.

Jacobs (2023g) Maribyrnong River Hec-Ras Model Updates: Mid and Lower Maribyrnong IA5000NN_MEM_005_Hec-Ras_Model_Update_Mid_and_Lower_Maribyrnong_002. September 2023. IA5000NN_MEM_003_Hec-Ras_Model_Update_005. August 2023.

Jacobs (2023h) Survey Report - Maribyrnong River Flood Modelling IA5000NN_REP_001_Survey_Report_Maribyrnong_River_Flood_Modelling_001_C. 13 November 2023

Jacobs (2023i) Draft Hydraulics & Hydrology Model Calibration Report. IA5000NN_RPT_002_Final_Report_002_DRAFT. November 2023.

Jacobs (2024a) 2024 Lower Maribyrnong Flood Model Report. Melbourne Water Lower Maribyrnong Flood Mapping Study for Melbourne Water Corporation May 2024.

Jacobs (2024b) VRC Wall & Mitigation Report. Melbourne Water Lower Maribyrnong Flood Mapping Study for Melbourne Water Corporation March 2024.

Jacobs (2024c) Summary of Investigations – 2024 Maribyrnong River Flood Model and the VRC Flood Wall for Melbourne Water Corporation March 2024.

Jacobs (2024d) Addendum to VRC Wall & Mitigation Report. Melbourne Water Lower Maribyrnong Flood Mapping Study for Melbourne Water Corporation March 2024.