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Annexure F — Flood Defence Options at Tunnel Portals

1 Introduction

Flood immunity of the proposed Eastern and Western Portals is described in Sections 8.5 and 14.5 of the Surface Water Impact Assessment. These sections quantify the risk of inundation at each of the Metro Tunnel portals.

The purpose of this report is to summarise the options available for providing flood defence at the Metro Tunnel portals during operation.

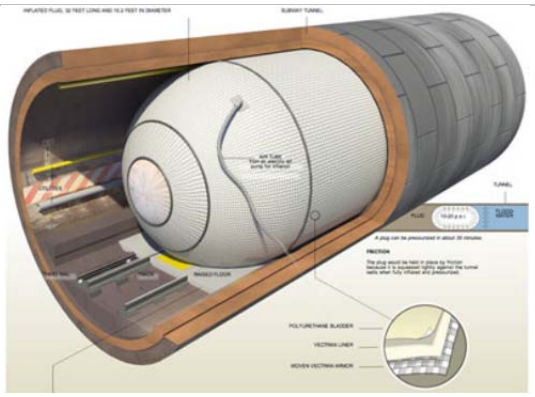
2 Options

A range of measures have been installed at comparable projects internationally. For example, closing doors (both hinged and sliding) have been installed on the London Underground and London CrossRail and a form of sluice gate has been used in the Hamburg UBahn. A different response incorporating resilient tunnel plugs has been developed in the US in the wake of Hurricane Sandy but has not yet been installed in a live tunnel.

Table 1 identifies typical automated and manual flood defence systems that manage flood risks at existing sites across the world. One or a combination of these systems could be adopted to protect the Metro Tunnel portals from inundation during flood events.

Table 1 – Existing Flood Defence Systems

Flood Defence System	Description of operation	Example Image
Sluice Gate	A permanent sliding gate controlled by a mechanical valve to open and close is used extensively in the water industry to control open channel flows. These are typically installed on the outside of a portal but a similar mechanism could be developed as an internal gate within a tunnel. The Hamburg Ubahn incorporates this type of flood defence system.	
Automated Flood Doors (recessed into portal wing walls)	Doors designed to seal against flooding when closed. Design would need to include these doors as an integral part of the portal structure. This type of mechanism has been used historically in the London Underground and has been installed on CrossRail in London.	

Flood Defence System	Description of operation	Example Image
Singular Structure Bulkhead **(i.e. doors stored off-site and installed in extreme flood event only)**	As per the automated flood doors but with the doors stored off-site and craned into place when required. This is a commonly used reactive flood control mechanism. Frames can be integrated into tunnel portal walls so that a singular structure bulkhead makes a seal. There is potential to use this as a back-up system in the event of automatic flood defence fault or failure.	
Resilient Tunnel Plug	This is a scalable technology that is intended to plug rail, automotive, or other tunnels from threats, including flood water. It is designed to be deployed from a container mounted inside the tunnel. An inflation system pressurises the plug rapidly and maintains its pressure whilst it is in use. There is presently no example of these plugs having been commercially deployed.	
Stop Logs	This is a commonly used reactive flood control mechanism. Frames can be provided at the tunnel portal walls so that individual bars or logs combine to make a seal. There is potential to use this as a back-up system in the event of automatic flood defence fault or failure.	

There are a number of proprietary variations to these standard flood defence systems but the basic elements described in Table 1 are common to each system.

In addition to providing flood defence for tunnel portals, consideration should also be given to secondary infrastructure that may convey flood waters into the tunnels, effectively bypassing any tunnel portal flood

defences. The detailed design of the Metro Tunnel should consider mitigation and defence strategies to protect the tunnel system from flooding via secondary routes (including via the Melbourne Underground Rail Loop (**MURL**)).

3 Preliminary Flood Defence Selection Criteria

As noted in the Surface Water Impact Assessment EPR SW1, a risk assessment approach is recommended for the project, based on well-defined criteria provided by stakeholders, which will inform the detailed design. In analysing the suitability of a flood defence system as part of this risk assessment, regard should be had to the following parameters:

1. The level of flood immunity provided by a system — robustness and resilience of the nominated system, 'water tightness' of the seal formed, etc.
2. Inspection of flood defence systems, including assessment of comprehensiveness and reliability of ongoing inspections and ensuring maintenance activities identified during regular inspections are acted upon.
3. Maintenance, including the likelihood that comprehensive and continuous activities are undertaken on a regular basis in a manner consistent with the manufacturer's specifications and recommendations.
4. Deployment of the flood defence during flooding events. The final design of the adopted flood defence system should consider the time required for deployment and the availability of any required plant for deployment, operation and retrieval following the flood event.
5. Personnel for deployment of the flood defence systems. Consideration should be given to the availability of staff to attend each site, as appropriate, to deploy the flood defence system. Consideration should also be given to access to each site during each event, as well as the resource requirements placed upon the responsible authority during a flood event.
6. Requirements for reinstatement of the nominated flood defence. This includes reinstatement of damaged, dislodged and deliberately removed infrastructure (e.g. overhead conductor line (**OCL**), rail track, etc.).

During a large flood event, consideration should also be given to:

- Access to sites in the vicinity of the flood defence which may be adversely impacted by flood waters thus impeding or prohibiting access to the flood defence.
- Required plant for the installation or removal of manual components of the flood defence. If not readily available, flood defences may end up being in place longer than necessary or not being installed in an appropriate timeframe.
- Ongoing monitoring of hydrologic conditions in each catchment, which would be critical for automatic and manual flood defence systems. This would require a clear line of responsibility and operational response to be established. It is worth noting that whilst both automatic and manual options require implementation of flood monitoring and warning systems, automated systems may be able to minimise tunnel closure time as they may accommodate a higher intervention flood level, as compared to manual systems.

On my initial assessment, a number of the flood defence systems set out in Table 1 would respond appropriately to the above parameters, in the context of the Metro Tunnel.

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. Possible flood defence systems for each of the sensitive areas along the alignment are considered below.

4.1 Eastern Portal

As discussed in Section 14.5 of the Surface Water Impact Assessment, the Eastern Portal is subject to potential flooding by the Yarra River. At this location, there would be an approximate warning time of 2–3 days, depending upon antecedent conditions.

The Surface Water Impact Assessment recommends that a flood warning system be implemented at this location, such that rail services could be suspended and the tunnel and stations evacuated in advance of an extreme flood. This system would link to existing systems in place in the Yarra Catchment. The Surface Water Impact Assessment goes on to recommend that if the risk associated with more extreme floods is not deemed to be acceptable, emergency management measures, such as sandbagging or flood gates, and emergency evacuation procedures, would need to be in place to protect the tunnel from flooding.

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.

A flood warning system would continuously monitor precipitation and Yarra River water levels and, once predefined flood levels were reached, the system would issue a series of warnings to the operators (including operational and maintenance staff). Once the critical flood level was reached, the operational system would then close down the rail infrastructure (e.g. de-energise the OCL) and automatically close the flood gates.

4.2 Western Portal

As discussed in Section 8.5 of the Surface Water Impact Assessment, the Western Portal is subject to potential flooding by the Maribyrnong River. The Maribyrnong River typically has an approximate warning time of 12 hours in advance of floods, depending upon antecedent conditions. Due to the relatively short advance warning times involved, an automated flood gate defence system that integrates an appropriate flood monitoring, warning and fault reporting system is recommended.

Such a system would continuously monitor precipitation and Maribyrnong River water levels and, once predefined flood levels were reached, the system would issue a series of warnings to the operators (including operational and maintenance staff). Once the critical flood level was reached, the system would then close down the rail infrastructure (e.g. de-energise the OCL) and automatically close the flood gates.

4.3 Interconnection between the MURL and Metro Tunnel Rail Network

The proposed interconnection between the MURL (Melbourne Central Station) and Metro Tunnel (CBD North Station) networks would provide pedestrian access between the underground station platforms, thereby providing an ingress for water to the Metro Tunnel. 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.

4.4 Secondary Flooding Issues

As noted in Section 2, flood defences should be implemented to protect the tunnel system from flooding via secondary routes (i.e. services and conduits).

5 IAC Queries

5.1 Query 58

The IAC has requested information on how the retaining wall and matched automated flood gates proposed for the Western Portal in the Surface Water Impact Assessment would reliably and robustly operate in conjunction with the tunnel portal in times of flood.

Details concerning different types of flood gates that could be implemented at the Western Portal are set out in Table 1 above. The successful integration of these measures into the Project would need to be determined as a matter of detailed design.

5.2 Query 59

The IAC has requested 'further information on how … 'stop logs' used possibly in combination with sand bags could be deployed and operate at the Eastern portal, including reference to any relevant examples from other similar projects'.

Section 14.5 of the Surface Water Impact Assessment suggests the use of stop logs as a possible flood defence measure during operation. Details concerning this potential response are set out above in Table 1. In my view, this may be an appropriate measure but would be subject to detailed design and the risk assessment, as per EPR SW1.

In Section 14.5 of the Surface Water Impact Assessment, sandbags are also suggested as a possible flood defence measure to be used during construction and, possibly, operation of the Metro Tunnel. In my view this may be appropriate but, again, would be subject to detailed design and the risk assessment, as per EPR SW1.