# 12. Surface Water

The Surface Water Assessment examined the potential effects of the Project on surface water environments including water quality, hydrology, waterway health and beneficial uses and values.

The Project crosses the following six major or significant named watercourses: Fiery Creek, Middle Creek, Charliecombe Creek, Billy Billy Creek, Hopkins River, Green Hill Creek and would consequently require water crossing structures to be constructed at these locations. There will be new crossing structures and replacement of existing with the same type of structure, retaining or enhancing the ability to convey flood waters and avoid river health impacts.

The key risks are associated with either impacts to river health or hydraulic impacts to waterways and floodplains, due to the construction of waterway crossings and embankments. Construction of waterway crossing structures has the potential to impact on waterway health through disturbance to the bed, banks, vegetation, and aquatic fauna movement. In terms of flooding there is a requirement for the Project to be flood free and to not impact existing properties.

Specific sites where there are river health risks include the new crossing of Billy Billy Creek (Ch. 18200) where there are significant river health values. The potential disturbance of channel planform and river health values, as well as potential for fragmentation will result in specific requirements to mitigate the risk (e.g. longer span bridge). Another key risk is the requirement for Charliecombe Creek to be diverted over a length of approximately 250 metres (m) (between Ch. 14200 and Ch. 15300). The Creek flows intermittently (ephemeral), and whilst channelised has some natural diversity. The re-created diversion channel would therefore need to incorporate a high level of natural features to mitigate the potential impact.

The impact of the Project on flooding was considered low for the majority of waterway crossing locations, other than a number of specific locations where identified properties are potentially affected.

Option 2 is marginally the preferred option in relation to surface water impacts as it would involve the least potential impact on flooding and least disturbance to significant waterways.

## 12.1 EES Objectives

The EES objectives relevant to surface water are:

- *To protect catchment values, surface water and groundwater quality, stream flows and floodway capacity, as well as to avoid impacts on protected beneficial uses*.

This chapter discusses the surface water environment within the Project area, including flooding, the wider catchment and waterways to be crossed by the highway. The potential impacts on surface water have been assessed as well as management measures proposed to be implemented to minimise these impacts. More specifically, this chapter:

- Characterises surface water environments and drainage features (including tributaries, drains and drainage reserves) in the project area in terms of water quality, hydrology and related beneficial uses and values;
- Identifies and assesses potential short and long term effects of the construction and operation of the duplicated highway on surface water quality and hydrology, surface drainage, flooding, the quantity and quality of surface runoff and river health values of the waterways, tributaries, drains, wetland systems or drainage reserves that may be crossed, including the Hopkins River, Fiery Creek, Middle Creek, Charliecombe Creek, Billy Billy Creek and Green Hill Lake. Consideration should also be given to potential effects on the proclaimed special water supply catchment areas located near the project area;
- Identifies measures to avoid, mitigate and manage any potential effects, including design features for the road, preventative techniques for construction and measures to reinstate affected waterways and drains;
- Describes likely residual effects of road construction and operation activities on waterways in the project area at a level of detail proportionate to the risk affected assets.
- Evaluates the effects of preferred waterway crossing methods and relevant alternatives;
- Addresses the environmental management practices to be employed at waterway crossings in relation to disturbance of stream beds and banks, construction and removal of temporary barriers and crossings, release of diverted stream flow to watercourse during crossing construction and maintenance of sediment control facilities;
- Addresses environmental management practices to be employed generally along the road alignment for activities, especially in disturbed areas within the construction footprint for sediment control and water quality protection; and

- Addresses contingency plans, in the event of failure of the proposed control measures (i.e during heavy rainfall or flooding).

This chapter is based on a surface water assessment completed by GHD Pty Ltd (2012e). The detailed assessment report is included in Technical Appendix G.

## 12.2 Study Area

The surface water study area encompasses a corridor extending approximately 1500m to the north and south of the edge of the existing Western Highway. The study area is shown in Figure 12-1. The greater catchment area has been considered.

## 12.3 Methodology

To assess the surface water environment in the study area, a combination of desktop and field based assessment was completed, including the following tasks:

- Description of the catchment systems and water courses that the Project may impact
- Review of information from flood modelling undertaken by Bonacci Water
- A river health assessment.

The waterways were classified as major, significant or minor for the purpose of defining impact significance. Minor waterways are undefined tributaries often without permanent water; significant waterways are those with a defined channel, some in-stream vegetation and some sections of permanent water; and major waterways are named and have a well-defined channel, intact vegetation and have notable in-stream features contributing to river health.

The magnitude of impact from physical disruption took into account the size of the area disrupted, the likely extent of impact into adjacent areas of watercourse, and the expected recovery time.

A detailed description of all reports reviewed for the assessment is included in Technical Appendix G.

## 12.4 Legislation and Policy

The relevant legislation and government policies related to surface water are shown in Table 12-1.

**Table 12-1 Relevant legislation and government policies**

| Legislation / Policy | Description |
|---|---|
| State | |
| *Water Act 1989* | Any works which intercept waterways and their floodplains must be undertaken in accordance with the requirements of the *Water Act 1989*.<br>The Glenelg Hopkins Catchment Management Authority (GHCMA) is the responsible authority for issuing licences for works on waterways and permission would be required from GHCMA for the crossing of waterways for the Project. |
| State Environment Protection Policy (Waters of Victoria) (2004) | The State Environmental Protection Policy (SEPP) (Waters of Victoria (WoV)) identifies the beneficial uses of waterways, which must be protected.<br>Works undertaken for the Project on or near waterways would need to be managed to reduce the risks to aquatic ecosystems and other beneficial uses of the waterway, as defined by the SEPP (WoV). |
| Ararat and Pyrenees Planning Schemes | The Ararat and Pyrenees Planning Schemes include a Land Subject to Inundation Overlay (LSIO), Environment Significance Overlay (ESO) and Vegetation Protection Overlay (VPO). The purpose of these overlays are as follows:<br>▪ LSIO: Ensure that development within the 1 in 100 year flood extent maintains the free passage of floodwaters, and protects water quality in accordance with the SEPP (WoV).<br>▪ ESO: To ensure development is compatible with identified environmental values.<br>▪ VPO: To ensure that development minimises impact to significant vegetation. |
| Glenelg Hopkins River Health Strategy (2004 – 2009) | The Glenelg Hopkins River Health Strategy (2004 – 2009) provided a five year blue print for improving the health of rivers and creeks within the catchment. The main aim of the River Health Strategy were to:<br>▪ Identify and prioritise actions for river restoration, considering environmental, social and economic values;<br>▪ Identify threats to waterway health and assess the level of risk based on the interaction between threats and values;<br>▪ Identify priority actions required to protect and enhance high value river reaches;<br>▪ Identify opportunities to actively involve the community in river health; and<br>▪ Provide the strategic framework for investment in river health for the five year period. |

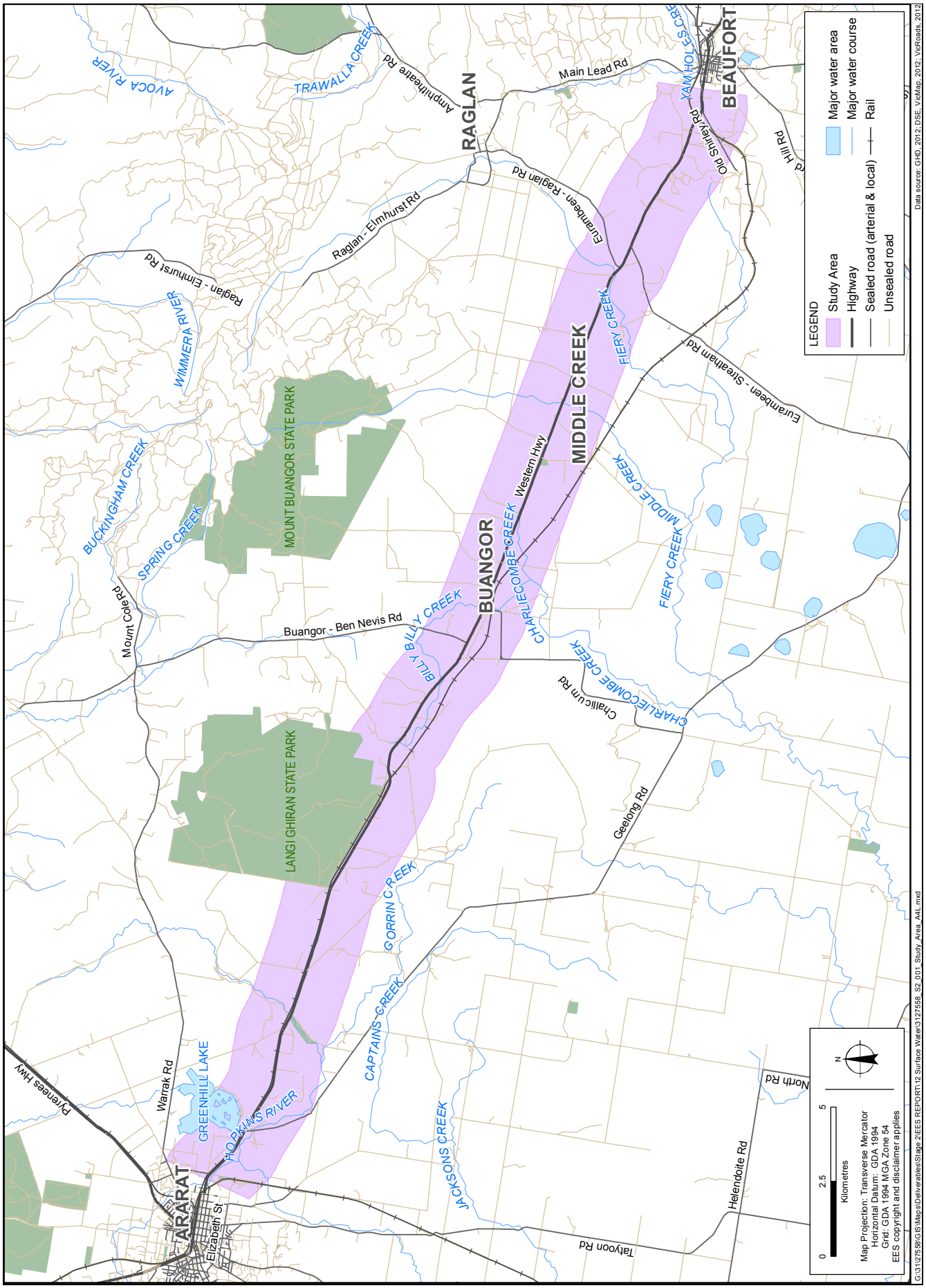


**Figure 12-1 Surface Water study area and named waterway crossings**

## 12.5 Existing Conditions

### 12.5.1 Catchment

The project is located within the upper Hopkins Basin Catchment. Apart from relatively small areas of remnant forest, the catchment has been substantially cleared of native vegetation and now supports significant agricultural activity. The Glenelg Hopkins River Health Strategy 2004-2009 (RHS) does not identify any sub-catchments for restoration, however some reaches are recognised for maintaining high social and economic values. There are no proclaimed special water supply catchments within the project area.

### 12.5.2 Waterways

The environmental quality of the various waterways within the identified catchment systems varies between reaches. The project crosses the major or significant named waterways described in Table 12-2.

**Table 12-2 Summary of named waterway characteristics**

| Waterway | Description and ecological features | Current structure |
|---|---|---|
| Fiery Creek | Straightened channelized creek with exposed banks with slumping in some sections. Low vegetation diversity. Channel choked with reeds. | Bridge |
| Middle Creek | Perennial waterway with well vegetated channel (including willows (invasive weed species)) and pool-riffle features | Culvert |
| Charliecombe Creek | Ephemeral waterway, well vegetated in patches but predominately cleared banks with uncontrolled stock access | Bridge |
| Billy Billy Creek (two crossings ) | Ephemeral waterway with pool-riffle features, well vegetated banks and habitat features (eg large woody debris). Aquatic surveys (described in Chapter 13 (Biodiversity and Habitat)) found abundant Dwarf Galaxias, which is listed as endangered under the *Environment Protection and Biodiversity Conservation Act 1999*. | Bridge and Culvert |
| Hopkins River | Large channel with variable in stream features and bank conditions alternating between dense vegetation and exposed banks. Some high value features | Bridge |
| Green Hill Creek | Ephemeral, channelised waterway that connects Green Hill Lake with the Hopkins River. Highly disturbed, dominated by pastoral grasses | Culvert |

The SEPP (WoV) defines the beneficial uses to be protected in the major waterways, which are based on existing water quality.

Table 12-3 shows the beneficial uses to be protected (under Murray and Western Plains in the SEPP (WoV) Main Schedule (1970)) for the waterways in the study area. These beneficial uses, where they are relevant, need to be protected from potential impacts resulting from construction and operation of the Project.

No information on the existing water quality is available. The objectives in the SEPP (WoV) are listed below. Any discharges into waterways from the construction and operation of the Project must not cause the following criteria to be exceeded.

- Dissolved oxygen (% saturation): 85 – 110.
- Electrical conductivity at 25ºC: 500 µS/cm (75$^{th}$ percentile)
- pH: 6.5 – 8.3
- Turbidity: 10 NTU (75$^{th}$ percentile).

**Table 12-3 Beneficial uses to be protected for named waterways**

| Beneficial Use | Applicable Waterways |
|---|---|
| Maintenance of Aquatic Ecosystems that are slightly to moderately modified | All waterways in the study area |
| Primary contact recreation | All waterways in the study area |
| Secondary contact recreation | All waterways in the study area |
| Aesthetic enjoyment | All waterways in the study area |
| Indigenous cultural and spiritual values | All waterways in the study area |
| Non-indigenous cultural and spiritual values | All waterways in the study area |
| Agriculture and irrigation | All waterways in the study area |

| Beneficial Use | Applicable Waterways |
|---|---|
| Aquaculture | Any waterways in the study area that are used for aquaculture |
| Industrial and commercial use | Any waterways in the study area that are used for industrial or commercial purposes |
| Human consumption after appropriate treatment | Any waterways in the study area from which water for drinking purposes is drawn |
| Fish, crustacea and molluscs for human consumption | Any waterways in the study area from which fish, crustacea or molluscs for human consumption purposes are drawn |

### 12.5.3 Flooding

Preliminary flood modelling was undertaken by Bonacci Water (Bonacci Water, 2012). The 1 in 100 year flood modelling outputs indicates where the existing highway is flood affected and where various alignment options intercept areas of flood inundation. The main observations are:

- Fiery Creek floodplain is partly obstructed by the existing highway, and whilst the bridge opening has adequate capacity there is shallow backwater flooding upstream of the road embankment.
- Middle Creek consists of a complex braided floodplain and the existing highway embankment is a significant obstruction leading to extensive backwater flooding affecting properties immediately upstream. There are inadequate culvert connections across the highway, leading to extensive flooding across the highway over a width of approximately 700m.
- Charliecombe Creek has a complex interaction with the existing highway as several tributaries converge with Charliecombe Creek. There is backwater flooding resulting in the existing highway overtopping, but the nearby properties upstream remain unaffected by flooding.
- Billy Billy Creek at Buangor includes extensive backwater flooding and shallow flooding across the existing highway. The alignment options will cross Billy Billy Creek upstream of the existing highway and will require new structures.
- Billy Billy Creek west of Buangor includes extensive backwater flooding behind the existing highway, and some overtopping of the road. There is also significant flooding at several locations along the existing highway from upstream flow paths of Billy Billy Creek.
- The Hopkins River has backwater flooding behind the existing highway and railway embankment.
- There is backwater flooding behind the length of the existing highway south of Green Hill Lake, and from Green Hill Creek to the confluence of Hopkins River as it runs adjacent to the south of the highway.
- There is overtopping of the existing highway between Ararat and Green Hill Lake, due to overflow from Cemetery Creek combining with local catchment flows.

## 12.6 Impact Assessment

### 12.6.1 Key Issues

The Project would involve replacing or constructing new culverts and bridges at most waterway crossings. This associated disturbance could result in changes to the ecological or geomorphological nature of the waterway as well as floodplain characteristics.

The key issues with surface water are associated with either impacts to river health, water quality, or hydraulic impacts to waterways and floodplains.

Following construction work, there would be opportunities to enhance waterway condition and ecological health through revegetation and stabilisation methods. The Project alignment would be constructed to be above the 1 in a 100 year flood level, and there is also opportunity for improving flood conditions adjacent to the road.

### 12.6.2 Impact Pathways

The two Project alignment options would cross six named waterways at the locations described in Table 12-2, and shown in Figure 12-1. The new crossings to be constructed would typically be similar to the existing crossings of these waterways. For example, where the current highway has culverts, the duplicated highway would also include the construction of culverts.

#### 12.6.2.1 Physical Disturbance to Waterway (Channel form and vegetation)

Construction could result in local removal of riparian and in-stream vegetation at waterway crossing locations. This could increase the potential for channel erosion, impacting bed and bank stability. Riparian vegetation can be degraded by increased fragmentation, weed invasion and the loss of vegetation diversity.

At the proposed crossings of the Hopkins River and Billy Billy Creek, destabilisation of waterway banks, the channel profile and loss of vegetation and habitat features may also occur.

The Charliecombe Creek crossing (Ch. 14200 – Ch. 15300) would involve the carriageway overlying 250m of the present creek channel. For this reason and to reduce flooding impacts upstream, the creek would need to be realigned through an adjacent farm property. The existing channel has features which promote river health including established streamside vegetation, and within channel elements such as large woody debris, riffles and persistent pools. The loss of these elements could therefore degrade river health.

In order to mitigate such an impact, construction of the new realigned section would need to incorporate recreations of natural features such as pool and riffle sequences, bed control structures, bank stabilisation, and revegetation.

#### 12.6.2.2 Water Quality

Where construction activities are undertaken in, near or over waters, Construction Environmental Management Plan(s) would be prepared to protect beneficial uses in accordance with any permit, the SEPP (WoV), and its schedules and best practice guidelines. Mitigation measures would include using silt fences and sediment traps.

In addition to potential short term impacts on water quality from construction activities, there is potential for longer term impacts from stormwater runoff containing sediment, nutrients, heavy metals, petroleum based produces, organic compounds and rubber from the proposed highway entering waterways.

Given that the road area generating runoff in each of the catchments is low, at 1-5%, and the catchments are generally highly modified with dams and unfenced grazing access to watercourses, the relative water quality impact of the highway would be low. In addition, the design of the road drainage would meet the requirements of VicRoads Integrated Water Management Guidelines (VicRoads, 2011), and this would reduce the likelihood of long term impacts on water quality from the Project.

#### 12.6.2.3 Stream bed degradation and aggradation)

Construction activity could result in a short term downstream increase in sediment loading as a result of channel disturbance and removal of stabilising bed and bank vegetation.

Stream bed aggradation is a process of net sediment deposition within a stream channel that results in the ongoing rise in bed elevation. This can lead to the decline in waterway health by smothering of bed forms and associated loss of bed diversity including pools, riffles and in-stream structure.

Bed degradation refers to the lowering of the stream bed elevation through ongoing erosion processes. This can impact waterway health through the loss of existing in-stream habitat features, and can result in the production of sediment that may have adverse downstream impacts.

The construction of culvert or bridge crossings also has the potential to accelerate stream bed degradation by changing river flow or disrupting sediment transport processes. The risk of increased erosion potential is considered to be low given that flow constrictions already exist at each waterway crossing.

Due to management measures including the construction of bed control and/or bank protection works to protect waterways the impact of the Project on bed degradation and aggradation is expected to be minor.

#### 12.6.2.4 In-stream Barriers

In-stream barriers such as culverts can disconnect the upstream and downstream waterway environments preventing the passage of aquatic organisms, in-stream sediments and nutrients. This can result in the loss of fish populations by preventing the re-colonisation of stream reaches with species following disturbance, result in the isolation of fish populations and prevent completion of fish breeding cycles.

For named waterways, the bridges would be designed so that the piers are not placed in the low flow channel of the creek bed. Where possible, bridge piers would be set back to allow for wildlife corridors along waterways. At the minor waterway crossings, culverts would be placed at or slightly below the bed level, therefore minimising the fragmentation of the waterway. Due to the proposed management measures, it is expected that the Project will have a insignificant to minor impact on fish passage.

#### 12.6.2.5 Flooding

The Project could exacerbate flooding through afflux, or impacting floodplain function.

Afflux refers to the rise in water level on the upstream side of a bridge or obstruction, such as a blocked culvert. There is the potential that the project results in afflux in areas upstream of new culvert and bridge crossings during flood events. The impact of this would vary depending on catchment land-uses.

Floodplains accommodate flood flows that are beyond the bankfull capacity of the channel, and also provide temporary storage of flood waters, lowering the size and impact of floodwaters downstream. Floodplains also play an important ecological role in both land and water based ecosystems, and provide for the transfer of nutrient inputs.

Construction of the Project may result in changes to floodplain characteristics, impacting its functioning and flow conveyance during floods. The Project seeks to achieve a 1 in 100 year flood standard for the road.

Where the new proposed alignment is a deviation from the existing highway, there is generally no

significant or direct flood impacts to dwellings. The crossings of Middle Creek and Charliecombe Creek that are duplication of the existing crossings have properties immediately upstream of the existing highway that may be impacted by the modified conditions (mitigation measures are presented in Section 12.8). The Project alignment, whether following or deviating from the existing alignment, would be constructed to be above the 1 in a 100 year flood level.

During the detailed design phase, prior to construction commencing, hydraulic modelling would be undertaken to ensure the waterway crossings do not increase flows, depths and velocities across property boundaries up to and including the 100 year flood event. This is also required by the GHCMA 'Works on Waterways' approval process.

Initial hydraulic modelling has been undertaken for crossings with a potentially higher flood risk including Middle Creek and Charliecombe Creek, and the preliminary results indicate that the flood risks can be managed.

The potential flooding impacts for the significant crossings are summarised in Table 12-4.

**Table 12-4 Summary of Potential Flooding Impacts at Named Waterway Crossings**

| Waterway | Crossing ID | Change in potential flooding impact |
|---|---|---|
| Fiery Creek | WB211 | The potential impact from flooding is low, and no change is necessary to the existing highway levels and waterway crossing area. |
| Tributary of Middle Creek | WC212 | The potential impact from flooding is low, however the existing highway is overtopped and the upgraded highway will need to be raised and culvert opening increased. A larger waterway opening is proposed which would reduce flow impedance (afflux). |
| Middle Creek and tributary of Middle Creek | WC213 | The potential impact from flooding is medium, and the project would involve raising of the existing highway and larger waterway openings to reduce afflux and impacts to upstream properties (to be confirmed in detailed design from more rigorous hydraulic modelling). |
| Tributary of Charliecombe Creek | WB215 | The potential impact from flooding is medium, and therefore a larger waterway opening is proposed which would reduce afflux flooding potential but will need to consider potential downstream impacts (to be confirmed in detailed design from more rigorous hydraulic modelling). |
| Charliecombe Creek | WB216<br>WB217 | The potential impact from flooding is medium, and therefore a larger waterway opening is proposed which would further reduce the very low flood potential. Realignment may also be required where the alignment overlays the current creek channel (to be confirmed in detailed design from more rigorous hydraulic modelling). |
| Tributaries of Billy Billy Creek | WC219, WC220, WC221 | The potential impact from flooding is low, where the Project alignment (in both Option 1 and Option 2) deviates away from the existing highway, and involves an interchange. It is within the floodplain, and would require a new crossing of the tributary main flow path. Adequate openings would be provided for flood flow conveyance. |
| Billy Billy Creek | WB225, WB226 | The potential impact from flooding is low, where the project involves a deviation of the carriageways within the floodplain as above. Crossing structures would be provided for flood flow conveyance. |
| Billy Billy Creek | WB228 | The potential impact from flooding is low, however the existing highway is overtopped from flooding and the upgraded highway will need to be raised and waterway opening increased. |
| Hopkins River | WA243 | The potential impact from flooding is low, however no change is necessary or proposed to the existing highway level, or waterway crossing area. |
| Green Hill Creek | WB244 | The potential impact from flooding is low, however no change is necessary or proposed to the existing highway level, or waterway crossing area. |
| Cemetery Creek (overflow) | WC245 | The potential impact from flooding is low, however the existing highway is overtopped and the upgraded highway will need to be raised and culvert opening increased |

## 12.7 Risk Assessment

An environmental risk assessment was undertaken on the short listed alignments to identify key environmental issues associated with the construction and operation of the Project. The methodology for this risk assessment has been described in Chapter 4.2 (EES Assessment Framework). A risk assessment report that explains the process in detail and contains the complete project risk register has also been included as Technical Appendix Q. Table 12-5 shows a summary for surface water of:

- The impact pathways identified.
- A description of the consequence.

**Table 12-5 Surface Water Risks**

| Risk No. | Impact Pathway | Consequence Description |
|---|---|---|
| SW1A | Construction activities at Hopkins River and Billy Billy Creek at Ch. 18200 resulting in disturbance of channel planform, geometry and river health values. | Local destabilisation of waterway banks, channel profile and pools.<br>Reduction in aquatic and terrestrial habitat value in the vicinity of the crossing location. |
| SW1B | Construction activities on Billy Billy Creek at Ch. 20950 (Option 1) and Charliecombe Creek at Ch. 14400 & 14700 (Option 1 & 2) resulting in disturbance of channel planform, geometry and river health values | Service road overlays 250m of waterway banks, channel profile and pools.<br>Reduction in aquatic and terrestrial habitat value in the vicinity of the crossing location. |
| SW1C | Construction activities on crossings of all other named waterways resulting in disturbance of channel planform, geometry and river health values. | Local destabilisation of waterway banks, channel profile and pools.<br>Reduction in aquatic and terrestrial habitat value in the vicinity of the crossing location. |
| SW1D | Construction activities on all other waterways resulting in disturbance of channel planform, geometry and/or river health values. | Local disturbance or destabilisation of waterway banks and channel profile.<br>Reduction in aquatic and terrestrial habitat value in the vicinity of the crossing location. |
| SW2 | Construction of the Western Highway results in the change in hydraulic conditions and geomorphological response at crossing locations. | Increased erosion potential due to the concentration of flow through a culvert or beneath a bridge. |
| SW3A | Construction of the crossing at Billy Billy Creek at Ch. 18200 results in fragmentation of river health values at crossing locations. | Restrictions to aquatic and terrestrial fauna movement, impediments to future waterway and catchment rehabilitation efforts. |
| SW3B | Construction of the Western Highway results in fragmentation of river health values at crossing locations. | Restrictions to aquatic and terrestrial fauna movement, impediments to future waterway and catchment rehabilitation efforts. |
| SW4A | Construction activities result in increased sediment and contaminant loadings to Hopkins River and Billy Billy Creek at Ch. 18200. | Degradation of water quality in receiving waterways, impact on aquatic ecosystems. |
| SW4B | Construction activities result in increased sediment and contaminant loadings to all other named waterways. | Degradation of water quality in receiving waterways, impact on aquatic ecosystems. |
| SW4C | Construction activities result in increased sediment and contaminant loadings to all other waterways. | Degradation of water quality in receiving waterways, impact on aquatic ecosystems. |
| SW5A | Operation of the Western Highway road surface results in increased stormwater, sediment and contaminant loadings to Hopkins River and Billy Billy Creek at Ch. 18200. | Increase in quantity of stormwater runoff compared to the existing flow regime.<br>Degradation of water quality in receiving waterways, impact on aquatic ecosystems. |
| SW5B | Operation of the Western Highway road surface results in increased stormwater, sediment and contaminant loadings to all other named waterways. | Increase in quantity of stormwater runoff compared to the existing flow regime.<br>Degradation of water quality in receiving waterways, impact on aquatic ecosystems. |

| Risk No. | Impact Pathway | Consequence Description |
|---|---|---|
| SW5C | Operation of the Western Highway road surface results in increased stormwater, sediment and contaminant loadings to all other waterways. | Increase in quantity of stormwater runoff compared to the existing flow regime.<br>Degradation of water quality in receiving waterways, impact on aquatic ecosystems. |
| SW6B | Construction of the Western Highway results in changes to the floodplain characteristics for [Minor flood risk] | Increased afflux and extent of upstream flooding and/or redistribution of flows or local drainage results in a slight increase in flooding at a rural scale. |

In assessing the impact to surface water, just over half of the risks associated with the Project have been assigned a medium risk rating. There are necessary works to construct bridges which have the potential to reduce river health through disturbance to the bed, banks, habitat and water quality. There is also a medium risk of changes to floodplain characteristics.

Management and mitigation measures have been identified to address these issues and as a result, it is concluded that the risk to the surface water environment as a result of the construction and operation of the Project would be low to negligible. In some instances, the already low flood risk would be reduced further, providing a small benefit.

## 12.8 Environmental Management Measures

VicRoads has a standard set of environmental management measures which are typically incorporated into their construction contracts for road works and bridge works. These measures have been used as the starting point for the assessment of construction related risks and are described in detail in Chapter 21 (Environmental Management Framework). In some instances, additional Project specific environmental management measures have been recommended to reduce risks.

Management measures specific to each identified surface water risk, and the residual risk rating after environmental management measures have been applied, are outlined in Table 12-6.

**Table 12-6 Surface Water Environmental Management Measures and Residual Risk**

| Risk No. | Environmental management measures | Residual risk |
|---|---|---|
| SW1A | Waterways upstream and downstream of the road would be protected from scour. Appropriate measures would be in place to prevent scour for flows of not less than the design drainage flow.<br>Waterways would be realigned where required to maintain hydraulic capacity and allow appropriate reinstatement of waterway values.<br>Construction of bridge spans longer than required for flow conveyance in order to bridge areas of high river health value. | Low |
| SW1B | As above | Low |
| SW1C | As above | Low |
| SW1D | As above | Negligible |
| SW2 | There is no requirement for additional management measures beyond the standard controls (i.e. appropriately sized waterway openings and downstream bed and ban protection works) | Low |
| SW3A | Where a waterway has the potential to offer passage of aquatic fauna the road crossing would be designed in a manner that would not discourage fauna passage. | Low |
| SW3B | As above | Negligible |
| SW4A | Water quality upstream and downstream of works would be monitored.<br>Soil conservation measures would be employed on site to minimise the amount of sediment mobilised.<br>Works would be scheduled to avoid working in flowing waterways where possible.<br>Sediment basins would be designed to 'best practice' standard and sized specifically for each site.<br>Water quality treatment measures would collect and treat runoff from all pavement areas to the required levels prior to discharging into surrounding drainage networks and / or waterways. | Low |
| SW4B | As above | Low |

| Risk No. | Environmental management measures | Residual risk |
|---|---|---|
| SW4C | As above | Negligible |
| SW5A | Stormwater runoff from the road pavement would meet the water quality performance criteria requirements of the SEPP (WoV).<br>Best practice pollution reduction targets achieved.<br>During operation VicRoads would comply with Water Sensitive Road Design practices, including regular maintenance of design features intended to capture and treat stormwater run-off from the road. | Low |
| SW5B | As above | Negligible |
| SW5C | As above | Negligible |
| SW6B | Drainage systems would cater for the design storm event (1 in 100 year ARI) and would have sufficient capacity to accommodate the design drainage flow.<br>Compensation works for loss of flood plain storage where required due to a risk of increasing flood levels. | Negligible |

### 12.8.1 Residual Risks

Following implementation of the proposed mitigation measures there are not expected to be any significant impacts. The overall residual risk to surface water is low to negligible. In some instances the project would provide a small benefit by further reducing any flood risk and improving the existing waterway condition through rehabilitation following construction.

## 12.9 Conclusion

The Project crosses six named waterways: Fiery Creek, Middle Creek, Charliecombe Creek, Billy Billy Creek, the Hopkins River and Green Hill Creek. The Project would require water crossing structures to be constructed. Existing watercourse crossing structures would typically be replaced with a similar type of crossing structure (for example a culvert would be replaced with a culvert) which would retain or enhance the ability to convey flood waters and avoid erosion. New waterway crossing structures where the Project is a deviation from the existing highway will need to meet both flooding and river health requirements.

Potential impacts from the construction of these waterway crossings include potential impacts on waterway health through disturbance to the bed, banks, vegetation, and aquatic fauna movement, however with the proposed mitigation measures as listed in Table 12-6, it is expected that the impacts on these waterways would be low.

The project will require a new crossing of Billy Billy Creek (Ch. 18200) where there are significant river health values. The potential disturbance of channel planform and river health values, as well as potential for fragmentation will result in specific requirements to mitigate the risk (e.g. longer span bridge). The Project would also require a 250m section of Charliecombe Creek be diverted. The Creek flows intermittently (ephemeral), and whilst channelised has some natural diversity. The re-created diversion channel would therefore need to incorporate a high level of natural features to mitigate the potential impact. With the proposed mitigation measures it is expected that the potential impacts to both Billy Billy Creek Charliecombe Creek would be low.

The Project also has the potential to alter floodplain characteristics and impact on rural property dwellings. Mitigation measures via appropriate crossing design (to be determined from future detailed hydraulic modelling) can be achieved to reduce the flood risk to low, with the further potential to reduce existing flood levels, providing a small benefit.

As a result of the surface water assessment and proposed mitigation measures for the identified risks, it is concluded that the impact to the surface water environment from the construction and operation of the Project would be low to negligible.

Option 2 is the marginally preferred option in relation to surface water impacts due to least potential impact on flooding and least disturbance to significant waterways.