12. Surface Water

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

The proposed alignment follows the existing highway on either side of Great Western. It crosses four significant watercourses including Concongella Creek (7 crossings), Allanvale Creek, Robinsons Creek and Donald Creek, and 28 minor waterways. Where the proposed alignment deviates from the existing highway to bypass Great Western, there are there new crossings proposed of significant waterways (two of Concongella Creek and one of Allanvale Creek).

Surveys of the waterways were undertaken by Ecology Partners (2012) and no national or state significant aquatic species were identified.

Existing waterway crossing structures would be upgraded and duplicated with a similar type of crossing structure (for example a culvert would be replaced with a culvert), retaining or enhancing the ability to convey flood waters and minimise river health impacts.

For locations where there are existing crossings of significant waterways the river health impacts are considered to be minor. This is on the basis that there are existing crossings and the relative disturbance to the waterway affects is a relatively small area. Through the mitigation measures proposed for the project, the impacts could be managed.

North of the crossing of Concongella Creek at Armstrong (Ch. 8200, WA323), the proposed alignment is located parallel and over 140m of the creek. This would require the realigning of the creek into the adjacent paddock.

For locations where there are existing crossings of significant waterways (other than Concongella Creek at Ch. 8200) the river health impacts are minor, predominately on the basis of there being an existing crossing already causing a river health impact.

In two locations where new crossings are proposed and in the location where realignment of Concongella Creek is proposed, the impacts are considered to be moderate. However with appropriate measures develop through detailed design the consequence could be reduced from moderate to minor.

Most of the study area is located within the Concongella Creek subcatchment. Concongella Creek is the predominant waterway in the project area with many tributaries, which flow north westerly, and cross the existing highway in a number of locations.

Overall, the preliminary modelling indicates that the level of flood protection for the existing road is relatively low and demonstrate that:

- the existing highway restricts flood waters at a number of waterway crossings;
- the modelled 100 year ARI flood extent upstream of the existing highway stretches for several hundred metres affecting property and dwellings in some locations;
- there are a number of crossings where a significant portion of flood waters currently overtop the existing highway.

Construction of the Project would result in changes to floodplain characteristics. Changes to the characteristics of Concongella Creek and its tributaries could result in potential impacts to rural properties and Great Western.

There is the potential to impact floodplain function and flow conveyance, particularly during peak events. This is because the existing highway is flood affected, providing some attenuation and diversion of flows. However, the Project seeks to protect the road from flooding and cause no afflux.

The potential flooding impacts can be summarised as follows:

- Potential flooding impacts to Great Western township would be Major (given the township scale affected) but can be reduced to Minor subject to detailed flood modelling and detailed design of the road and waterway crossings.
- Potential flooding impacts to rural properties with dwellings at significant crossing locations would be moderate, but can be reduced to minor subject to detailed flood modelling and detailed design of the road and waterway crossings.
- Potential flooding impacts at rural properties with no dwellings at significant crossing locations are minor.
- Potential impacts to minor waterways crossings were considered to be minor.

The preliminary flood modelling showed that the Project could be implemented without worsening the flooding impacts at Great Western, subject to mitigation measures to be implemented to restrict flood waters. Detailed design of the road and waterway crossings, and flood modelling would be required to confirm where and how restricting the flows upstream would benefit Great Western.

Selection of appropriate waterway openings sizing and areas for storage of flood waters would require:

- Detailed survey of the road level, waterway crossings and the floor levels of houses in potentially affected areas;
- Further hydraulic assessments of waterway crossings and iterative flood modelling to inform the development of the crossing designs to meet the project criteria;
- Detailed design of carriageways and waterway crossings; and
- Ongoing consultation with the Catchment Management Authority, local Council and potentially affected landowners.

Overall, the Project would provide opportunities to improve existing conditions of waterway reaches within the vicinity of the works, as well as improve existing fragmentation caused by the existing highway by redesigning crossings (eg by oversizing waterway crossings). The Project could also provide water quality treatment outcomes that are better than existing conditions.

12.1 EES Objectives

The EES evaluation objective relevant to surface water is:

- *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 describes the surface water environment within the study area, and discusses the potential effects of the Project including water quality, flooding, waterway health and impacts on beneficial uses and values. This is provided in the context of the State Environment Protection Policy (Waters of Victoria), and other water-related legislation, policies and strategies. More specifically, this chapter addresses the following requirements of the EES Scoping Requirements:

- Characterise 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;
- Identify and assess potential short- and long-term effects of the construction and operation of the duplicated highway on surface water quality and hydrology, 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 Allanvale Creek, Cobey Creek, Concongella Creek, Donald Creek, Hyde Park Creek and Robinsons Creek. Consideration should also be given to potential effects on the proclaimed special supply catchment areas located near the project area;
- Identify proposed 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; and
- Describe likely residual effects of road construction and operation activities on waterways in the project area, at a level of detail proportionate to the risk to affected assets.

This chapter is based on the Surface Water Impact Assessment report completed by GHD (2012e). The assessment report is included as Appendix G.

12.2 Study Area

The surface water study area encompasses a corridor extending 1500 metres (m) either side (east and west) of the existing highway, except around Great Western where the study area extends up to 1800m (encompassing the extent of new alignment possibilities). The study area and major waterway crossings are shown in Figure 12-1.

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 that the Project may impact and the catchment characteristics including land use or catchment activities.
- Identification and characterisation of existing watercourses (or “surface water systems”) within the study area that may be impacted from the Project.
- Identification of waterway characteristics – number and extent of waterways within the study area as well as considering the status of river health of the catchment system (including downstream receiving waterway) and potential to impact on waterway health and local conditions such as loss of habitat, aquatic invertebrates and riparian vegetation.
- Identify floodplain characteristics – number and extent of waterways within the study area that may impact floodplain characteristics and potential to change the flow hydraulics at waterway crossings as well as encroachment on the floodplain and change of flood flow characteristics.

- Hydrologic and floodplain assessment – A concurrent flood study was undertaken by UWCS/TGM (2012) as commissioned by VicRoads for the existing Western Highway corridor. The following information from this preliminary investigation has informed the impact assessment:
  - The catchment delineation and hydrology assessment to determine existing conditions at the crossing locations; and
  - Output from preliminary 2D floodplain hydraulic modelling including 100 year average recurrence interval (ARI) flood extents and depths.
- Waterway assessment – The assessment was based on the current conditions in the Glenelg Hopkins River Health Strategy, Wimmera River Health Strategy and other relevant documents. It was also based on understanding the long term management objectives and regional significance of the waterways. A desktop condition assessment was undertaken using aerial photography and topographical information, as well as interpreting other commercially available resources. This was followed by a field assessment of existing waterway crossings.

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

Concongella Creek, Western Highway Crossing (WB323)

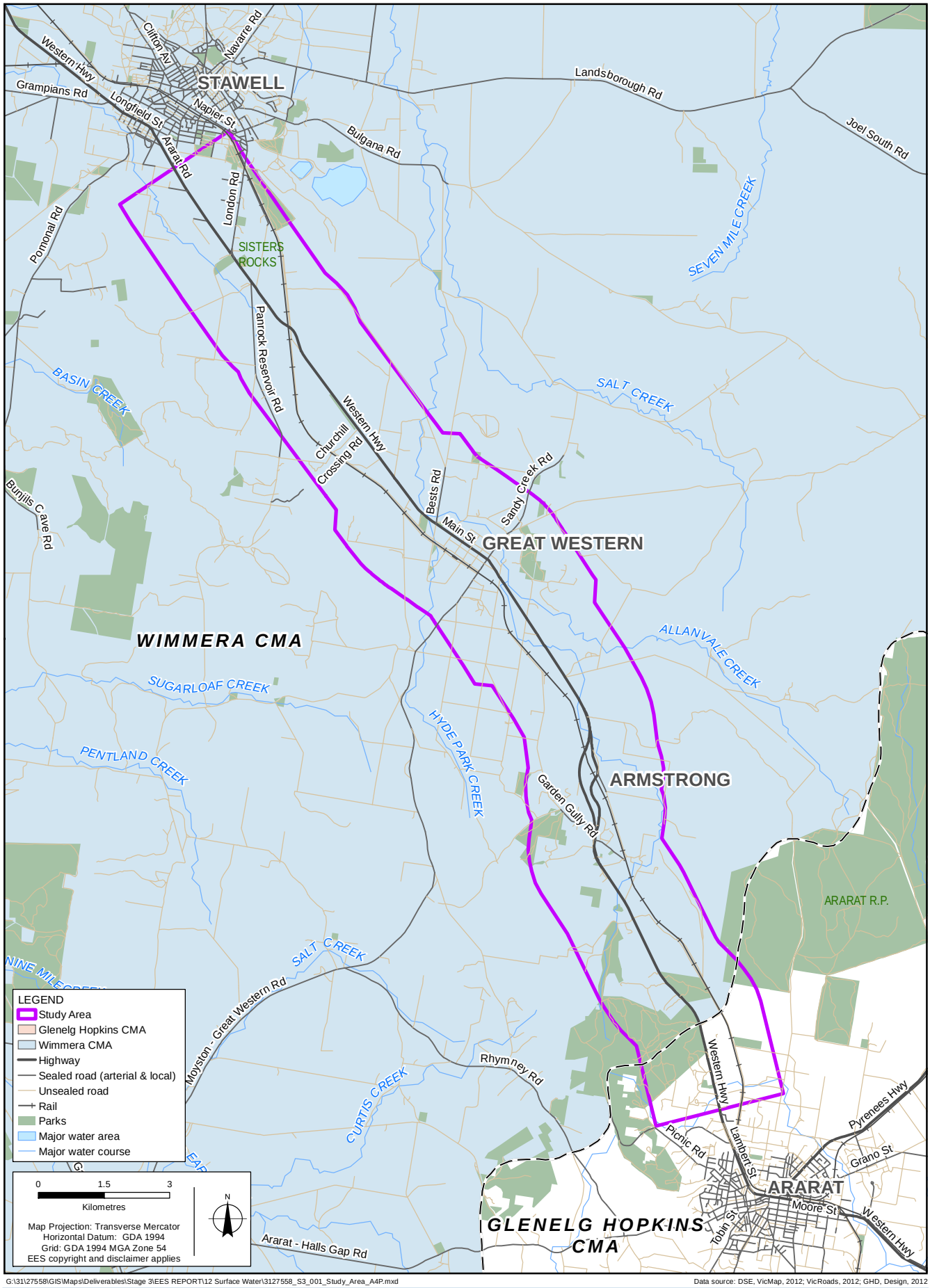

Figure 12-1 Surface Water Study Area and Named Waterways

12.4 Legislation and Policy

The relevant legislation and government policies that apply to surface water assessment within the study area are shown in Table 12-1.

Table 12-1 Relevant Surface Water Legislation and 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*. The Wimmera Catchment Management Authority (WCMA) is the responsible authority for issuing licences for works on waterways for most of the Project area and permission would be required from Glenelg Hopkins CMA for the crossing of waterways for the Project. A small part of the south-eastern end of the Project area is within the GHCMA region.
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. 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).
Catchment and Land Protection Act 1994	The *Catchment and Land Protection Act 1994* has the objective of establishing a framework for the integrated and coordinated management of catchments that will: ▪ Maintain and enhance long-term land productivity while also conserving the environment; and ▪ Aim to ensure that the quality of the State's land and water resources and their associated plant and animal life are maintained and enhanced. The Act provides for the development of Regional Catchment Strategies that must assess the nature, causes, extent and severity of land degradation of the catchments in the region and identify areas for priority attention. Local Planning Schemes must have regard for the Regional Catchment Strategies.
Glenelg Hopkins River Health Strategy (2004 – 2009) (still in use)	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 aims of the River Health Strategy were to: ▪ Identify and prioritise actions for river restoration, considering environmental, social and economic values; ▪ Identify threats to waterway health and assess the level of risk based on the interaction between threats and values; ▪ Identify priority actions required to protect and enhance high value river reaches; ▪ Identify opportunities to actively involve the community in river health; and ▪ Provide the strategic framework for investment in river health for the five year period.
Wimmera Waterway Health Strategy (still in use)	The Wimmera Waterway Health Strategy has been developed to provide a strategic framework to protect and enhance the high value assets of waterways and terminal lakes within the Wimmera catchment basin. The strategy is aligned with the Wimmera Regional Catchment Strategy five year blue print for improving the health of rivers and creeks within the catchment. In protecting and improving the region's rivers and creeks, the main objectives of the waterways strategy are to: ▪ Proactively manage the waterways of Wimmera, considering environmental, social and economic values; ▪ Maintain ecologically healthy waterways; ▪ Achieve an overall improvement in the environmental condition of the region's waterways; and ▪ Prevent damage to the waterways from future management activities. The implementation of this strategy is the responsibility of the CMA in partnership with the local community, local government and State Government agencies (Department of Sustainability and Environment, EPA Victoria and Department of Primary Industries).
Local	
Ararat and Northern Grampians Planning Schemes	The Ararat and Northern Grampians Planning Schemes both 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: ▪ 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). ▪ ESO: To ensure development is compatible with identified environmental values. ▪ VPO: To ensure that development minimises impact to significant vegetation.

12.5 Existing Conditions

12.5.1 Catchments and Waterway Crossings

The Project is primarily located within the Wimmera CMA region, with a small section in the Glenelg Hopkins CMA region, see Figure 12-1. The alignment interacts with one sub-catchment system (or management unit) within each CMA area, located in the upper catchment areas of each of the CMA regions including:

- Upper Hopkins River (Glenelg Hopkins CMA); and
- Concongella Creek (Wimmera CMA).

12.5.1.1 Subcatchment- H5 Upper Hopkins River (Glenelg Hopkins CMA)

The study area commences just within the Glenelg Hopkins CMA, north-west of Ararat. The beginning of Section 3, leaving Ararat, intersects a number of minor upper tributaries of Hopkins River.

The existing Western Highway divides the current land use in this part of the sub-catchment with upstream of the highway consisting of forest and downstream of the highway cleared land. The un-named tributaries of the upper Hopkins River cross the existing Western Highway at two locations.

12.5.1.2 Subcatchment- Concongella Creek (Wimmera CMA)

Most of the study area is located within the Concongella Creek subcatchment. Concongella Creek is the predominant waterway in Section 3 with many tributaries, which all flow in a north-west direction. The major waterways and tributaries within this sub-catchment that are within the study area include:

- Concongella Creek- currently intersects the Western Highway in Section 3 at seven locations, as the existing highway runs parallel with the valley that and the creek over several kilometres. Concongella Creek drains to the Wimmera River. Its substrate is coarse sand with some gravel, with deposition of sands forming distinct benching along the length of the reach. Floodplain vegetation is pasture grasses and riparian zone vegetation is open woodland dominated by River Red Gums, other eucalypts, acacias and pasture grasses. The creek crosses the existing Western Highway and potential duplication alignments numerous times.
- Allanvale Creek- is a tributary to the Concongella Creek, with headwaters north of the highway near Armstrong, intersecting with Concongella Creek near Great Western. It is not currently crossed by the existing highway however the proposed alignment would cross Allanvale Creek with the bypass of Great Western.
- Pleasant Creek- The headwaters of Pleasant Creek are between Great Western and Stawell on the south of the highway. It does not intersect the existing highway or the proposed alignment. Pleasant Creek discharges into Anderson Creek prior to Lake Lonsdale; and
- Other Tributaries- The smaller tributaries of Donald Creek, Robinsons Creek, Hyde Park Creek and Cobeys Creek commence to the south of the existing highway and converge and cross the highway west of Great Western, discharging into Concongella Creek.

Table 12-2 Summary of Waterway Characteristics

Waterway	Description	River Health (Observation)
Concongella Creek	Actively eroding waterway with exposed banks and bank slumping in some sections.	Low diversity inhabited by reeds.
Allanvale Creek	A laterally unconfined, sandy waterway with sinuosity.	Some diversity (reeds, sedges).
Robinsons Creek	A low sinuosity, fine grained system with some sandy deposits.	Some habitat diversity including: in stream pool-riffles with sedges and reeds, and pockets of woody vegetation.
Donald Creek	A low sinuosity fine-grained waterway with some bank slumping and smaller sand deposits present within the channel.	Some diversity (reeds, sedges).
Pleasant Creek	A small, unconfined, ephemeral waterway.	Well vegetated, steep short banks.

12.5.2 Waterway Conditions

The State of our Streams 2006, was produced by Wimmera CMA detailing the results of the waterway conditions found in the Wimmera region. The document highlighted the key findings, in which the stream condition rating of the Concongella Creek WMU was ‘good’ to ‘moderate’.

The surrounding Upper Wimmera sub-catchment was found to have variable stream condition, with generally ‘good’ hydrology assessment, and ‘moderate’ to ‘poor’ physical form and streamside zone classifications. Water quality and aquatic life were both assessed as ‘good’.

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.

Surveys of the waterways were undertaken by Ecology Partners (2012) and no national or state significant aquatic species were identified.

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 (75th percentile)
- pH: 6.5 – 8.3
- Turbidity: 10 NTU (75th 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
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 Declared Water Supply Catchments

The catchments for the study area including Concongella Creek are within Declared Water Supply Catchments (DWSC). Formally known as Proclaimed Water Supply Catchments, DWSCs are the basis for catchment planning and management under the provisions of the *Catchment and Land Protection Act 1994*. This process highlights to the community and land managers, the importance of the catchment for water supply purposes. Whilst DWSCs are subject to a Land Use Determination or a Land Use Notice, there are no specific requirements or restrictions beyond the management controls outlined from the impact assessment.

12.5.4 Flooding

Preliminary flood modelling was undertaken by UWCS/TGM (2012). The 100 year ARI flood extent was estimated for a 3 kilometre (km) wide corridor along the existing Western Highway.

The UWCS/TGM (2012) modelling indicates that at a number of waterway crossing locations the existing highway causes flood waters to be restricted. It also indicates that the modelled 100 year ARI flood extent upstream of the highway stretches for several hundred metres. In some locations, property and dwellings would be affected.

The modelling also suggests that there are a number of crossings where flood waters currently overtop the existing highway. This indicates that the level of flood protection for the existing road is relatively low.

The main observations from the flood modelling are:

- Concongella Creek and its main tributaries interact with the existing Western Highway extensively between Ch. 6000 and Ch. 12000 upstream (south) of the township of Great Western. The convergence of Concongella Creek and several of the main tributaries has the potential to result in significant flooding of the township of Great Western;
- Allanvale Creek converges with Concongella Creek just north-west of the existing highway at Great Western. Allanvale Creek does not currently cross the existing highway but contributes to backwater flooding of the existing highway near Great Western;

- Hyde Park Creek crosses the existing highway in the township of Great Western and combines with Concongella Creek at the north end of town. There is an existing crossing (Bests Road) of Concongella Creek with extensive flooding over the road. The two creeks combine in the floodplain downstream (north) creating a backwater that compounds the flooding in Great Western.
- Several tributaries flow from the east and converge upstream of the existing Highway including Donald, Robinson and Cobeys Creeks and combine with Concongella Creek downstream. The backwater associated with the confluence of these streams results in the existing highway being flood affected; and
- Pleasant Creek runs parallel to the highway south-east of Stawell. There is no flooding of the existing highway indicated by the modelling, and there are no designated tributaries that cross the highway.

For the following locations, the existing highway is overtopped in the modelled 100 year ARI flood event (see Figure 12-2):

- Tributary of Concongella Creek (Crossing WB321)
- Concongella Creek (Crossings WB323) – minor overtopping (significant flow diverted upstream)
- Concongella Creek (Crossings WB325) – overtopping (with significant flow diverted upstream)
- Concongella Creek (Crossings WB325 to WB327) – extensive overtopping of road across a length > 1000m leading into Great Western
- Concongella Creek (Crossings WB328 – Bests Road)
- Robinsons Creek (WB330).

For more detail on the preliminary flood modelling and maps, refer to Technical Appendix G.

12.5.4.1 January 2011 Event

High intensity rainfall in mid-January 2011 caused extensive flooding and road closures along the existing Western Highway. During the flooding, the Western Highway was closed from Ballarat to Horsham. During this event, major flooding occurred in Section 3 on Concongella Creek near the town of Great Western.

The January 2011 event was unique as it was a result of the combination of multiple rainfall events falling in succession, rather than a single high rainfall event. The storm event that lead to the flooding could be divided into three defined storm bursts that individually had an ARI (average recurrence interval) of between 20-50 years (UWCS & TGM, 2012).

The storm event that resulted from the combination of these three smaller bursts had an ARI of 88 years with a duration of 101 hours, and the already saturated catchment conditions contributed to the extensive flooding that occurred as a result of this storm event (UWCS & TGM, 2012).

Whilst the January 2011 event had an ARI of 88 years, the flood extent is similar to the modelled 100 year ARI event (UWCS &TGM, 2012). In some areas the flood extent goes beyond the modelled 100 year ARI event due to the additional volume associated with the extended duration of this event event.

Data collected during the January 2011 event including peak flows, was used by UWCS & TGM (2012) in the calibration of the hydrology model developed for Section 3.

Robinsons Creek, Western Highway (WB331)

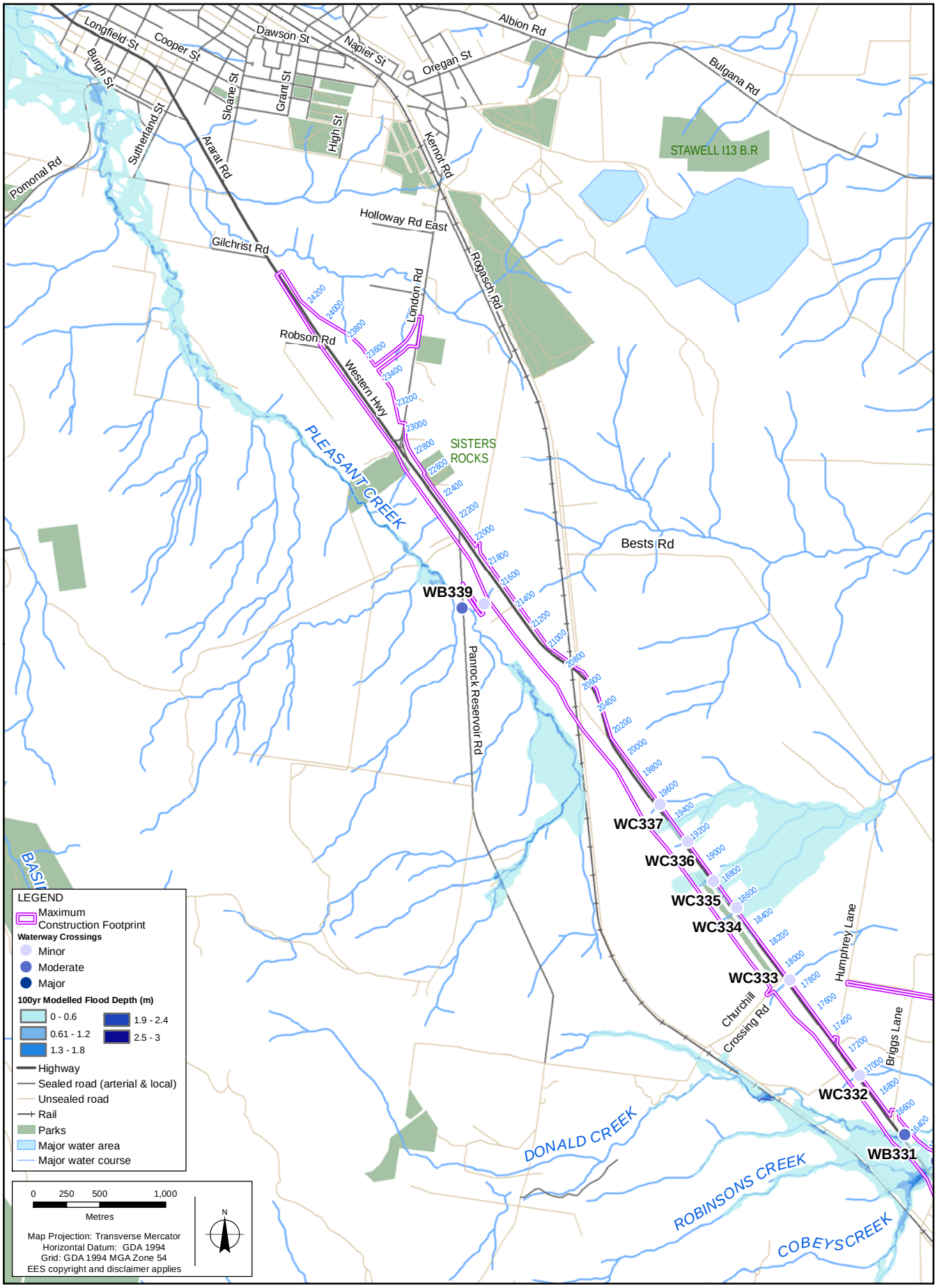

Figure 12-2a Waterway Crossings and modelled 100 year ARI Flood Levels for Existing Highway

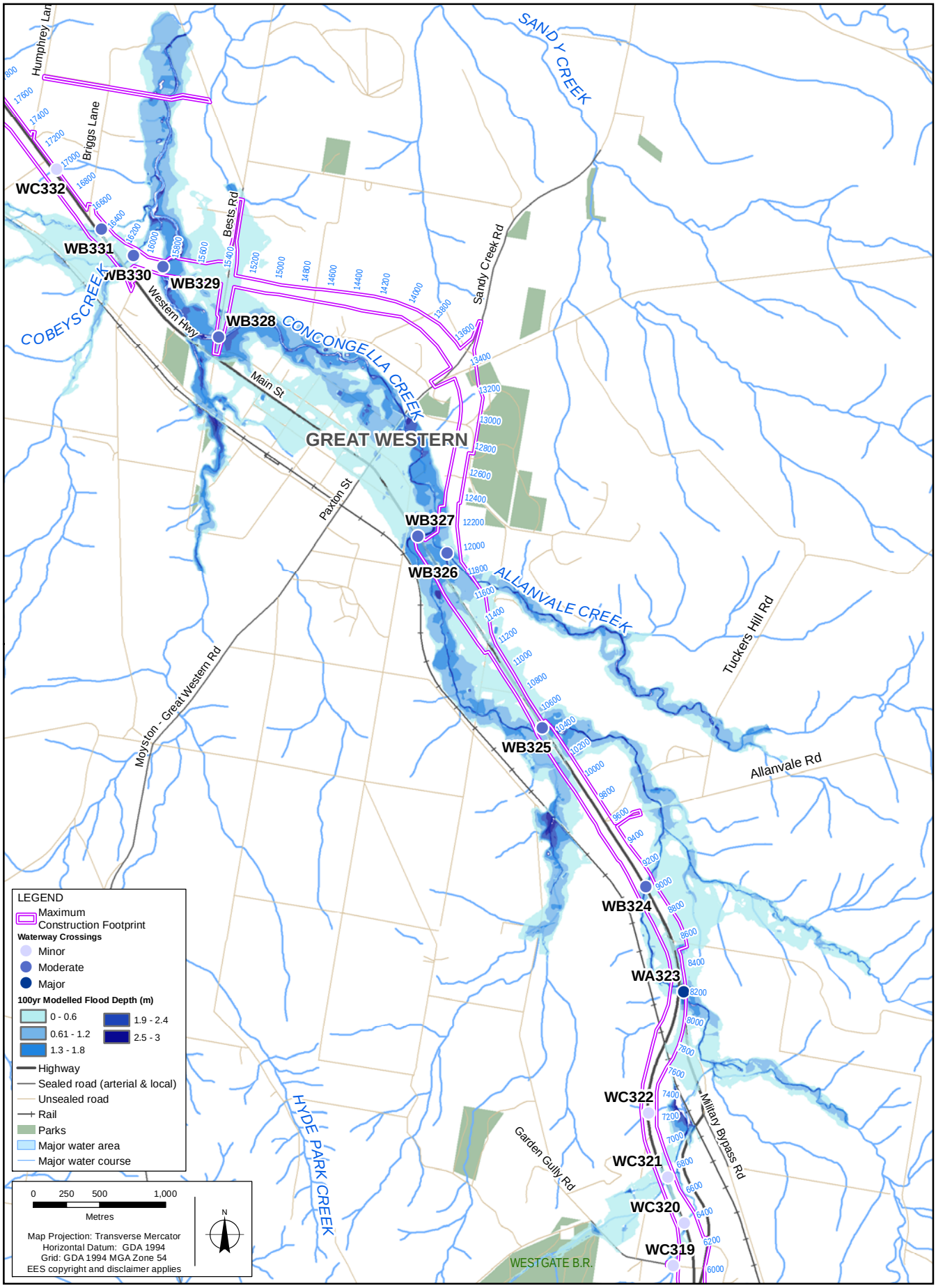

Figure 12-2b Waterway Crossings and modelled 100 year ARI Flood Levels for Existing Highway

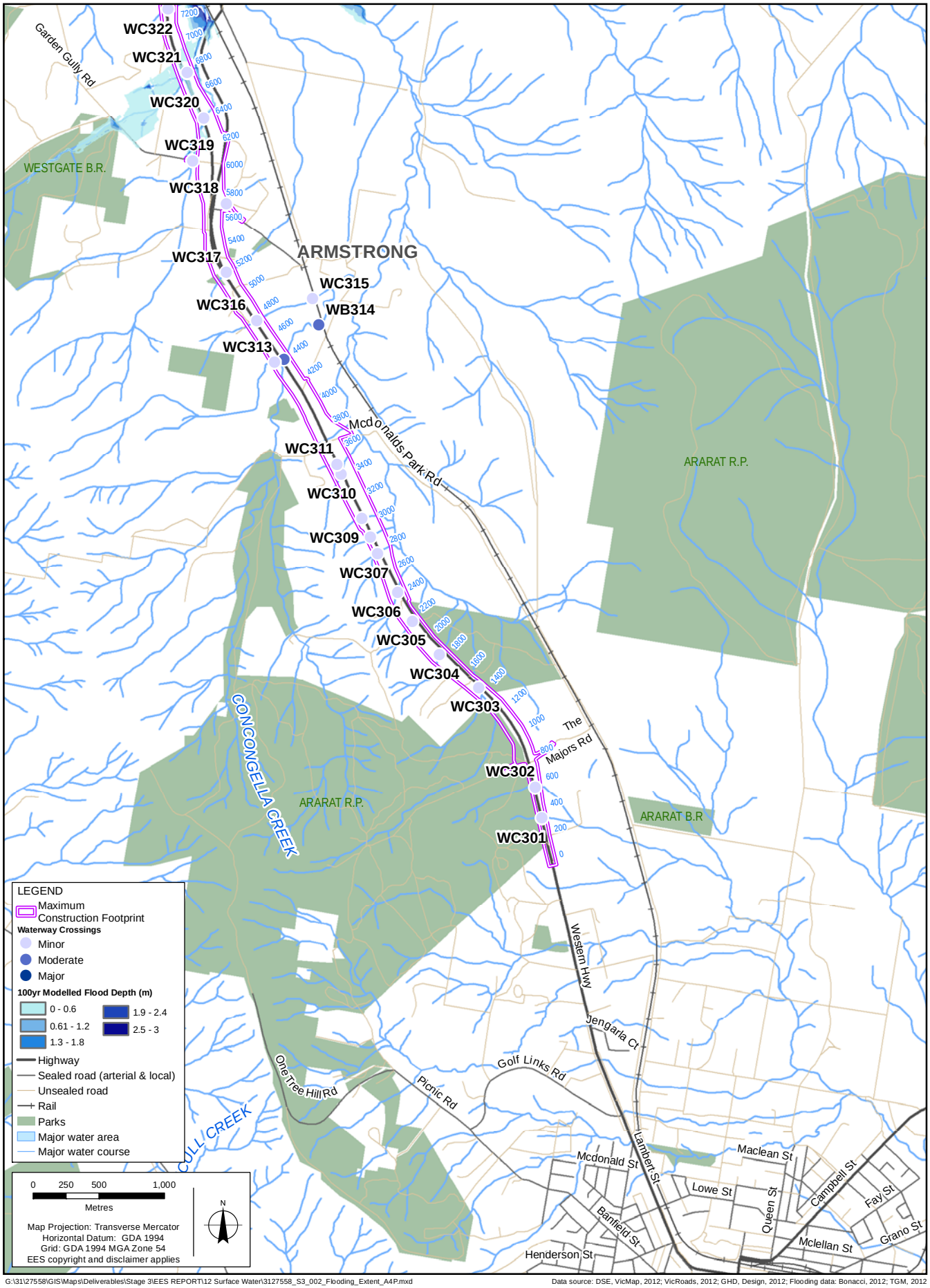

Figure 12-2c Waterway Crossings and modelled 100 year ARI Flood Levels for Existing Highway

12.6 Impact Assessment

12.6.1 Key Issues

The key issues that could arise from the Project are associated with either impacts to river health and water quality of receiving waters, or hydraulic impacts to waterways and floodplains.

Impact to river health and water quality can arise from physical disturbance to existing waterways, fragmentation of waterways and water quality impacts. Impacts to waterways and floodplain hydraulics can arise from changes to hydraulic conditions of waterway crossings and impacts on flooding.

The key potential impacts associated with the project include:

- Replacing or constructing culverts and bridges at most waterway crossings. Construction of these features could involve physical disruption to the waterway channel and banks. This could result in changes to the ecological or geomorphological nature of the waterway as well as the floodplain characteristics.
- Intersecting the catchment area of a number of waterways and may alter the flood regime and flooding patterns as flows across the catchment are impeded.
- Additional traffic volumes may also lead to an increase of contamination of storm water runoff from the road which would ultimately end up in the waterways.

The Project could also provide potential benefits that include:

- Following construction works, there would be opportunities to improve waterway condition and ecological health to beyond the current condition. This can be achieved through revegetation and other waterway stabilisation works.
- There could also be opportunities for flood attenuation at selective locations upstream of the highway which would reduce the influence of flooding on downstream locations.

12.6.2 Impact Pathways

Impacts to waterways may arise from:

- **Construction activities** – The construction activities associated with the Project impact the river health characteristics of the waterways and
- **Footprint of the project** – the footprint and location of the Project impacts the physical characteristics of the waterways and floodplain.
- **Operation of the Project** - The Project impacts the river health characteristics of the waterways.

The impact pathways have been determined through the consideration of these activities for each of the waterways crossed by the proposed alignment. The impact pathways are described in the following sections.

12.6.3 Physical Disturbance to Waterway (Channel From and River Health)

Construction could result in local removal of riparian and in-stream vegetation and habitat values at waterway crossings. Removal of vegetation may impact bed and bank stability and increase the potential for channel erosion.

The significance of the impact of the physical disturbance at each waterway crossing location is dependent on the classification of the waterway and the magnitude or extent of disturbance to the waterway.

The extent of disturbance when a crossing is perpendicular to the waterway is considered to be low. However, where a crossing is skewed and leads to significant lengths of waterway potentially being disturbed, the scale of disturbance is considered to be high.

For minor waterways the significance of the impact is generally minor. For the significant waterways, the significance of the impact is moderate where the magnitude of the disturbance is high.

The proposed alignment follows the existing highway on either side of Great Western and would require the duplication of 28 minor and seven significant waterway crossings. Where the proposed alignment deviates from the existing highway to bypass Great Western, there are also two new crossings of significant waterways proposed.

At the crossing of Concongella Creek near Armstrong (Ch. 8200, WA323) the proposed alignment would be built overlying 140m of the creek. This would require the realigning of the creek into the adjacent paddock. This section of creek to be relocated has established vegetation and in stream features such as large woody debris, riffles and persistent pools.

The proposed alignment requires a new crossing of Concongella Creek (Ch.15900 , WB329) on the north side of Great Western. The proposed crossing is perpendicular to the creek which would reduce the impact to the waterway.

The proposed alignment does however cross Allanvale Creek (Ch. 12000, WB326) on the south side of Great Western at a skewed angle. There is also an interchange proposed at this location within the floodplain, which would result in a higher impact. Partial realignment of the waterway and/or increased bridge spans would be required to mitigate the impact.

The proposed alignment would also crosses Robsons Creek at Ch 16100(WB330) near the new crossing of Concongella Creek. Whilst the crossing is existing and the proposed alignment is perpendicular to the waterway, there would be a lengthy extension required of the existing crossing as it is where the new alignment merges with existing highway.

An approach for installation of bed control structures, bank stabilisation, revegetation and recreation of natural features such as pool and riffle sequences would be developed during detailed design for waterway crossing in consultation with the relevant CMAs.

For most locations where there are existing crossings of significant waterways the river health impacts are considered to be minor. This is on the basis that there are existing crossing and the relative disturbance to the waterways is a relatively small area. Through the mitigation measures proposed for the project, the impacts could be managed.

At the followings locations it was considered that the impact to river health values would be moderate:

- New crossings proposed of Concongella Creek and Allanvale Creek,
- The realignment of 140m Concongella creek at crossing WB323; and
- The lengthened crossing of Robinsons Creek.

For these locations, specific mitigation measures (e.g. in terms of water realignment, rehabilitation and requirements of the crossing design) would be developed in consultation with the CMA to minimise the impact.

With appropriate measures developed through detailed design and implemented during construction, the consequence of the impact from new waterway crossings could be mitigated from moderate to minor.

The waterways potentially impacted and the significance of the impact is summarised in Table 12-4. Waterway crossing are show in Figure 12-2.

Table 12-4 Impacts to Significant Waterways

Waterway (Classification)	Crossing and Risk ID	Existing Crossing Type	Description and Magnitude of Disturbance	Initial Impact	Residual Impact*
Concongella Creek	WB312 SW1C	Bridge	Minor skewed crossing of significant waterway and tributary, <200m footprint disturbed - managed as discrete crossings for each carriageway (Low).	Minor	Insignificant
Concongella Creek	WC321 SW1C	Culvert	Perpendicular crossing (extension of existing crossing) in significant channel (Low).	Minor	Insignificant
Concongella Creek	WA323 SW1A	Culvert	>100m of significant waterway (with good habitat and river health values) directly impacted by the footprint of the project (High) and would require realignment.	Moderate	Minor
Concongella Creek	WB324 SW1C	Bridge	Skewed crossing of significant waterway, <200m footprint disturbed - managed as discrete crossings for each carriageway or realignment of channel (Low).	Minor	Insignificant
Concongella Creek	WB325 SW1C	Culvert	Perpendicular crossing (extension of existing crossing) in significant channel (Low).	Minor	Insignificant
Allanvale Creek	WB326 SW1B	New crossing	New crossing - Highway crossing location of a skewed channel alignment of Allanvale Creek (High).	Moderate	Minor
Concongella Creek	WB327 SW1D	Bridge	No disturbance to existing crossing or main creek channel from the footprint of the interchange arrangement (Negligible).	Insignificant	Insignificant
Concongella Creek	WB328 SW1D	Bridge	Minor disturbance of access road -limited change (Negligible).	Insignificant	Insignificant
Concongella Creek	WB329 SW1B	New crossing	New crossing - Perpendicular crossing of Concongella Creek (High).	Moderate	Minor
Robinsons Creek	WB330 SW1B	Culvert	Perpendicular crossing but lengthy extension (due to realigned segment of highway merging with existing highway) of existing crossing of significant waterway (High).	Moderate	Minor
Donald Creek	WB331 SW1C	Culvert	Skewed crossing of disturbed waterway, <200m footprint disturbed - managed as discrete crossings for each carriageway.	Minor	Insignificant
Pleasant Creek	WB339 SW1D	No crossing	No direct crossing (creek alignment parallel) - some local catchment connections not recognised as designated waterways (Negligible).	Insignificant	Insignificant

* assuming additional mitigation measures adopted

12.6.4 Water Quality

Construction activities associated with the proposed alignment have the potential to impact water quality due to increased sediment loading. The sediment load can be generated from general construction activities from the overall footprint of works (typically managed within a Construction Environmental Management Plan) prior to discharge to receiving waterways. Any construction activities around the waterways would be required to maintain water quality parameters within the SEPP WoV objectives.

The operation of the Project has the potential to impact water quality due to increased contaminants from the additional road surface being discharged to receiving waterways, including particulate matter, nutrients (nitrogen and phosphorous), heavy metals, petroleum based products, organic compounds and rubber products.

For all crossings of Significant waterways, the impact to water quality was considered to be minor for both construction and operation, assuming that standard controls are implemented i.e.:

- Design Phase - Water Sensitive Road Design (WSRD) measures would be evaluated for inclusion in the detailed design phase, as described in VicRoads Integrated Water Management Guidelines (August 2011);
- Construction Phase – appropriate environmental management controls for construction phase to manage discharge into waterways; and
- Operation Phase – maintenance of WSRD measures for managing runoff from the road.

There are currently no formal stormwater quality treatment measures in place or WSRD applied to the existing Western Highway. The existing highway was built prior to the requirement to address stormwater quality from road runoff. There is an opportunity for any WSRD elements implemented as part of the Project to be located and sized to treat the whole surface footprint of hardstand road surfaces.

12.6.5 Change in Geomorphological Response (Stream Bed Degradation and Aggradation)

The footprint of the Project has the potential to increase sediment loading to the downstream waterway in the short term, as a result of channel disturbance and removal of stabilising bed and bank vegetation. The construction of culvert crossings also has the potential to accelerate stream bed degradation and aggradation (sediment accumulation) processes due to the change in hydraulic conditions (i.e. increased scour potential downstream of the culvert) and discontinuity of sediment transport processes.

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. At existing crossing locations, the risk of increased erosion potential is considered to be low given that the flow constrictions already occur at these waterway crossings.

For new waterways crossings, the risk of increased erosion potential is dependent on the geomorphologic status or current stability of the waterway, and the magnitude of the disturbance. Two new crossings area proposed of Concongella Creek and one of Allanvale Creek on either side of Great Western, and these waterways are showing signs of actively eroding.

Mitigation measures such as additional culvert capacity or open span bridge could be adopted. Energy dissipation measures could also be considered, such as rock beaching, downstream of the culverts. The application of these measures for specific locations would be defined during detailed design.

For existing crossing locations, with the application of proposed 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 and may provide opportunities to improve local instabilities.

For the proposed new crossing at Concongella Creek and Allanvale Creek, there is the potential for higher impact. However with the application of management measures specific for these new crossings, the impact would also be minor.

12.6.6 Fragmentation of Habitat

The Project could lead to the fragmentation of river health values through in-stream barriers such as culverts. In stream barriers can disconnect the upstream and downstream waterway environments thereby 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.

The standard requirements for waterway crossings include sizing culverts to reduce velocities, arranging culverts so that invert levels match bed levels, and providing appropriate protection to bed and banks as part of the works.

The level of impact of fragmentation of habitat is dependent on the status of the waterway and the location and nature of the crossing. The significance of the impact associated with the proposed alignment would be greater for new crossings than for existing crossings.

The proposed alignment follows the existing highway and therefore most of the waterways have been disturbed previously. Duplication of these crossings with the proposed alignment could be an opportunity to address the fragmentation caused by existing crossings.

For all waterways except Allanvale and Concongella Creek, the significance of the impact to river health values through fragmentation is generally minor with application of standard controls.

The new crossings of Concongella Creek and Allanvale Creek associated with the proposed bypass of Great Western are considered to be a moderate impact because of the potential to cause fragmentation at new crossings locations compared to duplication of an existing crossing where there is existing fragmentation. These new waterway crossings may warrant further design considerations to reduce the impacts (e.g. open span bridge).

Related to this issue are the potential impacts of the Project on the hydrologic regime to ecologic areas of significance downstream of the study area. There is not expected to be significant environmental hydrologic changes (i.e. changes to the low flow regimes), and therefore impact on aquatic ecology downstream (in stream and in floodplains) and the related environment values is negligible.

Concongella Creek, Western Highway Crossing (WB325)

12.6.7 Flooding

The following criteria were applied to the Project in relation to flooding:

- There would be no increase in afflux at existing crossing or creation of afflux at new crossings that would impact properties; and
- The road would not be overtopped and adopt 1m freeboard above the 1 in 100 year flood event.

Afflux refers to the rise in water level on the upstream side of a bridge or obstruction.

Through applying the project criteria outlined above, there is the potential that the Project results in change in flood conditions downstream and potential increase in flood levels to rural properties and the township of Great Western.

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.

The potential impacts to Great Western have been assessed by considering the whole of the Concongella Creek system and major tributaries. Construction of the Project may result in changes to floodplain characteristics. There is the potential to impact floodplain function and flow conveyance, particularly during peak events. This is because the existing highway is flood affected and provides some attenuation and diversion of flows, and the Project seeks to protect the road from flooding and cause no afflux.

This existing highway generally runs parallel to and within the flood plain of Concongella Creek and its tributaries. The Project could result in changes to the complex flooding characteristics of Concongella Creek and its tributaries, which could result in potential impacts to rural properties and Great Western.

The following summarises the interaction of the Project with existing flood conditions and the potential impacts, which is based on the interpretation of preliminary flood modelling undertaken by UWCS/TGM (2012);

- The existing highway is flood affected in two locations in the upper Concongella Creek and tributaries (WB320 and WB321). These can be addressed by raising the road and increasing waterway openings as required (without any expected change in distribution of flows). In these locations there are not likely to be any rural properties with dwellings affected.

- The existing highway is significantly flood affected in the 2km section of road upstream (south) of Great Western at locations where the highway crosses waterways and between these crossings (WA323, WB324, WB325).

  The flooding between crossings appears to result from the complex interaction of Concongella Creek and its tributaries, and from breakway flows from Concongella Creek and Allanvale Creek. Constructing the proposed duplication to be above existing 1 in 100 ARI flood levels and to cause no afflux in these locations, could result in increased flood levels in Great Western. This could be due to change in flows downstream and reduced backwater storage provided by the existing highway.

- The existing flooding through the township of Great Western is extensive and the existing highway is flood affected throughout the township. The existing road is proposed to become an access exit/entry road for the duplication on both sides of Great Western. Changes to the existing highway within the town and associated with the Project are minor and are not expected to have any significant implications on flooding, however these entry/exit routes would be impassable during major flood events.

- The new alignment is a deviation from the existing highway (around the township of Great Western), and there will be a requirement for new crossing locations on Concongella Creek, (WB329, WB330) and Allanvale Creek (WB326). The new crossings would be designed to be flood free crossings with no allowable increase in flood levels.

- The existing highway and Best Road on the northern side of Great Western are affected by flooding at the confluence of Hyde Park Creek and Concongella Creek. Changes at this location are minor and are not expected to exacerbate upstream flood levels within Great Western. Changes to the access road (Bests Road) within the town are also minor and are unlikely to result in increases in flood levels in the adjacent rural areas.

- The existing highway downstream (north) of Great Western is flood affected by Robinsons Creek and Donald Creek (upstream of the confluence with Concongella Creek). This could be addressed by increasing waterway openings as required without significant change in the distribution and timing of flows.

The impact of flooding at minor waterways crossings was considered to be of minor consequence. It was assumed that waterway crossings would provide a minimum flow capacity equivalent to the current crossing.

12.6.7.1 Flood Mitigation

The Project is located within a complex floodplain environment with many waterway crossings. The interaction of the proposed alignment with waterways was modelled to assess the impacts and to determine preliminary crossing configurations.

Preliminary modelling analysis was undertaken by UWCS/TGM (2012) to consider:

- How the project criteria in relation to flooding could be met (no overtopping in a 1 in 100 year event and causing no afflux);

- The potential impacts to Great Western through meeting these criteria (Iteration 2A); and

- How flooding impacts could be reduced in Great Western (Iteration 2B).

Sensitivity modelling scenario to test the potential to reduce flood peaks/flood levels through Great Western by restricting openings at selective locations

The modelling considered the initial concept design developed for the EES carriageways and waterway openings with Iteration 2A to assess impacts in Great Western. Sensitivity modelling (Iteration 2B) was undertaken to test the potential to manage the impacts or reduce flood peaks and flood levels through Great Western by restricting openings at selective locations upstream of Great Western.

From Iteration 2A there were minor increases in flood level in parts of Great Western that can be attributed to the following:

- Change in upstream crossing configurations leading to minor changes flow distributions and flood levels downstream; and

- Change in flow distributions due to the complex interchange configuration immediately upstream of Great Western township.

From the interpretation of the results of Iteration 2B, it can be concluded that the impacts in Great Western can be managed via a combination of the following in the design of the proposed road:

- Design of the complex interchange arrangement and allowance of waterway openings so that there is minimal redistribution of Concongella Creek flows;

- Design of the new crossing of Allanvale Creek (south of Great Western) to provide some attenuation (subject to not impacting upstream rural properties); and

- Design of attenuation at select crossing locations upstream (potentially required).

The preliminary modelling showed that the Project could be implemented without worsening the flooding impacts at Great Western, however this would require mitigation measures to be implemented including design of the interchange arrangement and restriction flood waters upstream.

Detailed design of the road and waterway crossings, and further flood modelling would be required to confirm where and how restricting the flows upstream would benefit Great Western.

To develop the design of waterway crossings and identify areas for retention of flood waters would require:

- Detailed survey of the road level, waterway crossings and the floor levels of houses in potentially affected areas;
- Further hydraulic assessments of waterway crossings and iterative flood modelling to inform the development of the crossing designs to meet the project criteria;
- Detailed design of carriageways and waterway crossings;
- Consideration of runoff and the stormwater system within Great Western; and
- Ongoing consultation with the Catchment Management Authority, local Council and potentially affected landowners.

Table 12-5 provides a further description of the potential flooding impacts of the Project at significant and moderate waterway crossings, as presented in Figure 12-2, and the detailed flood extent maps in Appendix C of Technical Appendix G.

Table 12-5 Potential Flooding Impacts

Waterway	Waterway Crossing	Description of Proposed Highway Conditions and Potential Flooding Impacts
Concongella Creek	WB312	***Duplication:*** No change required to highway level and waterway opening to be marginally increased to minimise afflux.
Concongella Creek	WB320, WB321	***Duplication:*** Raising of existing highway level and increase of waterway opening required. Nearby property not expected to be impacted flood extent
Concongella Creek	WA323	***Duplication:*** Minor raising of existing highway and additional waterway area for the main flow path and culvert openings (or direct additional flow north of the highway). No properties in the vicinity of the upstream flood extent.
Concongella Creek	WB324	***Duplication:*** No change required to highway level and waterway opening – Based on upstream flow at WB323 diverted to the north of the highway. No properties in the vicinity of the upstream flood extent.
Concongella Creek	WB325	***Duplication:*** Significant raising of existing highway and increase in bridge opening required for the main flow path to maintain existing flow distributions, The backwater and breakaway flow on the upstream side of the highway towards the north currently impacts a property (adjacent to road Ch. 10600). Any change in distribution of flow at this location may have implications on the flooding behaviour in the township of Great Western.
Allanvale Creek & Concongella Creek	WB326 (new), WB327 (existing highway that becomes exit ramp)	***Deviation:*** Proposed Highway deviation and interchange is within the backwater and intersects the floodplain by over 1000m extending back to crossing WB325. A new crossing structure will be required of the Concongella Creek main flow path as part of the deviation and road interchange arrangement. There will also need to be significant openings provided in the backwater area of the existing carriageways as well as for the exit ramps and service roads. Any change in distribution of flow at this complex interchange location may have implications on the flooding behaviour in the township of Great Western. For Allanvale Creek, a nearby property upstream is not expected to be impacted by flood extent.
Concongella Creek	WB328 (existing crossing Bests Rd), WB329 (new)	***Deviation:*** Some raising of road at Bests Road crossing will be required (depending on upgraded design standard). Bests Road is currently inundated by the backwater of Concongella Creek. There is a significant increase in backwater flooding depths locally along Concongella Creek as a result of fill works for the Best Road overpass and new highway crossing. Proposed Highway will require a new crossing structure at WC329 which crosses an existing flood extent width of 200m.
Robinsons Creek	WB330 (extension of existing), WB331 (existing highway)	***Deviation / Duplication***: The proposed highway will require an extension of the exsitng crossing of Robinsons Creek 100m downstream of the existing highway where the new highway merges with the existing road Raising of the road and an upsized crossing will be required at the duplication of the existing crossing of Donald Creek.
Pleasant Creek		No crossing of Western Highway (other than local catchment flow paths).

12.7 Risk Assessment

An environmental risk assessment was undertaken on the proposed alignment 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) and details of the assessment are provided in the Surface Water Impact Assessment Report provide in Technical Appendix G. 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 12-6 shows a summary for surface water of:

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

In assessing the impact to surface water, just over half of the risks associated with the Project were initially assigned a medium or high risk rating. The highest initial risks were associated with new waterway crossings, realignment of a short section of Concongella creek and flooding impacts to Great Western.

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 low. In some instances, the already low flood risk would be reduced further, providing a small benefit.

Concongella Creek (WB331)

Table 12-6 Surface Water Risks

Risk No.	Impact Pathway	Consequence Description
SW1A	Construction activities on Significant crossing of Concongella Creek (Ch. 8200, WB 323) resulting in disturbance of channel planform, geometry and river health values.	Realignment of >100m of waterway banks, channel profile and pools. Reduction in aquatic and terrestrial habitat value in the vicinity of the crossing location.
SW1B	Construction activities for new or extended Significant crossings on Allanvale Creek (Ch.12000, WB326), Concongella Creek (Ch. 16000, WB329), and Robinsons Creek (Ch. 16200, WB 331) resulting in disturbance of channel planform, geometry and river health values.	Local destabilisation of >100m of waterway banks, channel profile and pools. Reduction in aquatic and terrestrial habitat value in the vicinity of the crossing location.
SW1C	Construction activities on other Significant crossings of Concongella Creek and tributaries (Ch. 4400, WB 312), (Ch 6450, WB 320), (Ch 6750, WC 321), (Ch. 9100, WB 324), (Ch. 10550, WB325) and Donald Creek (Ch. 16500, WB 331) resulting in disturbance of channel planform, geometry and river health values.	Local destabilisation of waterway banks, channel profile and pools. Reduction in aquatic and terrestrial habitat value in the vicinity of the crossing location.
SW1D	Construction activities on side roads at (SR6100, WC 319), Concongella Creek (SR12150, WB327), (SR15400, WB328) and Pleasant Creek (SR21700, WB339) resulting in disturbance of channel planform, geometry and/or river health values	Local disturbance to waterway banks (minor change to existing structure), channel profile and pools. Reduction in aquatic and terrestrial habitat value in the vicinity of the crossing location.
SW1E	Construction activities on all other Minor waterways resulting in disturbance of channel planform, geometry and/or river health values.	Local disturbance or destabilisation of waterway banks and channel profile. Reduction in aquatic and terrestrial habitat value in the vicinity of the crossing location.
SW2A	Construction of the Western Highway at **new** crossing locations results in the change reduction in the hydraulic conditions and geomorphologic response capacity at crossing locations.	Increased erosion potential downstream/increase sedimentation upstream due to the constriction centration of flow through a culvert or beneath a bridge.
SW2B	Construction of the Western Highway at existing crossing locations results in the change in the hydraulic conditions and geomorphologic response at crossing locations.	Some increased erosion potential downstream/increase sedimentation upstream due to the constriction of flow through a culvert or beneath a bridge (limited impact given existing crossing).

Risk No.	Impact Pathway	Consequence Description
SW3A	Construction of the Western Highway results in fragmentation of river health values at **new** crossing locations.	Restrictions to aquatic and terrestrial fauna movement, impediments to future waterway and catchment rehabilitation efforts.
SW3B	Construction of the Western Highway at existing crossing locations 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 (limited impact given existing crossing).
SW4A	Construction activities result in increased sediment and contaminant loadings to all other Significant waterways.	Degradation of water quality in receiving waterways, impact on aquatic ecosystems
SW4B	Construction activities result in increased sediment and contaminant loadings to all other (minor) 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 all other Significant waterways.	Increase in quantity of stormwater runoff compared to the existing flow regime. 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 (minor) waterways.	Increase in quantity of stormwater runoff compared to the existing flow regime. Degradation of water quality in receiving waterways, impact on aquatic ecosystems.
SW6A	Construction of the Western Highway results in changes to the floodplain characteristics and flooding characteristics in the township of Great Western from Concongella Creek and tributaries.	Increased afflux and extent of upstream flooding and/or redistribution of flows results in medium increase in flooding at a township scale.
SW6B-1	Construction of the Western Highway results in changes to the floodplain characteristics for Concongella Creek and tributaries where rural properties are impacted.	Increased afflux and extent of upstream flooding and/or redistribution of flows or local drainage results in a medium increase in flooding at a rural scale.
SW6B-2	Construction of the Western Highway results in changes to the floodplain characteristics for Concongella Creek and tributaries where no rural properties are impacted.	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.
SW6C	Construction of the Western Highway results in changes to the floodplain characteristics for all other waterways.	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.

12.8 Environmental Management Measures

VicRoads has a standard set of environmental management measures which are typically incorporated into its 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 12-7.

Table 12-7 Surface Water Environmental Management Measures and Residual Risk

Risk No.	Environmental Management Measures	Residual Risk
SW1A	Reinstatement of waterway in accordance with WCMA requirements (channel profile, floodplain revegetation) and avoid unnecessary works in the channel. Given the diversions of significant lengths of waterways are required, further investigations are required to be undertaken to develop a design concept for the realignment of the creek which would form part of the works on waterway application and be subject to CMA approval Realignment of waterway to follow eastern boundary of old highway, including bed control structures, bank stabilisation using a combination of rock, vegetation and erosion matting, creation of meanders, reintroduction of large woody debris, synthesis of existing pool and riffles, relocation of old highway bridge and construction of a new bridge on the new carriageway.	Low

Risk No.	Environmental Management Measures	Residual Risk
SW1B	Reinstatement of waterway in accordance with WCMA requirements (channel profile, floodplain revegetation) and avoid unnecessary works in the channel. Further investigations are required to develop a design concept for the realignment of the creek which would form part of the works on waterway application and be subject to CMA approval. This may lead to partial realignment of the waterway to limit the length of waterway beneath carriageways and/or construction of longer bridge spans to protect the existing waterway bed and banks. An alternative mitigation measure could be to construct a bridge with piers set outside the main flow channel and offset from the riparian vegetation.	Low
SW1C	Reinstatement of waterway in accordance with WCMA requirements (channel profile, floodplain revegetation) and avoid unnecessary works in the channel. Construction of bed control and/or bank protection works to protect vulnerable areas within or adjacent to the work area.	Low
SW1D	Reinstatement of waterway in accordance with WCMA requirements (channel profile, floodplain revegetation) and avoid unnecessary works in the channel	Negligible
SW1E	As above	Negligible
SW2A	Appropriate design standards (e.g. adequately sized culverts, rock protection to stabilise waterway bed and banks at the crossing location if required). Construction of oversized culvert crossings to minimise hydraulic change and/or limit disturbance to existing creek bed (i.e. impose bridge spans to minimise change to the existing waterway)	Low
SW2B	Appropriate design standards (e.g. adequately sized culverts, rock protection to stabilise waterway bed and banks at the crossing location if required).	Low
SW3A	Appropriate design standards (e.g. culvert sized appropriately and set at bed level of waterway where required, 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. Therefore additional design controls may be imposed to design fauna friendly features such as oversizing culvert, providing adequate light penetration to encourage fish passage where applicable and/or providing artificial features (eg culvert baffles). Alternatively, construction of open bridge spans to protect the existing waterway may be imposed.	Low
SW3B	Appropriate design standards (e.g. culvert sized appropriately and set at bed level of waterway where required,	Low
SW4A	Implement Erosion and Sediment Control Measures and SEPP requirements for receiving waterways through an EMP, including but not limited to: ▪ minimising the amount of exposed erodible surfaces, ▪ installation of erosion and sedimentation control, ▪ prompt covering of exposed surfaces, ▪ progressive revegetation of the site, ▪ management of stockpiles; ▪ and co-ordination to avoid works near watercourses. The EMP may also consist of: ▪ Water quality upstream and downstream of works would be monitored. ▪ Works would be scheduled to avoid working in flowing waterways where possible. ▪ Sediment basins would be designed to ‘best practice’ standard and sized specifically for each site.	Low
SW4B	As above	Negligible
SW5A	Water Sensitive Road Design measures would be evaluated for inclusion in the detailed design phase, as described in VicRoads Integrated Water Management Guidelines (August 2011), and at a minimum best practice pollution reduction targets achieved for the additional road surface compared to the existing road surface footprint. 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

Risk No.	Environmental Management Measures	Residual Risk
SW6A	Preliminary hydraulic modelling indicated that impacts of flooding in Great Western could be mitigated. Further hydraulic modelling will need to be undertaken during the detailed design phase to confirm the design arrangements of specific crossings and locations of any flood mitigation measures. From the interpretation of the preliminary modelling results, it can be concluded that the impacts in Great Western can be managed via a combination of the following in the design of the proposed road: ▪ Design of the complex interchange arrangement and allowance of waterway openings so that there is minimal redistribution of Concongella Creek flows; ▪ Design of the new crossing of Allanvale Creek (as part of this complex interchange) to provide some attenuation (subject to not impacting upstream rural properties) ▪ Design of attenuation at select crossing locations upstream (If required)	Medium
SW6B-1	Appropriate design standards to achieve highway flood risk requirements (e.g. adequately sized culverts or bridge spans where required). Further hydraulic modelling will need to be undertaken during the detailed design phase to minimise the risk of increased flooding.	Low
SW6B-2	Refer to SW6B-1	Negligible
SW6C	Appropriate design standards to achieve highway flood risk requirements (e.g. adequately sized culverts or bridge spans where required).	Negligible

12.8.1 Residual Risks

Following implementation of the proposed mitigation measures there are not expected to be any significant impacts (Table 12-7). The overall residual risk to surface water is Low. 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

Surveys of the waterways were undertaken by Ecology Partners (2012) and no national or state significant aquatic species were identified.

For locations where there are existing crossings of significant waterways (other than Concongella Creek at WA323) the river health impacts are minor, predominately on the basis of there being an existing crossing already causing a river health impact. In two locations where new crossing are proposed and where the Concongella Creek is re-aligned, the impacts are considered to be moderate. However with appropriate measures develop through detailed design and implemented during construction, the consequence could be reduced from moderate to minor.

The Project would provide opportunities to improve existing conditions of waterway reaches within the vicinity of the works, as well as improve existing fragmentation caused by the existing highway by redesigning crossings (eg by oversizing waterway crossings), and provide water quality treatment outcomes that are better than existing conditions.

Construction of the Project would result in changes to floodplain characteristics. There is the potential to impact floodplain function and flow conveyance, particularly during peak events. This is because the existing highway is flood affected, provides some attenuation and diversion of flows, and the Project seeks to protect the road from flooding and cause no afflux.

The potential flooding impacts can be summarised as follows:

- Potential flooding impacts to Great Western township would be Major (given the township scale affected) but can be reduced to Minor subject to detailed flood modelling and detailed design of the road and waterway crossings.
- Potential flooding impacts to rural properties with dwellings at significant crossing locations would be moderate, but can be reduced to minor subject to detailed flood modelling and detailed design of the road and waterway crossings.
- Potential flooding impacts at rural properties with no dwellings at significant crossing locations are minor.
- Potential impacts to minor waterways crossings were considered to be minor.

The preliminary flood modelling showed that the Project could be implemented without worsening the flooding impacts at Great Western, however this would require mitigation measures to be implemented to restrict flood waters. Detailed design of the road and waterway crossings, and flood modelling would be required to confirm where and how restricting the flows upstream would benefit Great Western.