6.8 Hydrology and flooding

This section provides a summary of the assessment of potential hydrology and flooding impacts during construction and operation of the proposal and identifies mitigation measures to address these impacts. A detailed hydrology and flooding assessment is provided in the technical working paper – hydrology and hydraulic assessment (Appendix K).

6.8.1 Methodology

The flooding and hydrology assessment involved the following:

- Undertaking a desktop review of available literature, databases, aerial photography, topographic mapping and existing land use to aid in interpreting the existing hydrological conditions of waterways and floodplains within the respective study areas
- Analysing of LiDAR terrain data to determine the stormwater sub-catchment areas upstream of the proposed alignment
- Developing a detailed hydrological model using TUFLOW and Australian Rainfall and Runoff 2019 (ARR2019) guideline data and methods for comparison with the previous study's results as well as the new ARR2019 Regional Flood Frequency Estimation method. The hydrological model was run for a range of rainfall events, ranging from relatively frequent (ten per cent Annual Exceedance Probability (AEP)) to extreme (Probable Maximum Flood (PMF)), including a Climate Change estimate as per Transport's guideline Climate Change Adaptation for the Road Network
- Developing two hydraulic computer models to analyse the flood behaviour under pre and post-construction conditions to check flood immunity and impacts of the proposal.

6.8.2 Existing environment

Catchment overview

Most of the proposal lies within the floor of Hartley Valley, a rural landscape of mainly open pastureland. The overall catchment upstream of the proposal is approximately 100 square kilometres in area, with steep bushland and cliffs in the upper reaches draining to flat open pasture. Runoff from the catchment travels past the Great Western Highway into Coxs River, one of the main inflow sources of Warragamba Dam.

Waterways

Key waterways within the study area include:

- River Lett is located near the village of Hartley. Where this waterway crosses the proposal, near the existing Great Western Highway, the river is confined within steep embankments and set deeply within the terrain. The riverbanks are thickly vegetated, and the existing two-span highway bridge (approximately sixty one metres long) is above flood level for all but the largest floods
- Boxes Creek is a tributary of River Lett crosses the highway about four hundred metres west of the River Lett crossing. It has a sizable catchment of almost six square kilometres, part of which extends to the steep terrain of Hassans Walls. A four-cell box culvert (2.74 metres wide by 2.74 metres high) conveys Boxes Creek flows across the highway. Boxes Creek joins River Lett just downstream of the highway, upstream of an old timber bridge which formed the River Lett crossing of the Old Great Western Highway
- Rosedale Creek is a minor waterway that crosses the proposal near its eastern end. Its upstream catchment is about two square kilometres, consisting of bushland in its steep upper regions and rural land-use in its valley floor. This catchment has approximately ten small dams which may influence the

hydrological response depending on their water level when a rainfall peak arrives. There is also a somewhat larger dam downstream of the highway which collects runoff from the catchment prior to discharging to the main tributary of this part of Hartley Valley originating at Mount Victoria (Butlers Creek). A two-cell box culvert (3.6 metres wide by 2.4 metres high) conveys Rosedale Creek flows across the highway.

Catchment areas for the main waterways are listed in Table 6-89.

Table 6-89 Catchment Areas of the Main Waterways

Waterway	Catchment Area (hectares)
River Lett (at the Great Western Highway)	9,240
Boxes Creek (at the Great Western Highway)	590
Rosedale Creek (at the Great Western Highway)	210

Flood conditions

River Lett and Boxes Creek

River Lett and Boxes Creek have a steep longitudinal profile with flow in both River Lett and Boxes Creek confined within steep banks. Modelling shows that floodwater does not overtop the Great Western Highway under existing conditions in the one per cent Annual Exceedance Probability (AEP). The results show that Blackmans Creek Road causeway at Boxes Creek overtops in the smallest flood analysed (ten per cent AEP).

The Probable Maximum Flood (PMF) results for River Lett and Boxes Creek show overtopping of the highway at both waterways. Even though the PMF flooding is large, flows are still confined to the waterways without breakouts across floodplains. This is due in part to the steep nature of the terrain.

Rosedale Creek

Modelling of existing conditions within Rosedale Creek shows flat water within the dams that form part of the upstream catchment, but outside of these dams the watercourses are very steep. Floodwater was shown to build up at the upstream (southern) end of the existing main culvert crossing Great Western Highway. Floodwater does not overtop the highway in the one per cent AEP, however it does overtop the highway in the PMF.

6.8.3 Potential impacts

Construction

Hydrology and drainage

Key activities during construction of the proposal that may impact the nature of surface water hydrology (volume, rate, timing, duration, velocity, etc.) associated with stormwater discharges include:

- Vegetation clearance (of trees, understory and ground cover) and reduced infiltration associated with soil compaction and paving within the road corridor
- Temporary dewatering of groundwater ingress to construction excavations
- Temporary and permanent alteration or impedance of existing drainage paths and waterways which have the potential to result in localised increases in flow velocities around instream features

- Attenuated or delayed discharge of stormwater captured in temporary construction sediment basins and permanent water quality basins
- Reuse of stormwater captured in temporary construction sediment basins and permanent water quality basins
- Construction of bridge abutments on watercourse banks
- Temporary access tracks across watercourses
- Use of haul roads
- Stockpiling and ancillary storage facilities.

Potential surface water quality contaminants during construction include sedimentation from earthworks and chemicals and fuels associated with operating machinery, road surfacing and landscaping. The erosion and sedimentation control strategy and water quality protection from hazardous material spills during construction is described in Section 6.12 Contamination.

The proposal would cross several local drainage lines. During construction there is a potential for drainage lines to be temporarily blocked or diverted. Blocking or diversion of drainage lines may result in localised areas of flooding on the upstream side of the proposal and may prevent flows from reaching downstream receiving waters or dams. Diversion of drainage lines may also create localised areas of flooding and scour. These temporary impacts are expected to be minor and would be managed through the implementation of standard construction techniques.

Operation

Flooding impacts

The proposed road alignment was modelled to determine how key aspects of the design that could affect flood behaviour (such as the road embankments, basin embankments, bridges, and culverts) interact with, and potentially impact on, flood conditions along the proposed alignment.

Potential flooding impacts associated with the proposal would be confined to River Lett (including Boxes Creek) and Rosedale Creek. There are no other upstream catchments along the proposed alignment that are large enough to produce flooding.

The flood analysis results show that the proposal may impact on localised areas, however these are all within land already flooded in present day conditions. This is due to the relatively steep terrain which acts to confine the flood extent in proposed conditions to minor increases.

River Lett and Boxes Creek

Modelling results show that flood behaviour for floods up to the one per cent AEP would be unchanged. There would potentially be two areas of localised flood level increase:

- Upstream of the proposed Great Western Highway River Lett bridge
- Upstream of the Kelly Street service road stub.

Flood velocity changes would be negligible. No dwellings would be impacted by the proposal in the one per cent AEP.

Inundation duration increases would be negligible due to the minor changes in flood levels. Upstream of the proposed River Lett bridge, the results show a 50 millimetre increase in flood level in a six hour duration event. The timespan of this additional 50 millimetre rise and fall is approximately 20 minutes. There are no consequences for 20 minutes for up to 50 millimetres of additional flood level to occur on a creek bank in a one percent AEP flood.

The PMF results show significant flood level increases within River Lett of up to one metre. However, due to the steep riverbanks, the flood extent would not widen by any significant distance, and there would be no

fundamental change in flow behaviour, such as flow breakouts. The Kelly Street service road stub would slow upstream flows with a subsequent velocity increase downstream. Moving this road stub eastwards may improve flooding conditions at this location, and would be considered during detailed design.

At Boxes Creek, the PMF flood levels show an increase of up to 5.5 metres. Floodwater may build up at this location due to the proposed alignment being higher than the existing conditions, however it would not overtop the higher proposed road. All Boxes Creek flows would be conveyed through an existing culvert that would be extended under the proposed road alignment. The flood level increase would dissipate to zero due to the steep gradient of Boxes Creek within a distance of about five hundred metres from the Boxes Creek culvert. No dwellings are within the potentially impacted area, and due to the steep terrain the additional area of flood extent would be a maximum distance of 40 metres, and mostly less than 20 metres compared to existing conditions.

Although the results show that the proposal alters the flooding behaviour at Boxes Creek in the PMF, in the Design Flood Event (and even the Climate Change estimate of 0.2 per cent AEP) there would be no change to flooding conditions. The PMF is an estimate of the most extreme flood possible. Its average recurrence interval is approximately ten million years compared to one hundred years for the Design Flood Event. It is not practical nor advised to use such an extreme flood event for design. The PMF should only be used in the design of critical infrastructure such as dams, or to define the extent of flooding in order to place infrastructure outside the floodplain, such as with tunnel portals susceptible to inflows.

As discussed above, there is an existing culvert proposed to be extended that would be the sole source of conveyance for floodwater at Boxes Creek. This increases the sensitivity of culvert blockage and embankment stress during an extreme flood event. During detailed design, the height of the proposed road embankment at this location would be reviewed or alternative designs considered to eliminate or reduce this potential PMF impact. Additional flood modelling would also be undertaken during detailed design to assess the revised design. If residual risk of embankment stress remains following design review and further modelling, a dam safety check would be undertaken and further mitigation such as a debris catch upstream would be considered.

Rosedale Creek

Modelling results show that flood behaviour for floods up to the one per cent AEP would be unchanged. There is one area of potential localised flood level increase, at the upstream (southern) end of the extended Rosedale Creek culvert beneath Great Western Highway. The results show a potential flood level increase at this location of about 100 millimetres. The flood extent would extend in the order of several metres because the land is relatively steep. Most of the land potentially affected by this flood level increase is flooded under existing conditions. This affectation is mainly on private property pastureland between the existing highway embankment and the base of the adjacent dam embankment, approximately 50 metres in width and about 70 metres in length.

The one per cent AEP results show that the potential inundation duration increase at the upstream end of the Great Western Highway culvert at Rosedale Creek would be about 30 minutes for the 100 millimetres of flood level increase to rise and fall.

The PMF results show a potentially small upstream flood level increase of about 20 millimetres because floodwater overtops the highway in both existing and proposed conditions. Under proposed conditions, any floodwater that may overtop the highway would be diverted westwards along the proposed carriageways across the ridge into the next sub-catchment. This proportion of the PMF flow would reach Butlers Creek via paddocks to the west.

This flow overtopping and diversion would only occur in an extreme flood event. In the one per cent AEP (and even the climate change estimate of 0.2 per cent AEP) there would be no change to flooding behaviour other than the localised flood level increase at the culvert inlet.

Climate change

Flood level results for River Lett show that the nominated climate change event may result in an overall flood level increase of about 700 millimetres in the river (proposed minus existing, both under an increased rainfall intensity scenario). The potential flood level increase due to the proposal under the climate change scenario would be similar in pattern to the one per cent AEP, but amplified along the river to about twice the length. The predicted effects of climate change would not alter the potential flood risks associated with the proposal.

The Rosedale Creek flood level results show that the nominated climate change event may lead to an overall flood level increase of about 400 millimetres at the upstream end of the Great Western Highway culvert at Rosedale Creek. The flood level increase due to the proposal is similar in pattern to the one per cent AEP but would be amplified by about 40 millimetres. The predicted effects of climate change would not alter the flood risks for the proposal.

6.8.4 Safeguards and management measures

Table 6-90 Safeguards and management measures – hydrology and flooding

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
HF01	Operational flooding impacts	All cross-drainage structures including culverts and bridges would be constructed to cater for the 100 year ARI local and regional storm events to minimise upstream afflux.	Contractor	Detailed design	Appendix K	All
HF02	Operational flooding impacts	During detailed design, the height of the proposed road embankment adjacent to Boxes Creek would be reviewed or alternative designs considered to eliminate or reduce potential PMF impact.	Contractor	Detailed design	Appendix K	River Lett to Forty Bends
HF03	Operational flooding impacts	Additional flood modelling would be undertaken during detailed design. If residual risk of embankment stress remains adjacent to Boxes Creek, a dam safety check would be undertaken and further mitigation such as a debris catch upstream would be considered.	Contractor	Detailed design	Appendix K	River Lett to Forty Bends
HF04	Operational flooding impacts	An eastwards shift of the Kelly Street service road will be considered during detailed design to mitigate potential flooding impacts at this location.	Contractor	Detailed design	Appendix K	River Lett to Forty Bends

Other safeguards and management measures that would address hydrology and flooding impacts are identified in section 6.15 Sustainability, greenhouse gas and climate change.