

MELBOURNE METRO RAIL PROJECT ENVIRONMENT EFFECTS STATEMENT
INQUIRY AND ADVISORY COMMITTEE

MMRA TECHNICAL NOTE

TECHNICAL NOTE NUMBER: 076

DATE: 6 October 2016

PRECINCT: All Precincts

EES/MAP BOOK REFERENCE: N/A

SUBJECT: Response to the Inquiry and Advisory Committee's 'Matters for further consideration and/or clarification' request dated 12 September 2016

(ix) Surface water

NOTE:

- 1) This Technical Note has been prepared with the assistance of AJM to respond to issues raised by the Inquiry and Advisory Committee ("**IAC**") in the 'Matters for further consideration and/or clarification' request dated 12 September 2016.
- 2) For ease of reference, this Technical Note sets out each relevant request made by the IAC followed by a response from MMRA.

Request:

- 3) The IAC has requested:
Clarification regarding the potential higher levels of flood immunity that may be adopted for Project infrastructure.

Response:

- 4) It is assumed that this question arises from statements made in Technical Appendix N to the EES and in John McCrann's evidence to the IAC that MMRA may decide to adopt higher flood immunity standards than the flood immunity standards required by Melbourne Water.

- 5) Melbourne Water generally requires that assets be protected against a year 2100 1% AEP event. Appendix N to the EES demonstrates that there are a number of ways that this could be achieved in respect of different components of Melbourne Metro infrastructure.
- 6) It is possible to achieve higher levels of flood immunity. A range of potential flood defence options are described in Appendix F to Mr McCrann's witness statement.
- 7) A decision to adopt higher flood immunity standards than those required by Melbourne Water would be informed by an additional flood immunity risk assessment as per EPR SW1. Its focus would be on asset protection and business interruption and would consider the impacts of a range of flood events in relation to matters such as clean-up costs and costs associated with any potential long-term disruption of the rail network.
- 8) By way of example, MMRA and PTV may decide, as a result of a flood immunity risk assessment, that the Western Portal ought to be protected against a year 2100 0.1% AEP event (rather than the year 2100 1% AEP event required by Melbourne Water). Achieving this would require installation of flood gates extending to the full height and width of the portal (this configuration would provide protection against even the most extreme flood event). The flood gates would be designed to the requirements of Melbourne Water and relevant authorities, in accordance with EPR SW1.

Request:

- 9) The IAC has requested:

Clarification of the method used for the calculation and application of the 1% AEP standard in the Year 2100, including in particular:

- a) *Whether the approach taken by MMRA is less conservative than the application of the Melbourne Water Year 2100 climate change water levels.*
- b) *The differences, if any, between the approach taken in Technical Appendix N generally and that taken in Appendix C to Technical Appendix N relating to the Arden precinct specifically.*

Response:

- 10) (a) Melbourne Water has not undertaken any detailed modelling to determine Year 2100 1% AEP climate change flood levels along the estuarine reaches of any of the Yarra River, Maribyrnong River or Moonee Ponds Creek. In instances where this modelling has not been undertaken, Melbourne Water approximates levels by adding 800 mm to its modelled current year 1% AEP flood levels. This is a rudimentary method. By contrast, AJM adopted a far more rigorous approach in preparing Technical Appendix N, which involved detailed modelling. Flood levels resulting from Melbourne Water's rudimentary method and from the detailed modelling undertaken by AJM, are presented in the table below.

Location	Year 2100 1% AEP Flood Levels (m AHD)	
	Melbourne Water	MMRA
Yarra River at Princes Bridge	2.9	3.8
Yarra River at South Yarra	4.85	5.2
Maribyrnong River at Western Portal	3.5	4.7
Moonee Ponds Creek at Arden Station	3.55	3.4

- 11) As can be seen from the table, in all instances except for Moonee Ponds Creek, the flood levels determined by AJM are higher than those estimated by Melbourne Water. In the case of Moonee Ponds Creek, the level determined by AJM is marginally lower, by 150 mm, than that estimated by Melbourne Water. In general, therefore, the flood levels estimated by AJM are similar to or more conservative than those estimated by Melbourne Water. In the case of Moonee Ponds Creek, the flood level determined by AJM has been adopted over the Melbourne Water estimate because it is based on a more rigorous assessment.
- 12) (b) There is no difference in the approach used to determine Year 2100 flood levels in Appendix C to Technical Appendix N and that used in the remainder of Technical Appendix N. The main underlying assumptions — which have been used consistently throughout the document — are as follows:
- Increase in rainfall intensity relative to existing – 32%.
 - 1% AEP tailwater level – 2.25 m AHD.
 - 0.1% AEP tailwater level – 2.4 m AHD.
 - 0.01% AEP tailwater level – 2.5 m AHD.

Request:

- 13) The IAC has requested:

Whether MMRA agrees with Mr Fox regarding the appropriate Year 2100 standard for pluvial flooding.

Response:

- 14) Mr Fox’s presentation included the following statements:
- “Pluvial” (Flash) flooding occurs when high intensity rainfall overwhelms the underground piped drainage network.
 - It occurs with little or no warning and consequences can be catastrophic.

- c) All Melbourne Metro station precincts are located in catchments at High or Extreme risk of pluvial flooding.

Mr Fox’s presentation also included a photograph of the famous 1972 Elizabeth Street flood, which shows floodwaters flowing over the bonnets of cars.

- 15) Mr Fox’s statements are generally agreed. In particular, it is noted that there are potentially catastrophic consequences associated with this type of flooding. AJM therefore undertook a preliminary assessment to determine the potential order of magnitude of flood depths in the low points of the tunnels resulting from extreme rainfall (‘pluvial’) events in the catchments around each of the station entrances. This assessment was undertaken after submission of the EES, with the intent of providing input to a further assessment of the risks associated with flooding of the tunnels.

There are three low points in the tunnels:

- a) Between the Western Portal and Arden Station. This area could potentially be flooded by runoff from an extreme rainfall event getting into the tunnel via the Arden and Parkville station entrances.
- b) At CBD South Station. This area could potentially be flooded by runoff from an extreme rainfall event getting into the tunnel via the Parkville, CBD North and/or CBD South station entrances.
- c) Between Domain Station and the Eastern Portal. This area could potentially be flooded by runoff from an extreme rainfall event getting into the tunnel via the Domain station entrances.

The results of this assessment are presented in the table below. This assessment showed that even in a 0.01% AEP rainfall event, the low points in the tunnels would only be inundated to depths of less than a metre, and less than 5% of the total tunnel length would be inundated. Whilst this might result in some short term disruption of the rail network, it is not regarded as “catastrophic”.

Tunnel Low Point	0.1% AEP Storm Event		0.01% AEP Storm Event	
	Flood depth in tunnel low point (m)	Length of tunnel draining to low point affected (%)	Flood depth in tunnel low point (m)	Length of tunnel draining to low point affected (%)
Between Western portal and Arden station	0.0	0.1%	0.1	0.2%
CBD South station	0.4	1.4%	0.5	1.8%
Between Domain station and Eastern portal	0.3	2.2%	0.7	4.9%

- 16) The degree of flooding suggested by the results in the table above and that which occurred during the 1972 Elizabeth Street flood, are clearly very different. There are a number of reasons for this.
- a) The photograph in Mr Fox's presentation shows flooding along Elizabeth Street itself. This runs approximately from north to south along the base of a very distinct valley through the CBD. This valley acts as a major overland flow path during major storm events. The catchment that contributes flow to the location of the photograph (near the corner of Elizabeth and Flinders Streets) is also relatively large, at something of the order of 300 hectares.
 - b) By contrast, none of the station entrances are located in the low points of valleys, and none of them are adjacent to any major overland flow paths. The catchments upstream of each of the station entrances are also much smaller. Most of them are less than 20 hectares. The only one that is larger than this is the catchment in the area around Domain Road upstream of the entrances to Domain Station, but even this is only around 40 hectares.
 - c) The flow depths that extreme storm events could generate at any of the station entrances are therefore much less than the flow depths shown in the photograph in Mr Fox's presentation. It is also worth noting that the proposed entrances to the CBD South station will be around 4 metres higher than the ground levels in the floor of the valley at the corner of Flinders and Elizabeth Streets.
- 17) There are two main reasons why these 'pluvial' flood events are generally less likely to cause catastrophic flooding of infrastructure such as a major tunnel.
- a) The first is that the rainfall that generates these events generally persists for only a relatively short duration, typically tens of minutes. By contrast, the durations of rainfall events that generate flood events in major rivers are much longer and typically persist for many hours to several days.
 - b) The second reason is that the areas of catchments subject to 'pluvial' flooding are generally much smaller than those of catchments subject to riverine flooding. These two factors mean that the total volumes of runoff generated by an extreme storm event on a catchment subject to 'pluvial' flooding are much less than in a catchment subject to riverine flood and are thus insufficient to cause major inundation of an asset such as the Melbourne Metro.
- 18) On the basis of the above, MMRA considers that an extreme 'pluvial' storm would not result in catastrophic flooding of the tunnel and that the appropriate Year 2100 standard for protection of station entrances against pluvial flooding is as presented in the EES.

Request:

19) The IAC has requested:

Having regard to Mr McCrann's evidence that he believed an automatic floodgate should be the 'default' flood protection option for the Eastern Portal and MURL cross-connections, does MMRA agree with that assessment and, if not, the reasons why it disagrees.

Response:

20) With specific regard to the Eastern Portal and MURL cross-connections, the content of Annexure F to Mr McCrann's Expert Witness Statement is agreed, subject to one clarification set out below. The relevant statements in Annexure F to Mr McCrann's Expert Witness Statement are as follows:

*“4. Metro Tunnel flood defence
To satisfy EPR SW1, flood defence systems would need to be integrated at certain points along the Metro Tunnel alignment. The detailed design would be informed by a flood immunity risk assessment....*

*4.1 Eastern portal
...In my opinion it will be necessary, as part of the assessment of potential flood protection measures at this location, to also consider the installation of automatic flood gates as a response to extreme flood events...*

*4.3 Interconnection between the MURL and Metro Rail Tunnel Rail Network
... As with the Eastern and Western Portals, it is recommended that automated gates are installed at each MURL tunnel portal vulnerable to flooding during a 'Probable Maximum Flood' event.*

Alternatively, it is possible to install a flood gate in the connecting tunnels which would isolate the Metro Tunnel from any flood water in the MURL tunnels, should the MURL not have flood defences retro-fitted.”

21) It should be noted that the second last paragraph extracted above should be reworded to read as follows: *“As with the Eastern and Western Portals, it is recommended that automated gates are installed at each MURL tunnel portal vulnerable to flooding during events up to and including a 'Probable Maximum Flood' event”*. The original wording of the Expert Witness Statement was not as intended and the above extract should be substituted into the statement.

22) MMRA understands that the term 'default' was used by Mr McCrann to indicate that:
a) until a risk assessment is undertaken in accordance with EPR SW1, it should be assumed that automatic flood gates might be needed at the

Eastern Portal and at each MURL tunnel portal vulnerable to flooding during events up to and including a 'Probable Maximum Flood' event; but

- b) following the risk assessment, it may be determined that alternative flood defence mechanisms would be more appropriate for the Eastern Portal and MURL cross-connection.
- 23) MMRA agrees that this is an appropriate approach. It is consistent with the approach adopted under the EPRs.

Request:

- 24) The IAC has requested:

Clarification of the bunding measures proposed for the Arden Electricity Intake Structure.

Response:

- 25) MMRA does not intend to be prescriptive about the surface water flood protection measures ultimately adopted for the Arden Electricity Intake Structure. However, two broad approaches could be to elevate electrical equipment above the flood level, or keep the electrical equipment at ground level but provide bunding around it. Both measures would comply with EPRs SW1 and SW2.
- 26) To minimise the area required for bunding and meet the requirements for access during operation and maintenance, it is likely that the bunding would be the wall type comprising of reinforce concrete, brick or stone. The bunding could also include flood gates. It is not expected that earthen levee type bunding would be adopted.

Request:

- 27) The IAC has requested:

Clarification regarding the existing flood warning systems for the Maribyrnong River, Moonee Ponds Creek and the Yarra River.

Response:

- 28) The Bureau of Meteorology ("**BoM**") constantly models and monitors the weather and advises agencies if there is severe weather that is likely to impact an area e.g. heavy rainfall that may lead to flooding in Melbourne. The BoM works closely with State Emergency Services ("**SES**") and other agencies to communicate forecasted severe weather.
- 29) Melbourne Water has an extensive network of flood and rain gauging stations across Melbourne, including within the catchments of Moonee

Ponds Creek, Maribyrnong River and the Yarra River. These are remotely monitored via telemetry. The attached figures (**Attachments A, B and C**) show the location of these gauges within each of the catchments of interest. This network continually monitors and logs rainfall and flood levels at 6 minute intervals in the respective watercourses.

- 30) Melbourne Water has arrangements in place with the BoM to receive severe weather data and information. Melbourne Water uses the data it receives from the BoM in conjunction with data from its own flood and rain gauging stations to run flood forecasting models from which forecast flood levels can be determined.
- 31) Melbourne Water issues flood alerts and warnings to the BoM and these are then issued to the agencies, i.e. SES, Councils and media. Additionally, Melbourne Water will issue notifications to registered stakeholders regarding observed and forecast flood levels within the catchments. Melbourne Water is also currently developing an application which will continually monitor flow and flood levels, which will then automatically issue alerts to subscribed individuals and organisations. It is anticipated that development of this application will be completed and available before the Melbourne Metro is operational.
- 32) Any flood protection measures requiring implementation for the Melbourne Metro will be implemented in response to known trigger levels. These predetermined flood conditions will have been identified during the flood immunity risk assessment required by EPR SW1, along with particular actions and assignment of those actions to responsible individuals and teams.
- 33) Melbourne Water has indicated that it would be possible to enter into an arrangement where the MMRA could commission Melbourne Water to install additional gauges, if deemed necessary and at the Project's expense, at appropriate locations close to vulnerable project infrastructure. These gauges could then be transferred to Melbourne Water for on-going monitoring and maintenance as technical expertise are required to manage and operate them. The additional gauges would then be connected to the existing Melbourne Water gauge network using telemetry and they could provide instantaneous data for the Melbourne Metro, which could be incorporated into its flood defense management strategy.
- 34) Whilst the EES refers to flood warning systems as a component of measures to mitigate flooding of the stations and tunnel portals from extreme flood events on the Yarra and Maribyrnong Rivers, and Moonee Ponds Creek, the context presented in the following paragraphs should be noted.
- 35) The rates at which flood levels would generally be expected to rise are approximately proportional to the duration of the storm events that would generate floods in each of these systems. Typical rates of rise are presented in the table below.

River/Creek	Duration of rainfall that would typically generate a flood (hrs)	Approximate rate of flood level increase (metres per hour)	
		0.1% AEP event	0.01% AEP event
Yarra River	72	0.05	0.1
Maribyrnong River	12	0.3	0.4
Moonee Ponds Creek	2	1.5	2.0

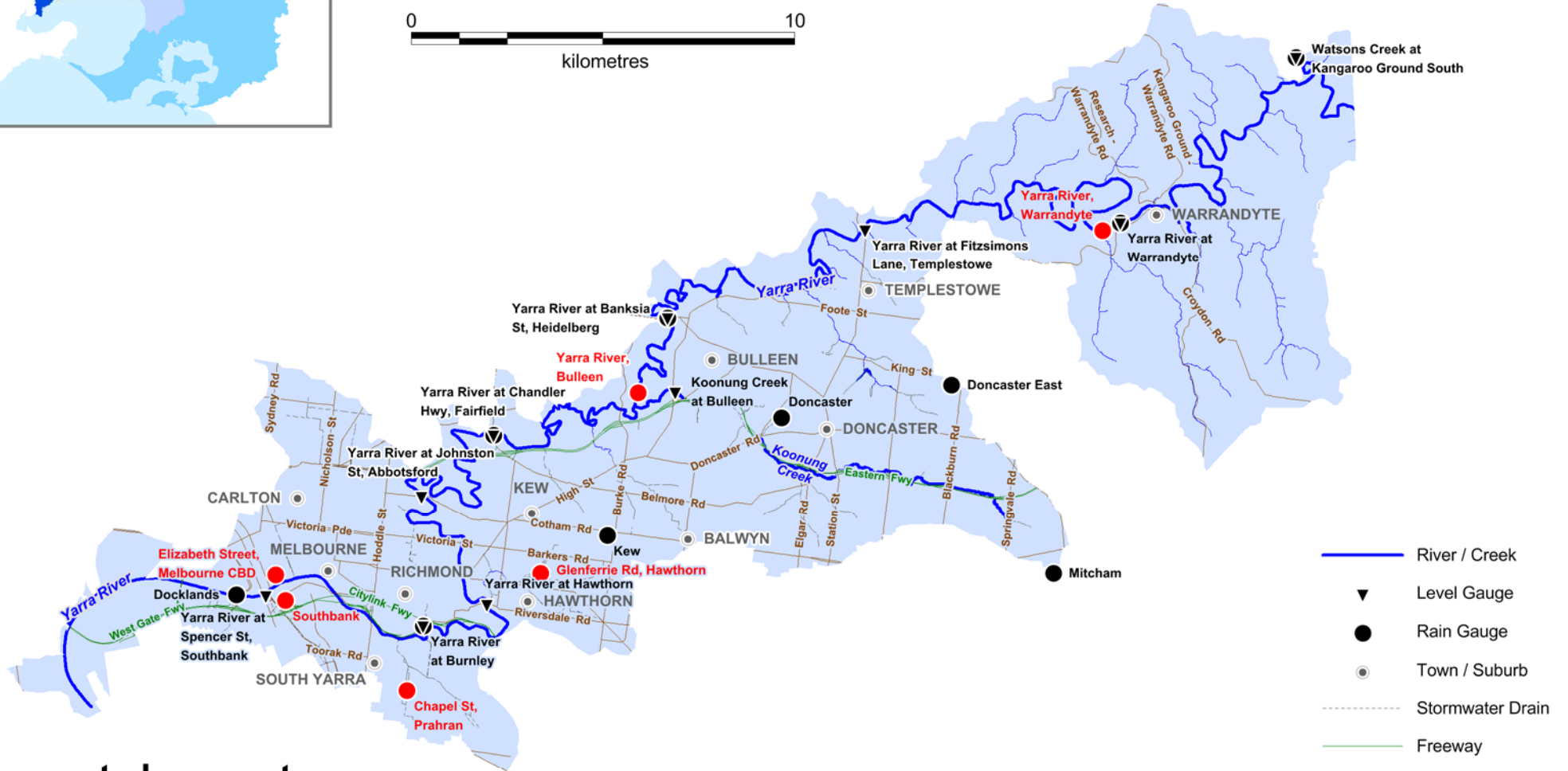
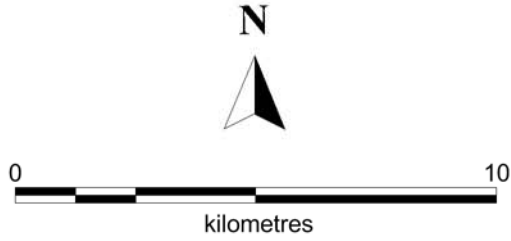
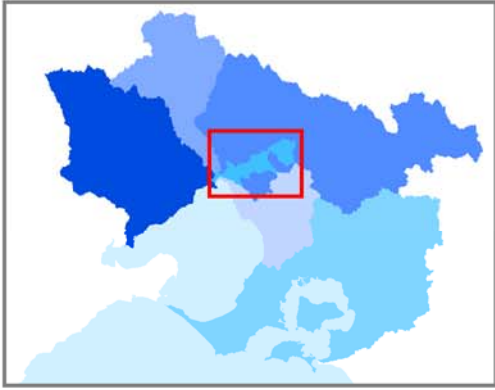
- 36) As is evident from the figures in the table above, flood levels typically increase relatively slowly in catchments as large as those of the Yarra and Maribyrnong Rivers. This fact, combined with the very comprehensive flood warning systems in place in these catchments, means that many hours (in the case of the Maribyrnong) and several days (in the case of the Yarra), will generally be available to implement mitigation measures in advance of an extreme flood peak.
- 37) Less warning time would generally be expected to be available in advance of a flood peak on Moonee Ponds Creek. However, the currently proposed Arden station entrance level is above the peak Year 2100 0.1% AEP flood level, so only a very extreme flood would inundate that station entrance. Furthermore, analyses similar to those outlined in paragraph (15) above, indicate that even in a 0.01% AEP flood event on Moonee Ponds Creek, floodwaters flowing into the tunnel via Arden station would only inundate the tunnel low point west of Arden station to a depth of around 0.2 metres, with less than 1% of that section of tunnel being inundated.

CORRESPONDENCE:

No correspondence.

ATTACHMENTS:

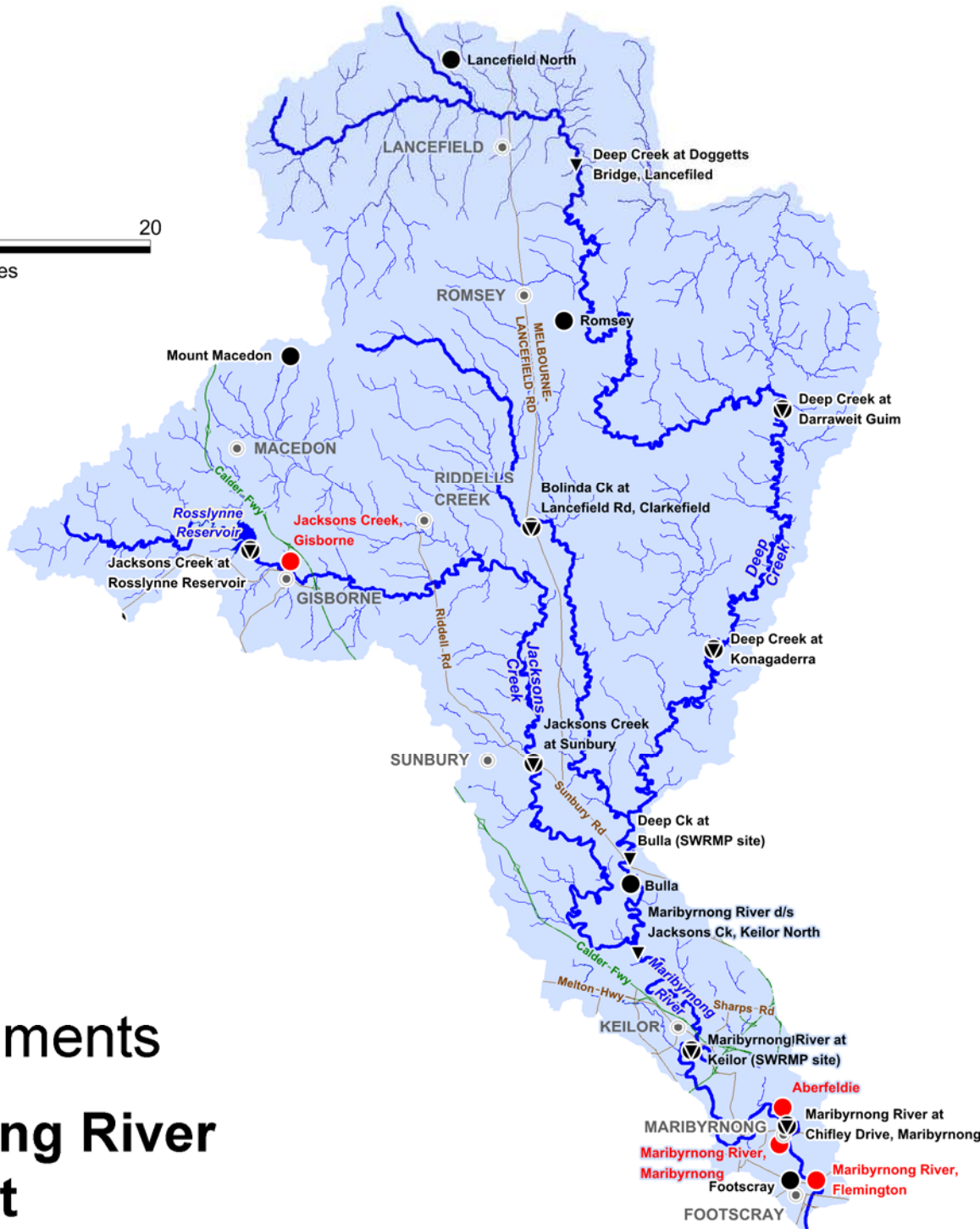
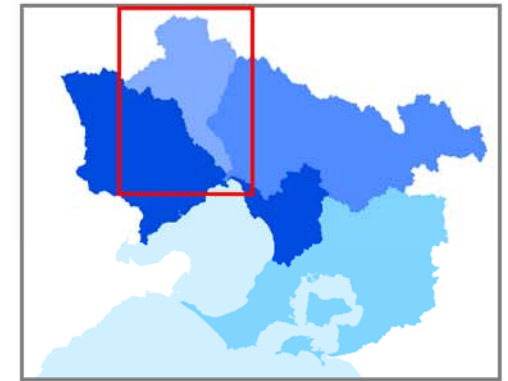
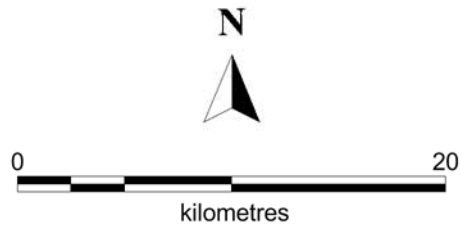
- A. Map of existing rainfall and streamflow gauges in Lower Yarra River Catchment
- B. Map of existing rainfall and streamflow gauges in Maribyrnong River Catchment
- C. Map of existing rainfall and streamflow gauges in Merri & Moonee Ponds Creek Catchment










Sub-catchments

Lower Yarra River Catchment

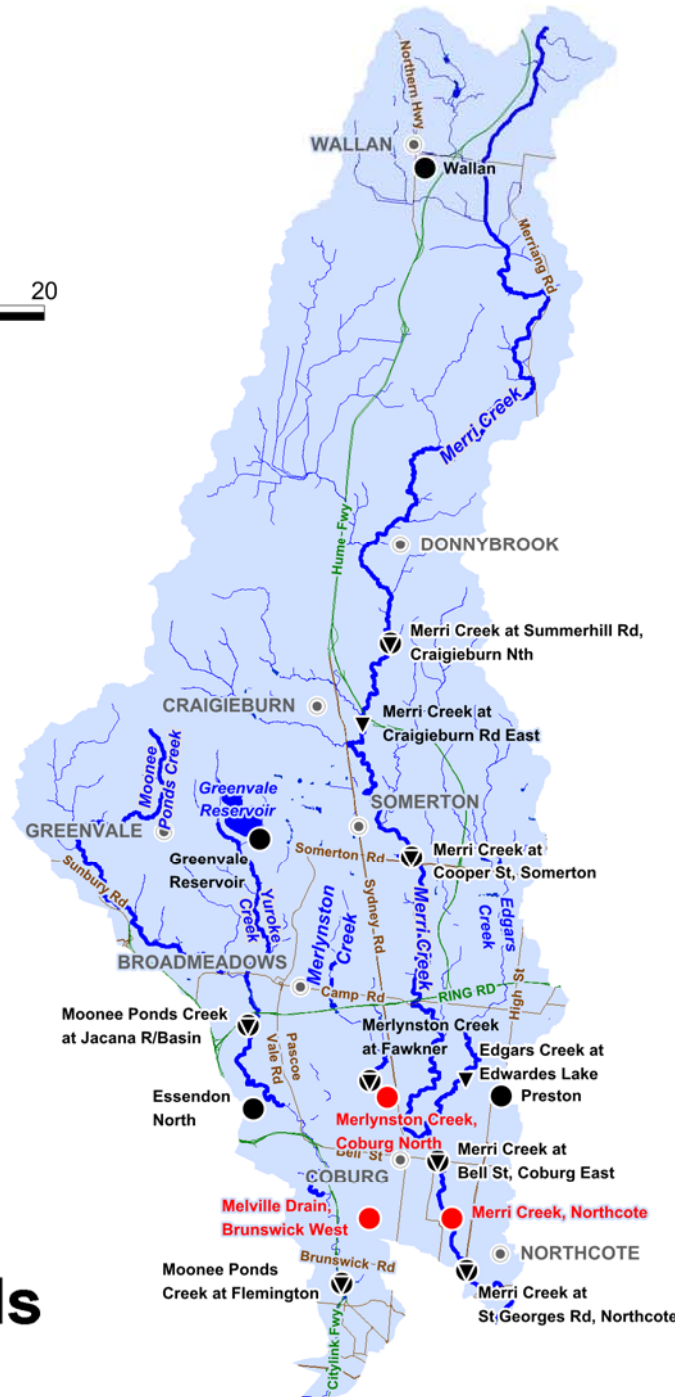
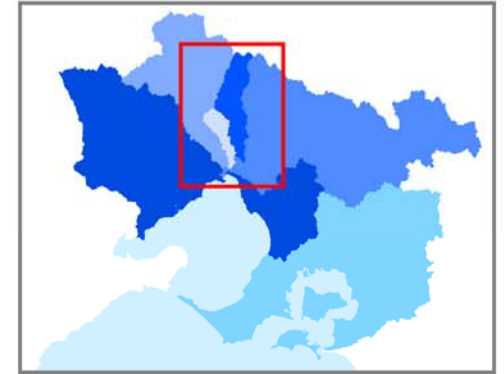
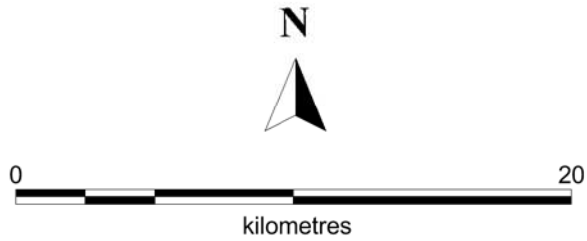











Sub-catchments Maribyrnong River Catchment

-  River / Creek
-  Level Gauge
-  Rain Gauge
-  Town / Suburb
-  Freeway
-  Main Road
-  Flooding Hotspot





-  River / Creek
-  Level Gauge
-  Rain Gauge
-  Town / Suburb
-  Freeway
-  Main Road
-  Flooding Hotspot

Sub-catchments

Merri & Moonee Ponds Creek Catchment

