REGIONAL ROADS VICTORIA

FEBRUARY 2022

BEAUFORT BYPASS ENVIRONMENT EFFECTS STATEMENT

SURFACE WATER IMPACT ASSESSMENT

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Beaufort Bypass Environment Effects Statement
Surface Water Impact Assessment

Regional Roads Victoria

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ABBREVIATIONS

AEP	Annual Exceedance Probability
ANZECC guidelines	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
BOM	Bureau of Meteorology
BPEMG	Best Practice Environmental Management Guidelines
CaLP Act	*Catchment and Land Protection Act 1994*
CEMP	Construction Environmental Management Plan
CMA	Catchment Management Authority
DEDJTR	Department of Economic Development, Jobs, Transport and Resources
DELWP	Department of Environment, Land, Water and Planning
DS	Drainage Scheme
EES	Environment Effects Statement
EPA	Environment Protection Authority
ERA	Environmental risk assessment
EY	Exceedances per Year
FO	Floodway Overlay
IFD	Intensity Frequency Duration (design rainfall data)
LSIO	Land Subject to Inundation Overlay
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
NWQMS	National Water Quality Management Strategy
RFO	Rural Floodway Overlay
RRV	Regional Roads Victoria (formerly VicRoads)
SBO	Special Building Overlay
SEPP	State Environment Protection Policy
TSS	Total suspended solids
TP	Total Phosphorus
TN	Total Nitrogen
UFZ	Urban Floodway Zone
VPP	Victoria Planning Provisions
WSRD	Water Sensitive Road Design

EXECUTIVE SUMMARY

Regional Roads Victoria (RRV) propose to construct a new duplication section of the Western Highway to bypass the town of Beaufort (the project), linking completed sections of the Western Highway duplication to the east and west of Beaufort. The project includes construction of a dual carriageway, interchanges to connect the township of Beaufort to the Western Highway, several waterway crossings including Yam Holes Creek, an overpass of the Melbourne-Ararat rail line and intersection treatments of local roads. The EES includes consideration of four alternative bypass alignment options.

On 22 July 2015, the Minister for Planning determined an Environment Effects Statement (EES) would be required under the *Environment Effects Act 1978* to assess the potential environmental effects of the project. The EES allows stakeholders to understand the likely environmental effects of the project and how they would be managed.

SURFACE WATER CONTEXT

CATCHMENT

The project catchment is within the Hopkins River Basin in the eastern half of the Glenelg Hopkins Catchment Management Region. The township of Beaufort is situated within a circle of hills, at the confluence of Ding Dong, Cemetery, Cumberland and Yam Holes Creeks.

Yam Holes Creek flows east through Beaufort and has a catchment area of approximately 70.1 km^2 to the confluence with Mount Emu Creek at Trawalla. Mount Emu Creek is a major tributary of the Hopkins River. The sub catchments within the project area are:

- Yam Holes Creek to Beaufort (situated to the north and west of Beaufort, has a catchment area of approximately 27.2 km^2); and
- Yam Holes Creek downstream of Beaufort (situated to the east of Beaufort, has a catchment area of approximately 21.1 km^2).

Slopes in the upper catchment of Yam Holes Creek are typically around 10%, whereas the lower catchment to the east of Beaufort is gently grading and has a more extensive 1% Annual Exceedance Probability (AEP) floodplain. The project area comprises mainly pasture dryland, remnant native vegetation, seasonal wetlands and the township of Beaufort. The Glenelg Hopkins Catchment Management Authority (GHCMA) provides that Yam Holes Creek and its tributaries to the west of Beaufort are Designated Watercourses, refer to Appendix A Map 1.1 and Map 1.2.

Streamflow data for Yam Holes Creek downstream of Beaufort is available for the 2.5 year period from May 2000 to November 2002. While the data from this station is for a very limited time, it shows Yam Holes Creek is subject to large seasonal variation, with very low discharge (median flows varying between 0.001 m^3/s and 0.021 m^3/s) being recorded between the months from December 2000 to May 2001.

A total of seven wetlands have been identified in the project area, the majority are located in the Yam Holes Creek valley. A number of these meet the definition of Seasonal Herbaceous Wetlands under the *Environment Protection and Biodiversity Conservation Act 1999.* The main wetland systems defined as Seasonal Herbaceous Wetlands are found in the following locations:

- extensive areas along the Yam Holes Creek and valley between Racecourse Road and Beaufort-Lexton Road
- south of Racecourse Road and within the Snow Gums Bushland Reserve
- north of Smiths Lane
- between Martins Lane and Western Highway.

Surface water interaction with groundwater and potential impacts to the wetlands are discussed in:

1. EES Appendix C: *Flora and fauna impact assessment*, WSP 2021
2. EES Appendix D: *Groundwater impact assessment*, WSP 2021
3. EES Appendix K: *Soils and geology impact assessment*, WSP 2021.

WATER QUALITY

Water quality within the region was reviewed based on available monitoring data and the *SEPP (Waters)* targets. In accordance with the *SEPP (Waters)*, the project is within the *Inland Waters* segment *Rivers and Streams – Central Foothills and Coastal Plains*. This segment applies to a broad region across the state of Victoria and comprises rivers and stream reaches generally above 200 mAHD in the central foothills. The catchments and basins included in this segment are the uplands of Moorabool, Werribee, Maribyrnong, Campaspe, Loddon, Avoca, Wimmera and Hopkins basins.

The GHCMA do not have monitoring sites within the Yam Holes Creek catchment or close to the project area. Available water quality data within the wider Glenelg Hopkins Basin provides a general context of water quality and these monitoring results were compared to *SEPP (Waters)* environmental quality indicators and objectives.

The SEPP (Water) clauses that directly relate to this project are:

- *Clause 34* of the *SEPP (Waters)* classifies runoff from roads as urban stormwater and includes the protection of beneficial uses and the demonstration of best practice. The *SEPP (Waters)* approach requires proposed road projects to meet the best practice performance objectives and process outlined in the Urban Stormwater: Best Practice Environmental Management Guidelines, Victorian Stormwater Committee (1999) (BPEMG) to minimise the quantity of stormwater leaving the project boundary and the pollution of stormwater.
- *Clause 46* of the *SEPP (Waters)* requires Councils and CMAs to ensure the management and protection of beneficial uses of floodplains, and in particular that:
  - land use or works on flood-prone areas do not increase the risk during flood events of transportation of materials which would pose a risk to beneficial uses
  - waterways and their floodplains retain sufficient flood detention capacity to moderate peak flows to protect the beneficial uses of downstream waterways.
- *Clause 42* of the *SEPP (Waters)* requires construction works be managed:
  - to minimise, the risk to beneficial uses, so far as reasonably practicable, including risks from land disturbance, soil erosion and the discharge of sediment and other pollutants to surface waters
  - by monitoring surface waters where the construction activity adjoins or crosses surface water to assess if beneficial uses are being protected
  - through compliance with guidelines published or approved by the Authority in relation to the construction activity.

The above SEPP (Waters) clauses will be incorporated into the detail drainage design, detailed flood modelling, water quality design and construction water quality management systems for this project.

In addition to the GHCMA water quality monitoring stations, Pyrenees Shire Council has two surface water sampling locations on Yam Holes Creek at Beaufort Landfill, located on Racecourse Road. The purpose of collecting this water quality data is to address due diligence environmental compliance of landfill operations. The water quality data collected was not sufficient for a direct comparison against the SEPP water quality objectives. However, this station does provide an indication of the existing water quality conditions of Yam Holes Creek.

FLOODPLAIN

Floodplain characteristics for the base case scenario were established using a two-dimensional model developed in TUFLOW modelling software. Based on the modelling results, the base case 1% AEP flood extent inundates sections of existing roads including Main Lead Road, Back Raglan Road, Jacksons Street, Beaufort-Lexton Road and Racecourse Road.

Downstream of Beaufort, Yam Holes Creek has an extensive floodplain, with water depths in the locations of the bypass crossings varying from between 1.34 m (for Bypass A0, A1 and C2) to 1.5 m (for Bypass C0). The Yam Holes Creek 1% AEP floodplain extends approximately 750 m at the intersection of Bypass A0 and A1, 810 m at Bypass C2 crossing and 300 m at Bypass C0 crossing.

SURFACE WATER IMPACT ASSESSMENT

The objective of this assessment is to ensure flooding and water quality impacts are managed so that surrounding water sensitive receptors, flood levels and drainage infrastructures are not adversely impacted.

All four alignments were subject to a high level surface water impact assessment. When all environmental, social and economic disciplines were considered holistically, Option C2 was preferred. Option C2 was therefore subject to a more detailed surface water impact assessment. The key findings below summarise the outcomes of the assessment of Option C2.

KEY FINDINGS FOR FLOODPLAIN IMPACTS:

The outcomes of the flood impact assessment were that flood impacts are mainly concentrated around the main crossing of Yam Holes Creek near Racecourse Road, with impacts on flood level and hazard being of most significance. No buildings are affected but parts of the floodplain and Racecourse Road upstream of the crossing are predicted to experience increased flood levels and hazard. The effects of climate change were modelled and found to not change the predicted impacts significantly. Flood level impacts during the construction and operational phase are largely contained within the existing floodplain for the 1 EY, 10%AEP and 1% AEP flood events. For the 1 EY and 10% AEP flood events, the impact from flood levels is considered low. For the 1% AEP, there are short duration localised impacts on the Western Highway at the west interchange, parcel 4~Q\PP2096 (220 Main Lead Road) and parcel 46~5\PP2096 (Beaufort-Lexton Road) where treated sewage irrigation ponds are currently located. The flood level impacts at these specific locations will be subject to further investigation and mitigation during the detailed design phase.

KEY FINDINGS FOR WATER QUALITY IMPACTS:

The water quality assessment concluded that best practice stormwater treatment measures are required at all road drainage discharge points to protect downstream receivers such as wetlands. Concepts for bioretention systems are proposed to reduce pollutant loads in accordance with best practice. MUSIC models for functional design have met water quality objectives. The impact on water quality during the operational phase is therefore low. At the detailed design stage these proposed treatment measures will be reviewed and optimised with the final design of the road drainage system, with basins rationalised by using additional lengths of swales as part of the treatment train to reduce land take and clearance requirements associated with basins.

KEY FINDINGS FOR WETLAND IMPACTS:

The wetlands impact assessment considered potential impacts at 9 wetlands in the vicinity of the project. The assessment identified that the flooding regime is only impacted at two of these wetlands, with the wetland upstream of the main Yam Holes Creek crossing affected and subject to increased flood levels, particularly in moderate and major flood events. The impacts on this wetland are considered minor due to the low velocity and duration impacts and the localised flood level impacts that do not extend over the majority of the wetland. Wetlands will be protected from water quality impacts by the proposed stormwater treatment measures. Only Wetlands 35649 and 35402 will experience changes in their flooding regimes but these changes are expected to be minimal and mainly occur at the high order events, with most significant impacts occurring within the project area. The impacts on the wetlands are therefore considered to be low.

KEY FINDINGS FOR CONSTRUCTION PHASE:

HYDRAULIC MANAGEMENT IMPACT

Clearing of vegetation may result in a reduced capacity of the ground to infiltrate runoff, increasing runoff rates and water quality impacts to the surrounding environment.

Temporary diversion of overland flow and restriction of flow paths also has the potential to change flooding behaviour including increasing flood depths, velocities and or altering the flood location. Wherever possible temporary works required for the project should occur outside the extent of the 1% AEP floodplain, to reduce the risk of increased inundation of properties.

However, due to the location of the project and the numerous watercourse crossings required for each bypass alignment option, it is likely construction elements will occur within the extent of the 1% AEP floodplain. All construction activity and temporary works associated with construction of the drainage and stormwater management systems will need to minimise disturbance and clearance of existing native vegetation.

All RRV maintenance and construction projects are required to develop a Construction Environmental Management Plan (CEMP). To minimise the impact of construction work on overland flow paths and floodplains, a CEMP will be developed in consultation with GHCMA and Pyrenees Shire Council prior to construction commencing.

WATER QUALITY

Construction works may give rise to erosion issues especially in locations where vegetation is removed and sub-soil is left unprotected. Sediment laden runoff from disturbed areas, stockpiles, storage areas and haulage routes may increase turbidity of receiving water bodies resulting in reduced water quality. There is also potential for runoff to contain pollutants including contaminated sediments, oils and/or chemicals.

A stormwater management plan will be developed prior to construction works commencing and will be consistent with *SEPP (Waters) Clause 42,* relevant Environmental Reference Standards and guidance in the Environment Protection Authority (EPA) publications Construction Techniques for Sediment Pollution Control (1991) and Civil construction and demolition guidelines (2020).

The CEMP will identify potential sources of contaminated runoff and procedures to treat and dispose of contaminated runoff ensuring that any runoff from site meets *SEPP (Waters)* requirements.

KEY FINDINGS FOR OPERATIONAL & MAINTENANCE PHASES:

The residual surface water risk associated with the operational phase was considered to be low, with the following key impacts identified:

- The flooding impacts around the main Yam Holes Creek crossing and floodplain in the vicinity of Racecourse Road require additional investigations as part of the detailed design phase to finalise the specific crossing design, which will further minimise and manage afflux and flood hazard impacts on the floodplain and section of Racecourse Road local to the crossing.
- Channel realignments will be carefully designed to ensure flow depths and velocities are minimised to avoid creation of new high hazard flow areas and transitions to the downstream watercourses are designed to avoid long term scour and erosion problems.

RECOMMENDATIONS FOR DETAILED DESIGN PHASE

The following recommendations are made for the detailed design phase:

- The flooding impacts around the main Yam Holes Creek crossing and floodplain in the vicinity of Racecourse Road require additional investigations as part of the detailed design phase to finalise the specific crossing design, which will further minimise and manage afflux and flood hazard impacts on the floodplain and section of Racecourse Road local to the crossing.
- Waterway crossings will be designed to facilitate fauna passage through the following further design developments:
  - replacement of some culverts with bridge structures where technically and economically feasible
  - realignment/repositioning of culverts to reduce culvert length in the direction of flow
  - inclusion of light wells into long culverts; and
  - inclusion of low-level cells to promote permanent or regular wetting of culverts.
- The channel realignments will be carefully designed to ensure flow depths and velocities are minimised to avoid creation of new high hazard flow areas and transitions to the downstream watercourses are designed to avoid long term scour and erosion problems. Ecological and landscape design principles will be used in the design to facilitate fauna passage and the following specific measures will be included:
  - transitions at the downstream ends of the channel realignments into the receiving stream lines that deliver flow at velocities similar to the existing conditions in the receiving streams
  - incorporation of suitable aquatic and terrestrial planting within and along the channel realignments, maximising the use of native species and species resilient to the expected hydraulic and climatic conditions; and
  - inclusion of pool and riffle features, stilling areas and other similar features to provide habitat and refuge for aquatic species.
- The design currently includes bioretention basins to remove pollutants from the road runoff prior to discharge to the receiving environment. Opportunities will be investigated to incorporate these treatment measures into the channel realignments where technically feasible, or to use similar design features (such as planting schemes) to integrate these elements of the water management system.
- Opportunities will be investigated to minimise basin size using a combination of measures such as Gross Pollutant Traps, swales and basins in a treatment train. The stormwater treatment system will be designed to achieve an appropriate balance between treatment outcomes and disturbance and clearing of existing land and vegetation.
- A spills risk assessment will be undertaken and, where required, spill containment will be incorporated into the road drainage/stormwater treatment system design to protect the downstream water quality regime.

RESIDUAL IMPACTS

Residual impacts predicted by this assessment and requiring further consideration at detailed design are as follows:

FLOOD LEVEL IMPACTS

It is expected that the residual impacts on flooding and floodplain/waterway hydraulics will be low following the detailed design phase when the issues below are further addressed:

- The flooding impacts around the main Yam Holes Creek crossing and floodplain in the vicinity of Racecourse Road require additional investigations as part of the detailed design phase to finalise the specific crossing design, which will further minimise and manage afflux and flood hazard impacts on the floodplain and section of Racecourse Road local to the crossing.
- Potential for the waterway crossings, specifically long culverts, and channel realignments to obstruct or restrict fauna passage around the project footprint.

- Potential for hazardous flow conditions to occur within the channel realignments due to the creation of new flow paths and potential for the channel realignments to introduce new scour, erosion and sedimentation issues within the channel realignments themselves and within the receiving streams downstream.

FLOOD VELOCITY IMPACTS

Through further detailed modelling during the detailed design phase and implementation of prescribed mitigations, flood velocity impacts during the operational phase for the 1 EY, 10% AEP and 1% AEP flood events will be low.

FLOOD DURATION IMPACTS

Through further detailed modelling during the detailed design phase and implementation of prescribed mitigations, flood duration impacts during the operational phase for the 1 EY, 10% AEP and 1% AEP flood events will be low.

FLOOD HAZARD IMPACTS

Through further detailed modelling during the detailed design phase and implementation of prescribed mitigations, flood hazard impacts during the operational phase for the 1 EY, 10% AEP and 1% AEP flood events will be low.

WATER QUALITY IMPACTS

It is expected that the residual impacts on water quality will be low following the detailed design phase, when the issues below are further addressed:

- The risk of contamination of the receiving environment as a result of spills is to be investigated through a spills risk assessment and spill containment measures may need to be incorporated into the stormwater management system to address this risk.
- All features of the water management system need to be designed to minimise impacts on existing native vegetation. The stormwater management and treatment system will be designed to achieve an appropriate balance between treatment outcomes and disturbance and clearing of existing land and vegetation.

WETLANDS IMPACTS

Through further detailed modelling during the detailed design phase and implementation of prescribed mitigations, wetland impacts during the construction and operational phases will be low.

1 INTRODUCTION

Regional Roads Victoria (RRV), formerly VicRoads proposes to construct a new freeway section of the Western Highway to bypass the town of Beaufort (the project), linking completed sections of the Western Highway duplication to the east and west of Beaufort.

On 22 July 2015, the Minister for Planning determined an Environment Effects Statement (EES) would be required under the *Environment Effects Act 1978* (EE Act) to assess the potential environmental effects of the project. The EES includes consideration of four alternative alignments and selection of a preferred bypass alignment which identifies the land to be reserved for the future construction. The EES process provides for identification and analysis of the potential environment effects of the project and the means of avoiding, minimising and managing adverse effects. It includes public involvement and allows stakeholders to understand the likely environmental effects of the project and how they will be managed.

1.1 PROJECT BACKGROUND

The Western Highway is the primary road link between Melbourne and Adelaide. It serves interstate trade between Victoria and South Australia and is a key transport corridor through Victoria's west. Over 6,500 vehicles utilise the Western Highway, west of Ballarat each day. Of these 6,500 vehicles, 1,500 are classed as commercial heavy vehicles. These traffic volumes are expected to increase to approximately 7,500 by 2025 and 9,500 by 2040.

RRV have identified the need to upgrade the Western Highway from Ballarat to Stawell to:

- improve road safety at intersections
- improve safety of access to adjoining properties
- enhance road freight efficiency
- reduce travel time
- provide better access to local facilities
- improve roadside facilities.

As part of planning studies commissioned by the Commonwealth and State Governments, bypass route options around the town of Beaufort have been considered to meet the objectives identified by RRV and the National Land Transport Network's Nation Building Program.

The project would include construction of a dual carriageway, connections to major intersecting roads, interchanges to connect Beaufort to the Western Highway at the eastern and western tie-in points, several waterway crossings, an overpass of the Melbourne-Ararat rail line, and intersection upgrades at local roads and provision for service roads as required.

1.2 PROJECT OBJECTIVES

The objectives of the project are to:

- improve road safety and maintain the functionality of Beaufort's road network
- improve freight movement and efficiency across the road network
- improve Beaufort's amenity by removing heavy vehicles
- improve access to markets and the competitiveness of local industries.

2 PROJECT DESCRIPTION

The project would comprise of an 11 km freeway standard bypass to the north of the township of Beaufort, connecting the two recently duplicated sections of the Western Highway to the east and west of Beaufort. The project would be constructed under a Design and Construction or Construction contract administered by a superintendent at RRV/MRPV, following a competitive tender process. Department of Transport would manage and maintain the asset.

2.1 FREEWAY STANDARD BYPASS

The project would connect the duplicated sections of the Western Highway to the east and west of Beaufort via the Option C2 bypass to the north of Beaufort that avoids Snowgums Bushland Reserve and cuts through Camp Hill. The bypass would include the following key components:

- designed as a freeway standard bypass
- approximately 11 km long
- designed to 120 km/hr and sign posted to 110 km/hr for its entirety
- two tie-in interchanges
- one road over rail bridge
- waterway crossings, including combinations of bridges and culverts
- diamond interchange to connect with the local road network
- four overpass bridge structures over the local road network.

2.2 INTERCHANGES

The project would have interchanges at the following locations:

- tie-in points to existing Western Highway at the eastern and western ends of the bypass
- diamond interchange at existing local road network connection (Beaufort-Lexton Road).

2.3 BRIDGES AND CULVERTS

The route option would have bridge structures at the following locations:

- road over rail bridge structure for the Melbourne-Ararat rail line
- several waterway bridge structures over Yam Holes Creek
- overpass bridge structures for the existing local road network:
  - Main Lead Road
  - Beaufort-Lexton Road (diamond interchange)
  - Racecourse Road
  - Back Raglan Road.

2.4 ALIGNMENT DESCRIPTIONS

Four alignment options, referred to as Options A0, A1, C0 and C2, were assessed in order to identify a preferred bypass (see Figure 2.1). Following extensive community consultation and technical assessments, Option C2 was selected as the preferred route.

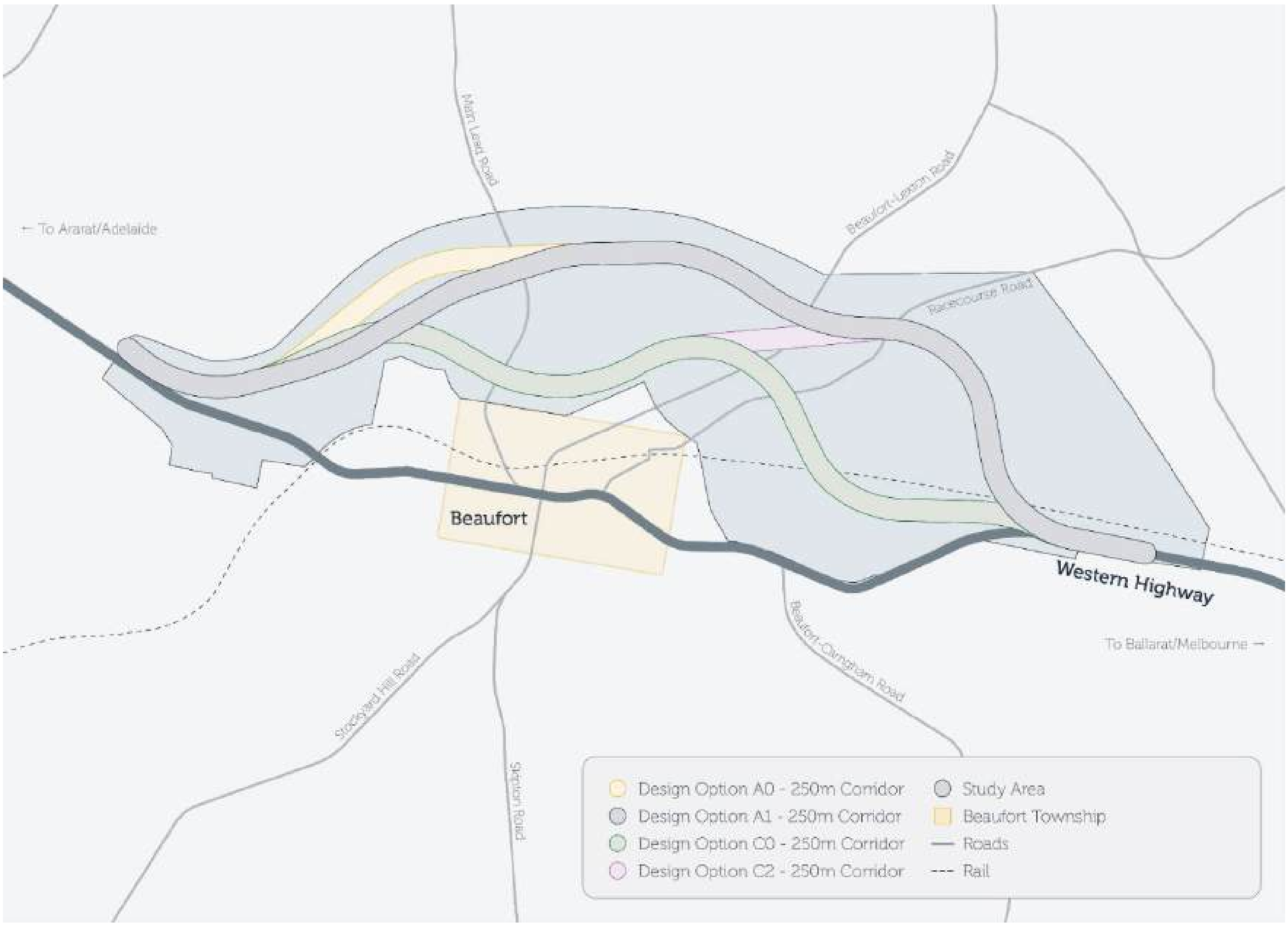

Figure 2.1 Beaufort Bypass alignment options and study area

2.4.1 *OPTIONS ASSESSED*

2.4.1.1 OPTION A0

The A0 bypass alignment is 11.2 km in length and is the northern most bypass option (see Figure 2.2). From the western tie-in point, approximately 3 km from the Beaufort township, this alignment curves north – north east, where there will be a west-facing, half diamond interchange to maintain access to private properties and the township via the existing Western Highway. The alignment passes over Main Lead Road then climbs through the State Forest north of Camp Hill. From here it descends to a full diamond interchange at Beaufort-Lexton Road, which will provide access to the north and south of the township, before re-joining the Western Highway at its eastern extent, approximately 4.5 km from Beaufort. An outbound exit ramp at the eastern interchange will allow for eastern access to Beaufort via the existing Western Highway. Bridges will pass over Main Lead and Racecourse Roads, as well as over the Melbourne-Ararat train line. The main areas of fill occur at bridge and interchange locations with a large cut section north of Camp Hill.

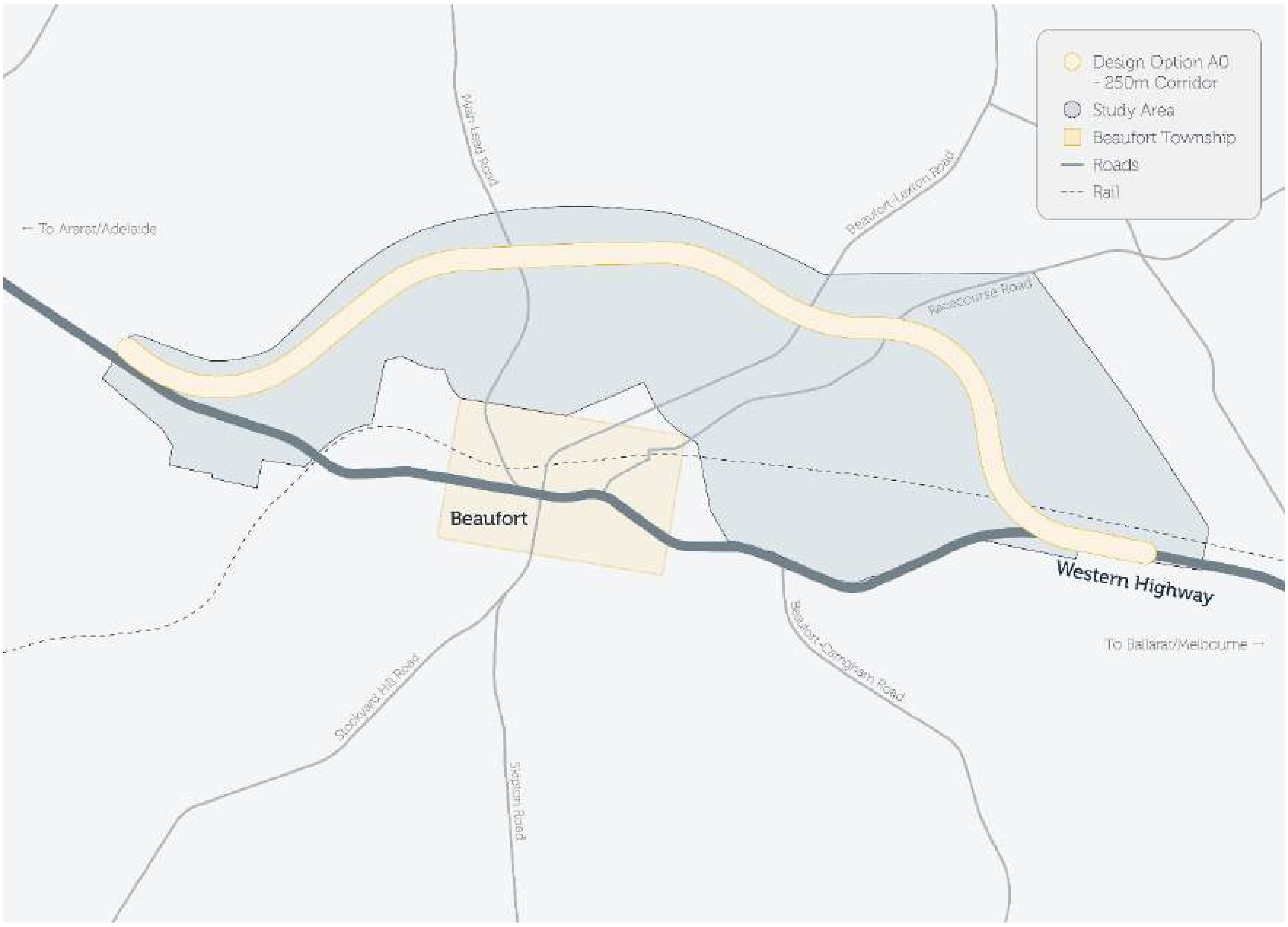

Figure 2.2 Beaufort Bypass A0 alignment option

2.4.1.2 OPTION A1

The A1 bypass alignment option is 11.1 km in length (see Figure 2.3). Approximately 3 km from the Beaufort township, this alignment deviates north-east from the Western Highway, staying slightly south of option A0 until a point east of Main Lead Road, where it re-joins the A0 alignment. There will be a west-facing, half diamond interchange at the western tie-in to maintain access to private properties and the township of Beaufort via the existing Western Highway, and a full diamond interchange at Beaufort-Lexton Road to maintain north-south access. The A1 alignment will re-join the Western Highway approximately 4.5 km to the east of the township. An outbound exit ramp at the eastern interchange will allow for eastern access to Beaufort via the existing Western Highway. Bridges will pass over Main Lead and Racecourse Roads, as well as over the Melbourne-Ararat train line. The main areas of fill occur at bridge and interchange locations, with cuts north-east of Back Raglan Road, and north of Camp Hill.

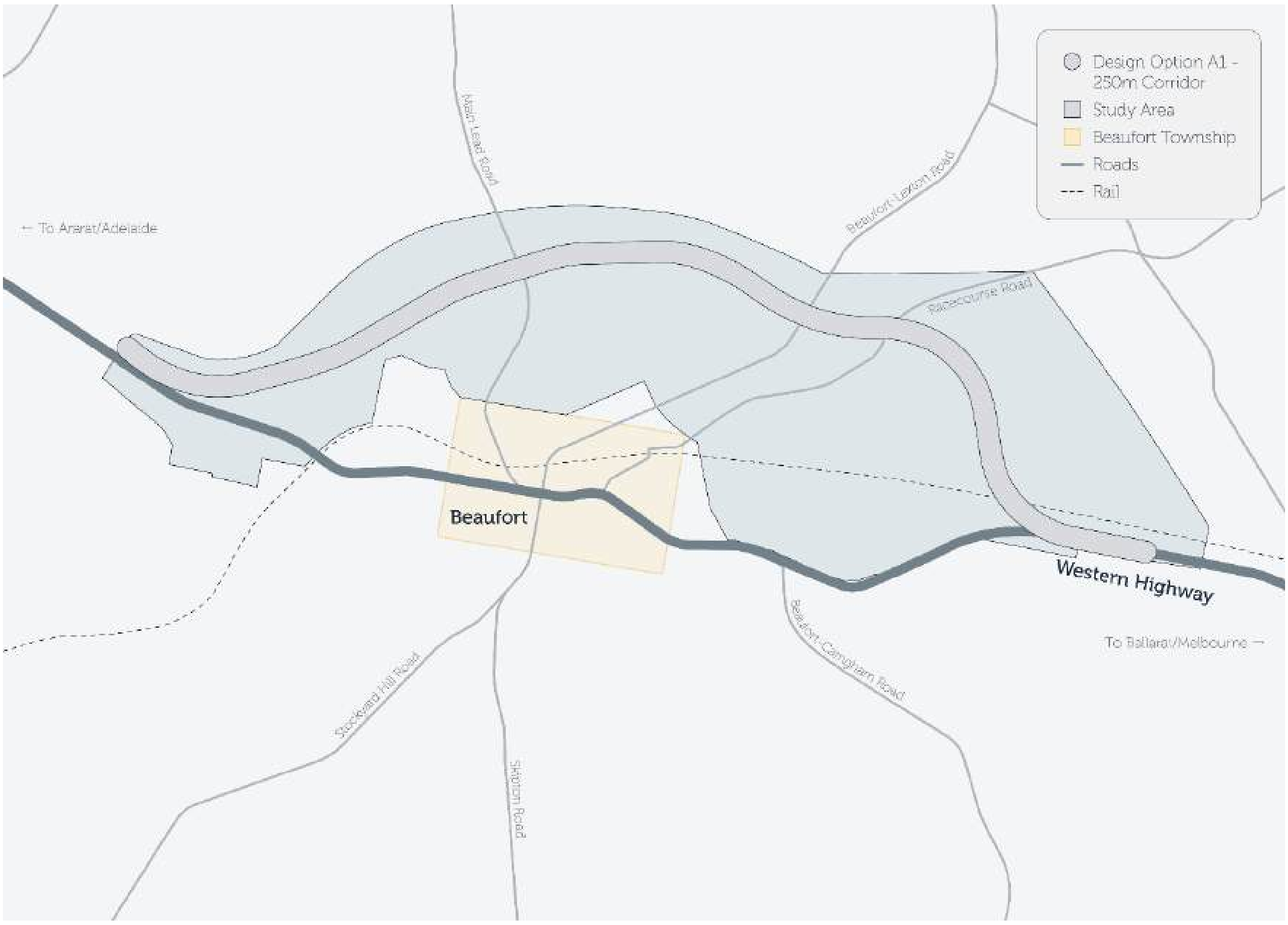

Figure 2.3 Beaufort Bypass A1 alignment option

2.4.1.3 OPTION C0

The southernmost option, C0, is approximately 10.6 km in length from the west to east tie-in points of the Western Highway (see Figure 2.4). Access to the Beaufort township via the existing Western Highway will be maintained by a west -facing, half diamond interchange in the west. The C0 option follows the A0 option from the western tie-in point, approximately 3 km from the Beaufort township, before deviating at Back Raglan Road in a more easterly direction almost parallel to the existing Western Highway. This option passes close to the north of Camp Hill, with some cut and fill required in this section, before curving south-east to a full diamond interchange at Beaufort-Lexton Road, providing north-south access. The C0 alignment will re-join the Western Highway approximately 4.5 km to the east of the township. Bridges will pass over Main Lead and Racecourse Roads, as well as over the Melbourne-Ararat train line. The main areas of fill occur at bridge and interchange locations, with the largest cut and fill areas north and north-east of Camp Hill.

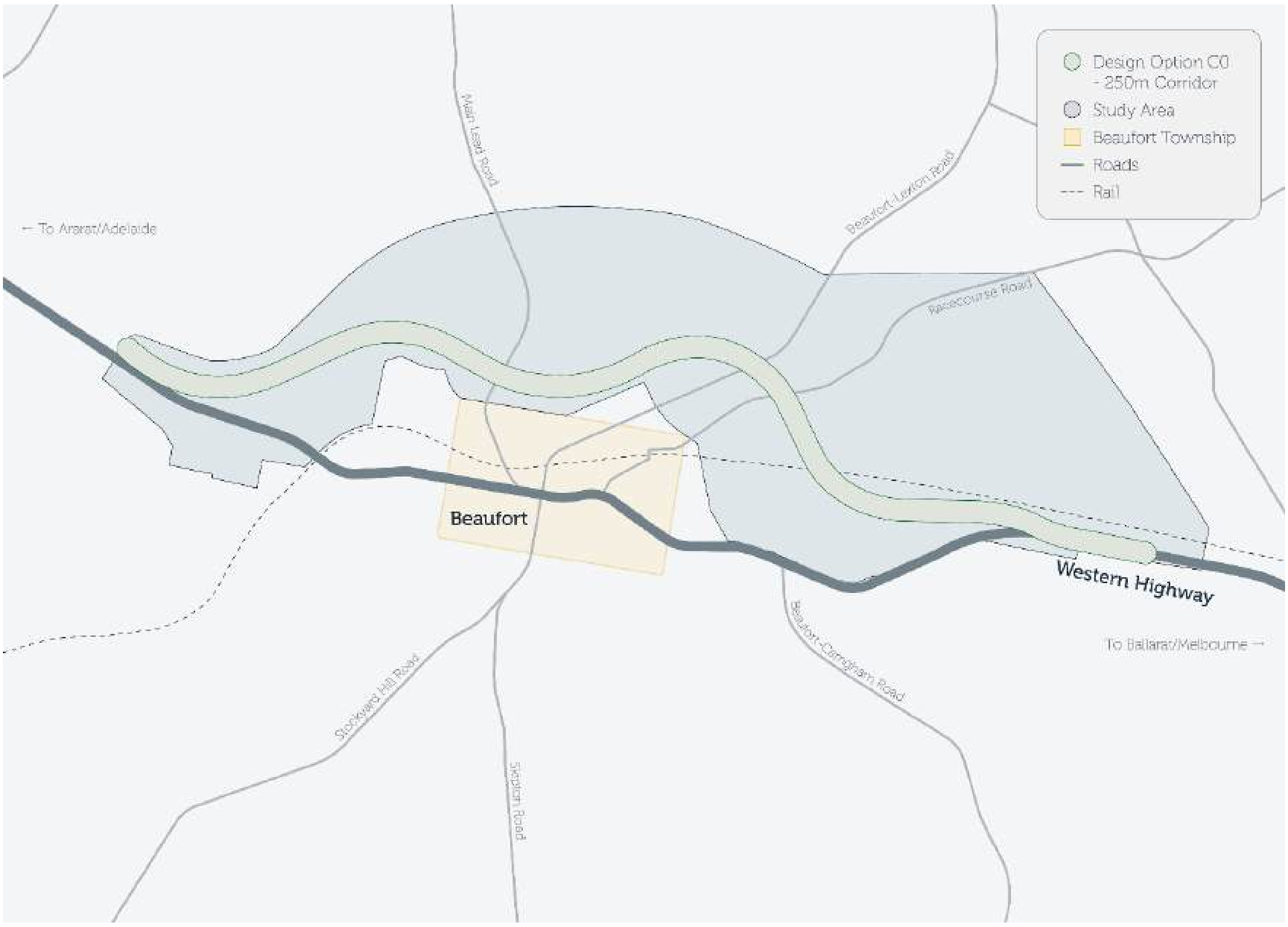

Figure 2.4 Beaufort Bypass C0 alignment option

2.4.2 PREFERRED ALIGNMENT

2.4.2.1 OPTION C2

Option C2 is 11 km in length and is a hybrid between the A0 and the C0 options (see Figure 2.5). It follows the C0 option from the western tie-in point (approximately 3 km from the Beaufort township) until Beaufort-Lexton Road, where it continues in an easterly direction and joins the A0 alignment near Racecourse Road. The C2 alignment will re-join the existing Western Highway at the eastern tie-it point, approximately 4.5 km from the township. At the western extent, access to Beaufort via the existing Western Highway will be maintained by a half diamond interchange, and there will be a full diamond interchange over Beaufort-Lexton Road. Access to Beaufort via the existing Western Highway at the eastern approach will be maintained by an outbound exit ramp at the eastern interchange. Again, bridges will pass over Main Lead and Racecourse Roads, as well as over the Melbourne-Ararat train line. The main areas of fill occur at bridge and interchange locations, with the largest cut and fill areas north and north east of Camp Hill.

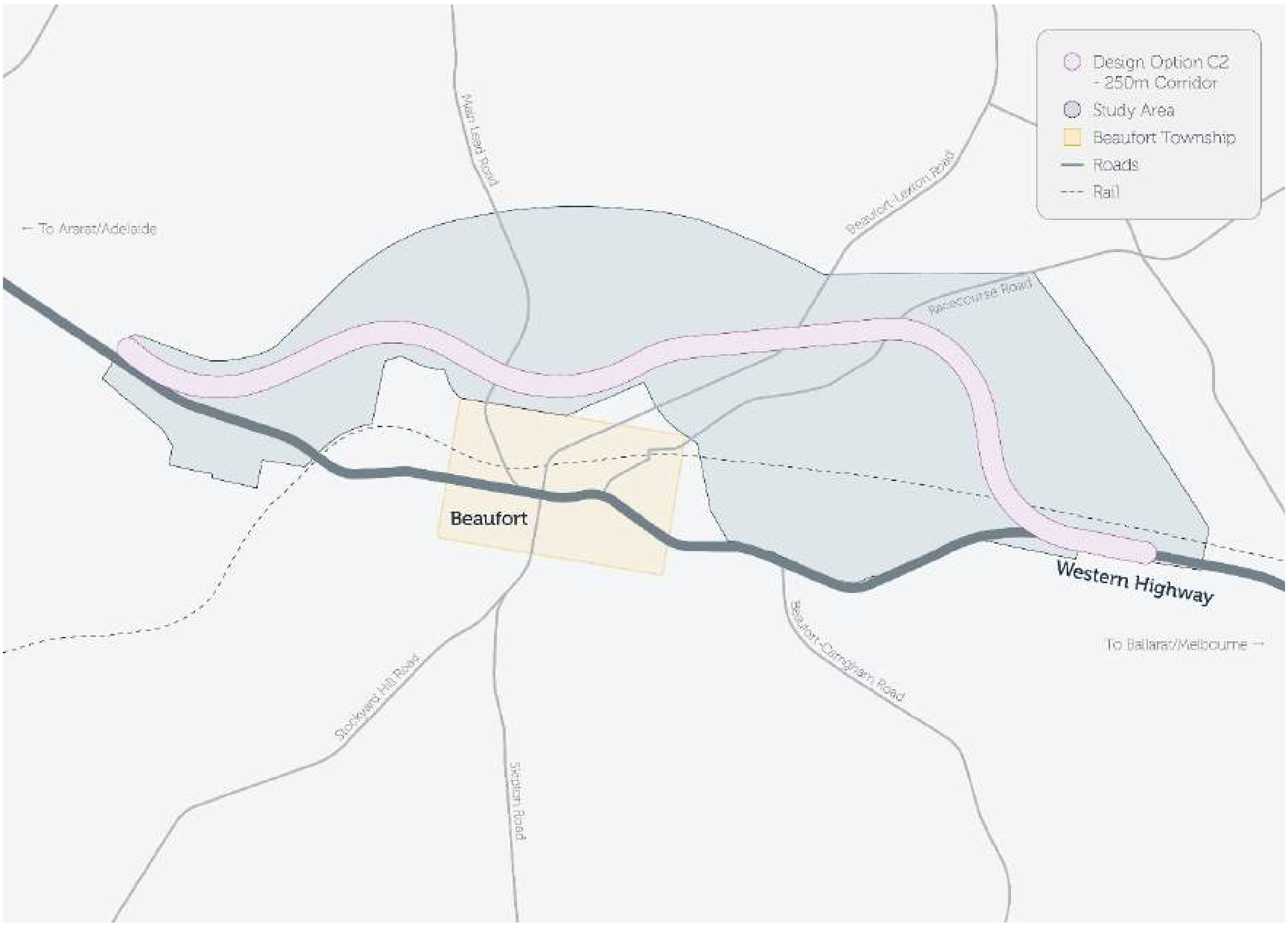

Figure 2.5 Beaufort Bypass C2 alignment option

2.5 PROJECT CONSTRUCTION

The following construction sub-sections describe the construction activities for the project. Construction of the bypass is expected to take two years and commence once construction funding and approvals are obtained.

2.5.1 *CONSTRUCTION ACTIVITIES*

Construction activities would include:

- preconstruction site delineation and compound setup, which may include (but not be limited to) tree clearance and vegetation lopping/removal, and establishment of construction site(s) and access tracks
- establishment of environmental and traffic controls
- route clearance and relocation and/or protection of utilities
- construction drainage and sediment and erosion control mitigation
- general earthworks:
  - excavation of a cut including stripping of topsoil and placement of fill
  - import, export and stockpiling of fill
  - treatment of contaminated soil or removal of hazardous material, if required
- development of structures, interchanges, batters, drainage and pavement
- development of ancillary infrastructure:
  - noise barriers
  - lighting
  - safety barriers
  - line marking
- landscaping and site reinstatement.

2.6 OPERATIONS AND MAINTENANCE

Operations and maintenance of the project would be consistent with current practices and standards, including the VicRoads' *Roadside Management Strategy* (2011). Key objectives include:

- asset management of:
  - landscaped areas
  - stormwater drains
  - bridges and culverts
  - road pavement
  - signage
  - barriers
  - line marking
- enhancement of transport safety, efficiency and access
- protection of environmental and cultural heritage values
- management of fire risk
- preservation and enhancement of roadside amenity
- routine and life cycle maintenance activities throughout operations
- monitoring and management of areas of environmental sensitivity such as water bodies and wildlife corridors.

3 EES SCOPING REQUIREMENTS

The *Scoping Requirements for Beaufort Bypass Project Environment Effects Statement* (DELWP 2016) (Scoping Requirements) have been prepared by DELWP on behalf of the Minister for Planning. The Scoping Requirements set out the specific environmental matters to be investigated and documented in the EES, which informs the scope of the EES technical studies.

The following matters of the Scoping Requirements are relevant to the Surface Water impact assessment:

EES EVALUATION OBJECTIVE

Catchment values and hydrology: To protect catchment values, surface water and groundwater quality, stream flows and floodway capacity, and avoid impacts on protected beneficial uses.

Table 3.1 EES scoping requirements – Surface water

SCOPING REQUIREMENTS SUB-SECTION	MATTER TO BE ADDRESSED	RELEVANT ASSESSMENT	ADDRESSED IN THIS ASSESSMENT
Key issues	Potential changes to the extent and severity of floodwaters in the area, that could have an effect on Beaufort or other significant locations.	Surface water	✓
	Potential adverse effects on the functions and values of existing waterways during construction and operation.	Surface water	✓
	Potential for unsuitable soil conditions to support the proposed bypass, including the potential for unearthing acid sulphate and contaminated soils.	Geology and soils	EES Chapter 20 (Soils, geology and contaminated land)
	Potential for effects on surface water quality, stream flows and ground water, in particular on protected beneficial uses.	Surface water	✓
		Groundwater	EES Chapter 13 (Groundwater)
	Potential for increased salinity, and related impacts on vegetation, soil and habitat values.	Groundwater	EES Chapter 13 (Groundwater)
		Biodiversity and habitat	EES Chapter 9 (Biodiversity and habitat)
		Geology and soils	EES Chapter 20 (Soils, geology and contaminated land)

SCOPING REQUIREMENTS SUB-SECTION	MATTER TO BE ADDRESSED	RELEVANT ASSESSMENT	ADDRESSED IN THIS ASSESSMENT
Priorities for characterising the existing environment	Undertake a hydrology assessment of the study area for the proposed project consistent with outcomes of the Glenelg Hopkins Catchment Management Authority (GHCMA) catchment and modelling study of Beaufort.	Surface water	✓
	Identify and characterise surface water environments, ground water, salinity and floodplain environments that could be affected by relevant alternatives, including an analysis of drainage features and flood behaviour.	Surface water	✓
		Groundwater	EES Chapter 13 (Groundwater)
	Undertake a geotechnical assessment to identify soil types and structures in the study area and to identify the potential for unsuitable soil conditions to support the bypass, and potential location of acid sulphate, contaminated soils and fill.	Geology and soils	EES Chapter 20 (Soils, geology and contaminated land)
Design and mitigation measures	Undertake assessment (modelling) of the hydrology of the study area to inform concept design(s) to minimise the impacts of the proposed project.	Surface water	✓
	Identify potential and proposed design alternatives and mitigation measures which could avoid or minimise effects on catchment functions and values, in particular for creeks and other surface water environments.	Surface water	✓
	Identify the potential risks at waterway crossings, and the potential for soil erosion, soil stability, aquifers, acid sulphate, cut and fill and storage of top soil in flood plains.	Surface water	✓
		Geology and soils	EES Chapter 20 (Soils, geology and contaminated land)
		Groundwater	EES Chapter 13 (Groundwater)
	Identify potential and proposed design alternatives and mitigation measures which have the least environmental, social, and economic impact.	Surface water	✓
		Economic impact assessment	EES Chapter 16 (Economics)
		Social impact assessment	EES Chapter 14 (Social impact assessment)

SCOPING REQUIREMENTS SUB-SECTION	MATTER TO BE ADDRESSED	RELEVANT ASSESSMENT	ADDRESSED IN THIS ASSESSMENT
Assessment of likely effects	Identify potential effects of alternatives on surface water environments especially in relation to run-off impacts on water quality and flood flows.	Surface water	✓
	Assess the potential for effects of alignment alternatives on groundwater and for effects of groundwater on the proposed project, as a result of intersection works with the groundwater.	Groundwater	EES Chapter 13 (Groundwater)
	Assess the potential for effects associated with the exposure and disposal of any waste including acid sulphate and contaminated soils.	Geology and soils	EES Chapter 20 (Soils, geology and contaminated land)
	Identify the potential risks of saline discharges and discharge impacts to soil, vegetation and habitat.	Geology and soils	EES Chapter 20 (Soils, geology and contaminated land)
		Biodiversity and habitat	EES Chapter 9 (Biodiversity and habitat)
		Groundwater	EES Chapter 13 (Groundwater)
	Confirm which alignment alternatives have the greatest risk from a geotechnical perspective and the relative cost implications of each alignment alternative.	Geology and soils	EES Chapter 20 (Soils, geology and contaminated land)
Approach to manage performance	Identify proposed principles or approach for managing surface run-off, preventing sedimentation of waterways, flood risks and risks associated with excavation spoil, areas of contaminated land and other waste management.	Surface water	✓
		Geology and soils	EES Chapter 20 (Soils, geology and contaminated land)
	Identify an approach to manage risk and impacts associated with construction and operation.	Surface water	✓
	Include identified measures in the EMF.	Surface water	✓

4 METHODOLOGY

4.1 STUDY AREA

The terminology utilised throughout the current technical assessment relating to the study area and alignment options is defined below.

Study area: The study area for the Beaufort Bypass EES project includes approximately 1,800 ha of land north of the Beaufort township, which contains the four bypass options assessed in this report. During the development stages of the alignment options, the study area was assessed to determine potential environmental impacts and constraints to individual alignment options.

Alignment options: Alignment options (A0, A1, C0 and C2) refer to the four selected bypass options assessed within the study area. Each alignment option consists of a 250 m corridor in which the specific bypass option has been designed. Each alignment option, unless otherwise stipulated, is the area assessed for direct and indirect impacts resulting from the construction, operation and maintenance of the project.

4.2 EXISTING CONDITIONS ASSESSMENT

The existing surface water conditions including catchments that interact with the study area, key flow paths and wetland systems are described in Section 6, with associated maps presented in Appendix A. The existing conditions of surface water bodies within the project area has been assessed based on a field assessment, review of publicly available information and previous modelling studies.

The desktop assessment has been supplemented with hydrologic and hydraulic modelling to provide a detailed quantitative assessment of existing conditions. The modelling results were used to identify the existing floodplain extents and depth where background data or flood overlay information was not available.

4.2.1 BACKGROUND INFORMATION

The following background information relevant to surface water was used for the assessment:

- previous studies – reports and models (refer to Appendix B)
- aerial photography
- topographic data – contours, LiDAR, photographs of structures and feature survey
- waterway, channel, underground pipe, water body, wetland and other drainage infrastructure GIS data
- Standard or Typical transverse drainage infrastructure drawings
- Drainage Scheme (DS) information
- Planning Scheme Overlays (e.g. LSIO, Special Building Overlay (SBO))
- project boundaries.

4.2.2 WATER QUALITY ASSESSMENT

The water quality assessment has been conducted through a desktop data review. The desktop review looked at available water quality reports and previous study reports to establish the existing conditions of the local waterways. Details of this assessment is presented in Section 6.7.

4.2.3 HYDROLOGIC STUDY

Hydrologic and hydraulic modelling was conducted for the study area and its contributing catchments. The purpose of this modelling was to define the existing flood conditions in the project area to enable a detailed analysis of flood impacts and the subsequent investigation of mitigation measures.

A rainfall-runoff model for Yam Holes Creek to Beaufort using hydrology software RORB was developed for the Beaufort Township Flood Study by Water Technology (2008), which was used as the basis of current hydrologic modelling. This hydrologic model was also used by Pyrenees Shire Council in developing the Beaufort Local Floodplain Development Plan (March 2011) and establishing the Land Subject to Inundation Overlay and Floodway Overlay.

The RORB model was extended further downstream to include the additional contributing catchments to Yam Holes Creek to the confluence of Mount Emu Creek. This model enabled estimation of the baseline peak flows at key locations in the study catchment. The details of this assessment are presented in Section 6.5.

4.2.4 HYDRAULIC MODELLING

TUFLOW modelling software was used to establish the extent of the floodplain for a range of flood events for the base case or existing conditions scenario. The TUFLOW model extended upstream at Yam Holes Creek's tributaries to the east of Beaufort and downstream to Yam Holes Creek crossing at Racecourse Road. During the hydraulic modelling, consultation with project Ecologists regarding the prioritisation of bridge and culvert structures was undertaken and input into the TUFLOW model. Ecological bridge and culvert prioritisation is discussed further in EES Appendix E: *Flora and fauna impact assessment* (WSP 2021)

4.3 SURFACE WATER ASSESSMENT CRITERIA

The surface water objectives and performance criteria were identified for the operational and construction phases based on key legislation, policies and guidelines (refer to Section 5 for a list of the key legislation).

4.3.1 OPERATIONAL PHASE

4.3.1.1 SEPP (WATERS) POLICY

The *SEPP (Waters)* sets the framework for the protection and improvement of water quality in Victorian waters. The application of this policy extends to all waters throughout Victoria, including surface water, groundwater and State Waters. The definition of surface water in *SEPP (Waters)* excludes water in artificial assets constructed for a specific purpose such as, constructed stormwater drains, constructed wetlands and other artificial assets determined by the Authority.

The *SEPP (Waters)* policy sets out:

- uses and values of water environments that communities want to protect (known as beneficial uses)
- establishes environmental quality objectives and obligations required to protect beneficial uses and improve water quality (known as environmental quality indicators and objectives)
- provides the rules for decision-making by protection agencies to protect beneficial uses and improve water quality.

The types and level of protection of beneficial uses depend on the segment of surface water environment the project area belongs to. The project area is within the *Inland Waters* segment *Rivers and Streams – Central Foothills and Coastal Plains.* This segment applies to a broad region across the state of Victoria and comprises of rivers and stream reaches generally above 200 mAHD in the central foothills. The catchments and basins included in this segment are the uplands of Moorabool, Werribee, Maribyrnong, Campaspe, Loddon, Avoca, Wimmera and Hopkins basins.

A review of the Victorian Wetland Inventory identified several 'palustrine' and 'lacustrine or palustrine' (classified as unknown) wetlands that are within the project area boundary. Therefore, the *Inland Waters* segments of *Rivers and Streams – Central Foothills and Coastal Plains* and *Wetlands* were assigned to this project area.

SEPP (WATERS) – REGIONAL BENEFICIAL USES

The *SEPP (Waters)* lists the range of beneficial uses to be protected in the *Inland Waters* segment *Rivers and Streams* and *wetlands*, which is where this project area is located. The beneficial uses are presented in Table 4.1.

Table 4.1 Beneficial uses for inland water segments rivers and streams and wetlands

BENEFICIAL USE	RIVERS AND STREAMS CENTRAL FOOTHILLS AND COASTAL PLAINS	WETLANDS LAKES AND SWAMPS
Water dependent ecosystems and species that are: Slightly to moderately modified	✓	✓
Human consumption after appropriate treatment	where water is sourced for supply in accordance with the special water supply catchments area set out in Schedule 5 of the *Catchment and Land Protection Act 1994* or the *Safe Drinking Water Act 2003*	
Agriculture and irrigation	✓	✓
Human consumption of aquatic foods	✓	✓
Aquaculture	where the environmental quality is suitable and an aquaculture licence has been approved in accordance with the *Fisheries Act 1995*	
Industrial and commercial	✓	
Water-based recreation (primary contact, secondary contact and aesthetic enjoyment)	✓	✓
Traditional owner cultural values	✓	✓
Cultural and spiritual values	✓	✓

A search of the Victorian Water Register shows 119 non-tradable licences and 152 Surface Water licences in the Hopkins Catchment. None of these licences are located on Yam Holes Creek.

SEPP (WATERS) – REGIONAL CATCHMENT WATER QUALITY OBJECTIVES

The water quality objectives for key environmental indicators and objectives, as set out in Table 1 Schedule 3 of *SEPP (Waters)*, are tabulated in Table 4.2.

For the beneficial use of water dependent ecosystems and species, the *SEPP (Waters)* recognises different levels of ecosystem protection and sediment quality objectives for inland and marine waters. Details of protecting ecosystems and species is not included in this Surface Water Impact Assessment report and are provided in the EES Appendix C: *Flora and fauna impact assessment, WSP 2021*.

Environmental quality indicators and objectives for aquaculture and the beneficial use of water-based recreation are also provided in *SEPP (Waters)*. These environmental quality indicators are not impacted by the proposed project (as they relate to wastewater indicators) and have not been included in this assessment.

Table 4.2 Environmental quality indicators and objectives for rivers and streams segment – Central Foothills and Coastal Plains and Wetlands

ENVIRONMENTAL QUALITY INDICATORS	ENVIRONMENTAL QUALITY OBJECTIVES		
	Central Foothills and Coastal Plains ***(Slightly to moderately modified) ****	**Wetland Type** Riverine Floodplain**	**Wetland Type** Flow-through**
Total Phosphorus (µg/L)	75^{th} percentile ≤ 60	75^{th} percentile = 100	75^{th} percentile = 30
Total Nitrogen (µg/L)	75^{th} percentile ≤ 1100	75^{th} percentile = 1500	75^{th} percentile = 500
Dissolved oxygen (percent saturation)	25th percentile > 70 Maximum = 130	Minimum = 80 Maximum = 120	Minimum = 80 Maximum = 120
Turbidity (NTU)	75^{th} percentile ≤ 25	75^{th} percentile = 15	75^{th} percentile = 5
Electrical Conductivity (µS/cm@ 25 °C)	75^{th} percentile ≤ 2000	N/A	1,500
pH (pH units)	25th percentile > 6.8 75th percentile < 8.0	Minimum = 6.5 Maximum = 8.5	Minimum = 6.5 Maximum = 8.5
Toxicants Water (% protection)	95	95	95
Toxicants Sediment	Low	Low	Low

* Uplands of Moorabool, Werribee, Maribyrnong, Campaspe, Loddon, Avoca, Wimmera and Hopkins basins
** Wetlands are located within the Yam Holes Creek channel and within proposed flood overlays LSIO and FO

4.3.1.2 SEPP (WATERS) – OPERATIONAL PHASE WATER QUALITY PERFORMANCE CRITERIA

Clause 34 of the *SEPP (Waters)* classifies runoff from roads as urban stormwater. Therefore, the project must meet the requirements of the *SEPP (Waters)* for urban stormwater runoff, which includes the protection of beneficial uses and the demonstration of best practice.

Best practice is defined in the *SEPP (Waters)* as "the best combination of techniques, methods, processes or technology used in an industry sector or activity that demonstrably minimises the environmental impact of that industry sector or activity." This approach requires proposed road projects to meet the best practice performance objectives and process outlined in:

- Urban Stormwater: Best Practice Environmental Management Guidelines, Victorian Stormwater Committee (1999) (BPEMG); and
- Austroads Guidelines for Road Drainage (AGRD).

The impacted areas in this project are along the proposed bypass corridors located in the sub-catchments of Yam Holes Creek. According to the BPEMG and AGRD Guidelines, WSRD is required to:

- protect the existing natural features and ecological processes
- maintain the natural hydrologic behaviour of the catchments
- protect water quality of surface and groundwater; and
- integrate water into the landscape to enhance visual, social, cultural and ecological values.

In general, road catchments are relatively small compared to the catchment of the waterway upstream of the discharge points. The impact on total flow downstream of these discharge points is expected to be minimal. However, the impact may become more notable further downstream where flow from numerous sub-catchments converge.

The performance criteria for stormwater quality and environmental flow regime impacts, as per BPEMG and AGRD, are summarised in Table 4.3.

Table 4.3 Performance criteria for water quality and flow regime impacts

INDICATORS	TARGETED REDUCTION OF TYPICAL URBAN (ROAD) ANNUAL LOAD
Total suspended solids (TSS)	80% retention of the typical urban annual load
Total phosphorus (TP)	45% retention of the typical urban annual load
Total nitrogen (TN)	45% retention of the typical urban annual load
Litter	70% retention of the typical urban annual load
Flow	Maintain discharges for the 1.5 year Average Recurrence Interval (ARI) at pre-development rates

Under the provisions of *Clause 22.03* of the Pyrenees Planning Scheme – Floodplain Management in Beaufort, the key water quality objective relevant to the bypass alignments is:

- to protect surface and ground water quality and preserve important wetlands and areas of environmental significance.

4.3.1.3 SEPP (WATERS) – OPERATIONAL PHASE FLOODING PERFORMANCE CRITERIA

Clause 46 of the *SEPP (Waters)* requires Councils and CMAs to ensure the management and protection of beneficial uses of floodplains, and in particular that:

- land use or works on flood-prone areas do not increase the risk during flood events of transportation of materials which would pose a risk to beneficial uses
- waterways and their floodplains retain sufficient flood detention capacity to moderate peak flows to protect the beneficial uses of downstream waterways.

Under the provisions of Clause 22.03 of the Beaufort Planning Scheme – Floodplain Management in Beaufort, the key objectives relevant to the bypass alignments are:

- to limit to acceptable levels, the effect of flooding for the well-being, health and safety of flood-prone individuals and communities
- to minimise flood risk and promote sustainable use and development of the floodplain
- to ensure development and land use on the floodplain is consistent with flood risk
- to ensure that where permitted, development in the floodplain
  - maintains the free passage and temporary storage of floodwaters
  - minimises flood damage
  - will not cause any significant rise in flood level or flow velocity, and
  - will not cause any impact on adjacent properties
- to discourage the intensification of land use and development in the floodplains of the Yam Holes, Ding Dong, Cemetery and Cumberland Creeks at Beaufort
- to recognise the natural flood carrying capacity of rivers, streams and wetlands and the flood storage function of the floodplains
- to minimise risk associated with overland flow of storm water.

4.3.2 CONSTRUCTION PHASE

4.3.2.1 SEPP (WATERS) – CONSTRUCTION PHASE WATER QUALITY PERFORMANCE CRITERIA

Clause 42 of the *SEPP (Waters)* requires construction works be managed:

- to minimise, the risk to beneficial uses, so far as reasonably practicable, including risks from land disturbance, soil erosion and the discharge of sediment and other pollutants to surface waters
- by monitoring surface waters where the construction activity adjoins or crosses surface water to assess if beneficial uses are being protected
- through compliance with guidelines published or approved by the Authority in relation to the construction activity.

4.4 RISK ASSESSMENT

An environmental risk assessment (ERA) has been utilised in the Beaufort Bypass EES to identify environmental impacts associated with the construction and operation phases of the project. The risk assessment process is consistent with the guidance provided in Sections 3.1 and 4 of the *Scoping Requirements for the Beaufort Bypass Project EES* (DELWP 2016) and the *Ministerial guidelines for assessment of the environmental effects under the Environment Effects Act 1978* (DSE 2006).

The purpose of the ERA was to provide a systematic approach to the identification and further assessment of potential impacts resulting from the project, whether they be environmental, social or economic. The ERA articulates the probability of an incident with environmental, social or economic effects occurring and the consequence of that impact to the environment. Identified potential impacts with a medium or higher initial risk are subject to detailed impact assessment and mitigation treatments, detailed within each discipline impact assessment.

RRV defines risk and impact as:

- "*Environmental risk reflects the potential for negative change, injury or loss with respect to environmental assets*" (DSE 2006). This approach is consistent with ISO 31000: 2018, which defines risk as "*the effect of uncertainty of [environmental] objectives*". Both definitions reflect the fact that risk is typically expressed in terms of the likelihood of a change occurring and the consequence of that change.
- Environmental impact is described as any change to the environment as a result of project activities.

The risk assessment is a critical part of the EES process as it guides the level and range of impact assessment for the EES and facilitates a consistent approach to risk assessment across the various disciplines.

4.4.1 RISK ASSESSMENT PROCESS

The ERA has guided the environmental impact assessment for the project. The objectives of the ERA are to:

- identify primary environmental risks that relate to the construction and operation of the project
- guide the level and extent of investigation and data gathering necessary for accurately characterising the existing environment and assessing the project's environmental impact
- help identify mitigation measures to avoid, minimise and mitigate environmental risks
- inform assessment of likely residual effects that are expected to be experienced after standard controls and proposed mitigations have been implemented.

The risk assessment process for the EES adopts a risk management framework as detailed in the VicRoads Environmental Sustainability toolkit. The process includes:

- an approach to environmental management which is aligned with ISO 31000: 2018
- systems used to manage environmental risk and protect the environment, and how these are implemented at different stages of road construction, operation and maintenance
- tools and reporting requirements which provide guidance in managing environmental issues throughout the project.

The ERA identifies impact events for each relevant element of the environment, details the primary risks and has informed the level and range of technical reporting required to address predicted impacts. The ERA utilises a risk matrix approach where the likelihood and consequence of an event occurring are considered (Table 4.4, Table 4.5 and Table 4.6). All risks are reassessed at regular intervals during all phases of the project, from the development of the EES to operation and maintenance, to ensure they are still applicable, that controls are appropriate and effective, and that they reflect most recent outcomes of specialist technical studies.

Table 4.4 Risk assessment matrix

			LIKELIHOOD				
CONSEQUENCE	**Risk categories**		**Rare (A)**	**Unlikely (B)**	**Possible (C)**	**Likely (D)**	**Almost Certain (E)**
	Catastrophic	**5**	Medium	High	High	Extreme	Extreme
	Major	**4**	Medium	Medium	High	High	Extreme
	Moderate	**3**	Low	Medium	Medium	High	High
	Minor	**2**	Negligible	Low	Low	Medium	Medium
	Insignificant	**1**	Negligible	Negligible	Negligible	Low	Low

Based on the project objectives and context, a set of project-specific and appropriate assessment, likelihood and consequence criteria were developed.

The likelihood categories and consequence descriptions are used as a guide for evaluating risk and are shown below in Table 4.5 and Table 4.6.

Table 4.5 Likelihood categories

RARE (A)	**UNLIKELY (B)**	**POSSIBLE (C)**	**LIKELY (D)**	**ALMOST CERTAIN (E)**
Less than once in 12 months OR 5% chance of recurrence during course of the contract	About once in 6 months OR 10% chance of recurrence during course of the contract	About once in 4 months OR 30% chance of recurrence during course of the contract	About once in 2 months OR 50% chance of recurrence during course of the contract	About once in a month OR 100% chance of recurrence during course of the contract
The event may occur only in exceptional circumstances	The event could occur but is not expected	The event could occur	The event will probably occur in most circumstances	The event is expected to occur in most circumstances
It has not happened in Victoria but has occurred on other road projects in Australia.	It has not happened regionally but has occurred on other road projects in Victoria	It has happened in the Beaufort region	It has happened on an adjoining section of the Western Highway	It has happened on more than one of the adjoining Western Highway projects OR It has happened multiple times on an adjoining Western Highway project.

Consequence criteria have been developed for the project in consultation with technical specialists. The result is a discipline and aspect-specific set of consequence descriptors used to define what would be considered an Insignificant, Minor, Moderate, Major and Catastrophic consequence associated with a risk event.

Table 4.6 Environmental risk assessment consequences descriptors

ASPECT	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC
Construction impact on water quality	Construction activities and/or runoff from construction site meets approved CEMP water management strategy, applicable water quality standards, SEPP (Waters) or VicRoads Water Management Guidelines	Construction activities and/or runoff from construction site results in temporary isolated and marginal exceedance of approved CEMP water management strategy, SEPP (Waters) or VicRoads Water Management Guidelines	Construction activities and/or runoff from construction site results in marginal exceedance of approved CEMP water management strategy, SEPP (Waters) or VicRoads Water Management Guidelines in a local area	Construction activities and/or runoff from construction site results in significant exceedance of approved CEMP water management strategy, SEPP (Waters) or VicRoads Water Management Guidelines in a number of local areas	Construction activities and/or runoff from construction site results in widespread exceedance of approved CEMP water management strategy, SEPP (Waters) or VicRoads Water Management Guidelines across the region
Operations impact on water quality	Road runoff meets SEPP (Waters) and applicable water quality standards and guidelines	Road runoff results in temporary isolated and marginal exceedance of SEPP (Waters) and applicable water quality standards and guidelines	Road runoff results in Marginal, temporary exceedance of SEPP (Waters) and applicable water quality standards and guidelines in a local area	Road runoff results in significant exceedance of SEPP (Waters) and applicable water quality standards and guidelines in a number of local areas	Road runoff results in widespread exceedance of SEPP (Waters) and applicable water quality standards and guidelines across the region
Design changes surface water flow regime or floodplain function (such as temporary storage of floodwater and/or beneficial uses)	The final bypass design results in negligible change to waterway flow regime or floodplain function	The final bypass design results in an isolated or marginal change to waterway flow regime or floodplain function	The final bypass design results in marginal changes to waterway flow regime or floodplain function at a number of localised areas	The final bypass design results in a significant change of waterway or floodplain function at a number of localised areas	The final bypass design results in extensive impact to waterway flow regime or floodplain function throughout the catchment

ASPECT	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC
Design increases flooding impacts	Flooding and overland flows are: — confined to existing floodway land and — do not expand to flood-prone land	Flooding and overland flows are: — confined to existing flood-prone land and — comply with CMA requirements	Flooding and overland flows are: — confined to existing flood-prone land and does not expand to flood-free land and — exceedance of CMA requirements (10 mm or greater) at localised area	Flooding and overland flows causing: — existing flood-free land to become flood-prone and — exceedance of CMA requirements (10 mm or greater) at a number of localised areas	Flooding and overland flows that cause: — existing flood-free land to become flood-prone and — exceedance of CMA requirements (10 mm or greater) across the region
Construction effects on protected beneficial uses	Negligible impact on beneficial uses as set out in the SEPP (Waters) under policy area Cleared Hills and Coastal Plains	Short term (Construction), localised (single point source) impact on Beneficial uses as set out in the SEPP (Waters) under policy area Cleared Hills and Coastal Plains	Short term (Construction), whole alignment impact on beneficial uses as set out in the SEPP (Waters) under policy area Cleared Hills and Coastal Plains	Long term (beyond construction phase of project), whole alignment impact on beneficial uses as set out in the SEPP (Waters) under policy area Cleared Hills and Coastal Plains	Irreversible or long term (beyond construction phase of project), regional impact on beneficial uses as set out in the SEPP (Waters) under policy area Cleared Hills and Coastal Plains

The risk assessment was undertaken for each discrete alignment option as each option had a distinct profile, type and extent of environmental impacts. The assessment of these impacts is detailed within Sections 7 and 9 of this report.

4.5 IMPACT ASSESSMENT

4.5.1 OVERVIEW

The impact assessment was undertaken in two stages:

- combination of qualitative and quantitative assessments of the four alignment options
- quantitative assessment of the preferred C2 alignment.

The stage 1 impact assessment is presented in Section 7 and the stage 2 impact assessment is presented in Section 9. Sections 4.5.2 to 4.5.4 describe the methodologies used for the stage 2 impact assessment.

4.5.2 *STAGE 2 ASSESSMENT OF FLOODPLAIN IMPACTS*

4.5.2.1 BASE CASE HYDROLOGICAL AND HYDRAULIC ANALYSIS

The hydrological (RORB) and hydraulic (TUFLOW) models were used to establish the base case flood behaviour for a range of flood events, including:

- the 1 Exceedance per Year (EY) event, or 1 year Average Recurrence Interval (ARI) event
- the 10% Annual Exceedance Probability (AEP) event, or 10 year ARI event
- the 1% AEP event, or 100 year ARI event; and
- the 1% AEP event with allowance for climate change.

The 1% AEP event was selected for a climate change scenario assessment. This scenario involved simulation of a 20% increase in flow for the 1% AEP event. The 20% increase is based on the adoption of the CSIRO Representative Concentration Pathway 8.5 to 2090 as per the Australian Rainfall and Runoff 2019 guideline. This scenario was used to determine the effects of climate change on the predicted flood impacts on land adjacent to the project.

For the base case the hydraulic model was used to determine the following parameters for each flood event modelled:

- flood level, depth and extent
- flood velocity
- flood duration (the length of time the floodplain remains active/flood); and
- flood hazard (the product of depth and velocity).

4.5.2.2 DESIGN CASE HYDRAULIC ANALYSIS

The hydraulic model was adapted to represent the design case for Option C2, and iterated to test configurations of cross drainage structures (bridges and culverts) to minimise impacts on the floodplain. The decision to adopt bridges or culverts was informed by the ecological assessment which identified sensitive areas that would benefit from clear spanning bridge structures across the floodplain.

Culvert structures have been represented in the hydraulic model using a one-dimensional (1D) network type '*1d_nwk'* TUFLOW input. This representation of culvert provides a 1D representation of a culvert structure, transporting flows between two locations within the TUFLOW two-dimensional (2D) domain that represented the wider floodplain. 1D/2D connectivity has been represented with a '*2d_bc'* layer, defining connection between the culvert network and the 2D domain. All culverts in the design case model were modelled with 20% blockage applied to represent the risk of blockage of the structures with silt and debris prior to or during a flood event. A sensitivity test using a higher blockage factor of 50% was also undertaken to assess changes in flood impact predictions under high blockage scenarios.

Bridge structures have been represented in the hydraulic model using a 'layered flow constriction' type TUFLOW input. This representation of the bridge structure allows a depth varied form loss coefficient to be applied to represent the different elements of the bridge structure. The representation of the future road embankment and bridge abutments are included in the 2D TUFLOW model grid, and this representation inherently simulates the contraction and expansion losses as flow passes through the bridge structures. The form losses are applied uniformly across the width of the bridge structure opening to represent the additional losses due to piers which are not represented in the TUFLOW model grid. At bridges that surcharge (i.e. flows that exceed the soffit level), the layered flow constriction file allows the level of the soffit to be set with an additional loss factor and blockage induced when this level is exceeded to represent surcharging of the bridge. In accordance with standard practice for modelling large bridges, no blockage factors due to debris or siltation were applied in the bridge representations.

The resulting changes in the base case flood parameters were determined and mapped as follows for each event:

- afflux, or change in flood level/depth
- change in flood extent, mapped as ‘no longer flooded’, or ‘newly flooded’
- change in flood velocity
- change in flood duration; and
- change in flood hazard, mapped as change in flood hazard category.

The results of the Stage 2 floodplain impact assessment are provided in Section 9.1.

4.5.3 STAGE 2 ASSESSMENT OF WATER QUALITY IMPACTS

The road pavement drainage catchments were delineated from the road geometric design and concepts for the road drainage system (i.e. kerb and gutter, pit and pipe and open channels) were identified. The points of discharge from the road drainage system to the external receiving catchments were determined and the discharges were modelled using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software program to determine the pollutant loads that would be discharged at each location. Where the receiving environment was considered to be sensitive, stormwater treatment measures based on WSRD principles were designed to reduce the pollutant loads in accordance with the requirements set out in Table 4.3.

The results of the stage 2 water quality impact assessment are provided in Section 9.2.

4.5.4 STAGE 2 ASSESSMENT OF IMPACTS ON WETLANDS

Details of surveys and assessments of the wetlands located in the study area are presented in the EES Appendix C: *Flora and fauna impact assessment,* WSP 2021. For the Stage 2 assessment, all wetlands in the DELWP mapping database that are located within the area of influence of the project were considered in the impact assessment, regardless of classification or level of importance.

Potential impacts on wetlands were assessed as follows:

- Changes in the flood regime at the wetlands in terms of changes to flood levels, velocities and durations were determined from the flood modelling.
- Wetlands that will receive runoff from the road drainage system, either directly or indirectly from discharge into streams that drain into the wetlands, were identified and the effects on wetland water quality and flow regimes of the residual pollutant loads following stormwater treatment and additional flows were assessed.

The results of the stage 2 impact assessment on wetlands are presented in Section 9.2.8.

4.6 MITIGATION

Mitigations for identified impacts were developed by discipline specialists in consultation with RRV. All identified mitigations developed for the project have been informed by specialist experience with proven feasible control measures for major civil infrastructure projects, industry best practice measures and regulatory measures defined by State, Commonwealth and International Government agencies.

Mitigations for the project were developed throughout the impact assessment process to inform the residual impacts of the preferred alignment, which are detailed in Section 10.

4.7 OPTIONS ASSESSMENT

The alignment refinement for the Beaufort Bypass has been undertaken in three distinct phases since project inception. These are discussed in the *Beaufort Bypass Options Assessment Report* as:

- Phase 1 – Concept alignment development
- Phase 2 – Option development and assessment
- Phase 3 – Identification of preferred alignment.

This options assessment method section considers the Phase 3 assessment and details the process for selection of the preferred alignment.

The Phase 3 assessment considered four alignment options to select the preferred alignment, utilising a customised comparative options assessment to rank each option against the following areas:

- biodiversity
- catchment values and hydrology
- cultural heritage (Aboriginal and historic)
- social and community
- amenity
- landscape and visual.

Multiple scoring scenarios and sensitivity testings were undertaken against each option to ensure the environmental, social, heritage and economic assessment criteria aligned with the EES evaluation objectives. The scoring framework developed sought to ensure a wholistic decision-making process was undertaken, and that no single scoring or sensitivity scenario would be the primary determining factor in the identification and selection of the preferred alignment.

Weightings for the assessment included the application of six scenarios and sensitivity tests to eliminate bias of specific environmental constraints. These scenarios included:

- Scenario 1: Apply a score of 1 to 4 from least to highest impact.
- Scenario 2: Alignment with highest number of least impact scores.
- Scenario 3: Apply a score of 1 to the highest impact and the subtract the percentage difference between alignments.
- Scenario 4: Apply a score of 1 to least impact and then add the percentage difference between remaining alignments.
- Scenario 5: As per Scenario 3, but minus criteria that can be mitigated.
- Scenario 6: As per Scenario 4, but minus criteria that can be mitigated.

The sensitivity tests included:

- Scoring sensitivity scenario 1:
  - Options with the lowest impact and other options within 5% of the lowest impact are apportioned a score of one point and a green light.
  - Options within 5–20% of the lowest impact option are apportioned a score of zero points and an amber light.
  - Options with an impact of 20% or greater than the lowest impact option are apportioned a score of minus one and a red light.
- Scoring sensitivity scenario 2:
  - Options with the lowest impact and other options within 5% of the lowest impact are apportioned a score of one point and a green light.
  - Options within 5–25% of the lowest impact option are apportioned a score of zero points and an amber light.
  - Options with an impact of 25% or greater than the lowest impact option are apportioned a score of minus one and a red light.

- Scoring sensitivity scenario 3:
  - Options with the lowest impact and other options within 5% of the lowest impact are apportioned a score of one point and a green light.
  - Options within 5–15% of the lowest impact option are apportioned a score of zero points and an amber light.
  - Options with an impact of 15% or greater than the lowest impact option are apportioned a score of minus one and a red light.

The assessment process included an iterative process with RRV, the Technical Reference Group (TRG), legal and discipline specialists to refine the assessment environmental risk workshops and develop a customised assessment matrix. The suite of assessment criteria are detailed within the *Beaufort Bypass Options Assessment Report.*

5 LEGISLATION

This section assesses the project against the Commonwealth and State legislation, policies and guidelines relevant to the surface water impact assessment.

5.1 COMMONWEALTH LEGISLATION

5.1.1 *NATIONAL WATER QUALITY MANAGEMENT STRATEGY*

The National Water Quality Management Strategy (NWQMS) is a joint approach by the Australian and New Zealand governments to improving water quality in waterways. The objective of the NWQMS is to achieve sustainable use of water resources, by protecting and enhancing their quality, while maintaining economic and social development.

The NWQMS provides a framework for the development and implementation of management plans for catchment, aquifer, coastal water and other water body, by community and government. The NWQMS includes a number of guidelines covering water quality benchmarks, groundwater management, diffuse and point sources, sewerage systems, effluent management, and water recycling. Guidelines relevant to the project include:

- Australian and New Zealand guidelines for fresh and marine water quality (ANZECC guidelines); and
- Australian guidelines for water quality monitoring and reporting.

If the level of any environmental quality indicator or objective is not provided in the SEPP (Water), contamination must not cause a risk to the beneficial uses and the environmental quality objective for that indicator becomes the levels specified in the ANZECC Guidelines.

5.2 STATE LEGISLATION, REGULATION AND POLICY

5.2.1 *ENVIRONMENT PROTECTION ACT 1970*

The *Environment Protection Act 1970* aims to prevent pollution and environmental damage by setting environmental quality objectives and establishing programs to meet them. The Act establishes the powers, duties and functions of the EPA. These include the administration of the Act and any regulations and orders made pursuant to it, recommending SEPPs, issuing works approvals, licences, permits, pollution abatement notices and implementing National Environment Protection Measures. SEPPs are Victorian Government policy established and maintained under the *Environment Protection Act 1970* to protect the environment and beneficial uses from pollution caused by waste discharges. They are subordinate to the *Environment Protection Act 1970*.

The project will discharge stormwater runoff to Yam Holes Creek catchment. *Clause 38* of the *Environment Protection Act* requires the discharge into waters of the State of Victoria shall at all times be in accordance with SEPP.

5.2.1.1 STATE ENVIRONMENT PROTECTION POLICY (WATERS)

The *SEPP (Waters)* sets the framework for the protection and improvement of water quality in Victorian waters. The application of this policy extends to all waters throughout Victoria, including surface water, groundwater and state waters.

The SEPP (Waters) was formally adopted 19 October 2018 replacing both SEPP (Waters of Victoria) and SEPP (Groundwaters of Victoria). Refer to the EES Appendix D: *Groundwater impact assessment,* WSP 2021 report for further information.

5.2.1.2 ENVIRONMENT PROTECTION AMENDMENT ACT 2018

The *Environment Protection Amendment Act 2018* will take effect in 2021 and provides the foundation for the transformation of Victoria's environment protection laws and the EPA. This Act focuses on preventing waste and pollution impacts rather than managing those impacts after they have occurred. New guidelines are under development by EPA and will be released following implementation of the *Environment Protection Amendment Act 2018*. Central to the Environment Protection Amendment Act is the general environmental duty (GED). Under the GED, businesses must understand the risk from their activities and how to address them. The extent of measures undertaken depends on how much risk the activities pose to human health and the environment.

5.2.1.3 ENVIRONMENTAL REFERENCE STANDARDS

A subordinate instrument to the Environment Protection Amendment Act 2018, Environmental Reference Standards (ERS) articulate community expectations about the state of the environment, providing a basis for assessing and reporting on environmental conditions. Over time the ERS will replace the existing suite of State Environment Protect Policy (SEPP) publications as they are reviewed and updated.

5.2.2 WATER ACT 1989

The *Water Act 1989* provides the legal framework for water management and use across Victoria, including the issuing and allocation of water entitlements and the provision of water services by state-owned water corporations and rural and urban authorities.

Catchment Management Authorities (CMAs) are provided with regional waterway, floodplain and environmental water reserve management powers under the *Water Act 1989*. The CMA is also responsible for regulation of works on designated waterways and floodplain management within its gazetted waterway management district.

The project area is in the Hopkins River Basin with the responsible authority being GHCMA. The project is therefore required to consult with and achieve GHCMA flooding and water quality criteria. Permits and approvals from GHCMA relating to working near waterways will be required prior to construction commencing.

5.2.3 CATCHMENT AND LAND PROTECTION ACT 1994

Victoria's framework for the integrated management of catchments is established under the *Catchment and Land Protection Act 1994* (CaLP Act). Under the CaLP Act, landowners have a responsibility to avoid causing or contributing to land degradation, including taking all reasonable steps to conserve soil, protect water resources, eradicate regionally prohibited weeds, prevent the growth and spread of regionally controlled weeds and where possible, eradicate established pest animals, as declared under the CaLP Act.

Land owners and managers have the responsibility to take all reasonable steps to prevent the growth and spread of regionally prevented and controlled weeds on their land. Victoria is divided into ten catchment regions with a CMA established for each region.

The project area is in the Yam Holes Creek Catchment with the responsible authority being GHCMA. The GHCMA is responsible for the integrated planning and coordination of land, water and biodiversity management, in conjunction with local communities via the Regional Catchment Strategy. The project is therefore required to consult with and achieve GHCMA flooding and water quality criteria.

5.2.4 PLANNING AND ENVIRONMENT ACT 1987

The *Planning and Environment Act 1987* establishes a framework for planning the use, development and protection of land in Victoria. Victoria Planning Provisions (VPPs) are set out in the Act to assist in proving a consistent and coordinated framework for planning schemes. Parts of the VPPs relevant to surface water on the project are summarised in Section 5.2.4.1.

5.2.4.1 STATE AND LOCAL PLANNING POLICY FRAMEWORK

The State and Local Planning Policy Frameworks contain the long-term directions and outcomes sought by the scheme. The requirements relevant to surface water are summarised in Table 5.1.

Table 5.1 State and Local Planning Framework

CLAUSE REFERENCE	TITLE	KEY REQUIREMENTS RELEVANT TO PROJECT
Clause 12.01-1S	Protection of biodiversity	Avoid potential for fragmentation of habitat due to waterway diversions or modifications. Consider impacts on wetlands and wetland wildlife habitat designated under the Convention on Wetlands of International Importance (the Ramsar Convention) and sites utilised by species listed under the Japan-Australia Migratory Birds Agreement (JAMBA), the China-Australia Migratory Birds Agreement (CAMBA), or the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).
Clause 12.01-2S	Native vegetation management	Avoid the removal, destruction or lopping of native vegetation.
Clause 12.05	Environment and Landscape Values – Significant Environments and Landscapes	Consideration of the Glenelg Hopkins Waterway Strategy (2014-22).
Clause 13.01	Environmental Risks – Climate change impacts	Plan for possible sea level rise of 0.8 metres by 2100.
Clause 13.03	Environmental Risks — Floodplains	Identify land affected by flooding (1 in 100 year flood event). Avoid intensifying the impacts of flooding through inappropriately located uses and developments.

CLAUSE REFERENCE	TITLE	KEY REQUIREMENTS RELEVANT TO PROJECT
Clause 14.02	Natural Resource Management – Water	Consider impacts of catchment management on downstream water quality and water environments. Retain natural drainage corridors with vegetated buffer zones of at least 30 m. Undertake measures to minimise the quantity and retard flow from developed areas. Encourage measures to filter sediment and wastes from stormwater prior to its discharge into waterways. Ensure land use and development minimise nutrient contributions to waterways. Use appropriate measures to restrict sediment discharges from construction sites. Coordinate with activities of catchment management authorities. Ensure activities potentially discharging contaminated runoff or wastes to waterways are sited and managed to minimise such discharges and protect the quality of water environments.
Clause 19.03-3S	Infrastructure – Integrated water management	Ensure that development protects and improves the health of water bodies including creeks, rivers, wetlands, estuaries and bays by: — minimising stormwater quality and quantity related impacts — filtering sediment and waste from stormwater prior to discharge from a site — requiring appropriate measures to mitigate litter, sediment and other discharges from construction sites.
Clause 52.17	Native vegetation	Ensure that there is no net loss to biodiversity as a result of the removal, destruction or lopping of native vegetation.

5.2.4.2 LOCAL PLANNING POLICY FRAMEWORK

The project area is within the Pyrenees Planning Scheme with the Pyrenees Shire Council being the responsible authority.

The Local Planning Policy Framework (LPPF) relevant to surface water on the project is:

- Clause 22.03 – Floodplain Management in Beaufort.

This policy applies to all land in Beaufort and its immediate environs that is within the Floodway Overlay (FO), the Land Subject to Inundation Overlay (LSIO) and the Urban Floodway Zone (UFZ). The policy implements the relevant provisions of the GHCMA's Regional Floodplain Management Strategy, the Beaufort Flood Study (2008) and the Beaufort Floodplain Management Plan (2011).

Applications to carry out construction works, buildings or to subdivide land in FO, LSIO or UFZ of the Pyrenees Planning Scheme must be consistent with the Local Floodplain Development Plan.

5.2.4.3 ZONES AND OVERLAYS

The type and purpose of overlays relevant to surface water on the project are summarised in Table 5.2.

Table 5.2 Type and purpose of overlays

CLAUSE REFERENCE	TITLE	KEY REQUIREMENTS RELEVANT TO PROJECT
Clause 44.03	Floodway Overlay (FO or RFO)	To identify waterways, major flood paths, drainage depressions and high hazard areas which have the greatest risk and frequency of being affected by flooding. To ensure that development maintains the free passage and temporary storage of floodwater, minimises flood damage and is compatible with flood hazard, local drainage conditions and the minimisation of soil erosion, sedimentation and silting. To protect water quality and waterways as natural resources in accordance with the provisions of relevant SEPPs. To ensure development maintains or improves river and wetland health, waterway protection and flood plain health.
Clause 44.04	Land Subject to Inundation Overlay (LSIO)	To identify land in a flood storage or flood fringe area affected by the 1 in 100-year flood or any other area determined by the floodplain management authority. To ensure that development maintains the free passage and temporary storage of floodwater, minimises flood damage and is compatible with flood hazard, local drainage conditions and will not cause any significant rise in flood level or flow velocity. To protect water quality in accordance with the provisions of relevant SEPPs. To ensure development maintains or improves river and wetland health, waterway protection and flood plain health.

5.3 REGIONAL

5.3.1 GLENELG HOPKINS CATCHMENT MANAGEMENT AUTHORITY

The study catchment is located within the Glenelg Hopkins Catchment Management Region. The GHCMA, along with nine other CMAs, was established in 1997 by the Victorian Government, under the *Catchment and Land Protection Act 1994*, with the aim of creating a whole of catchment approach to natural resource management in the state.

A review of strategies and other studies published by the GHCMA did not identify specific requirements that apply to the study area or Yam Holes Creek catchment. The following catchment strategies documents have been published by the GHCMA:

- Glenelg Hopkins Regional Catchment Strategy (2013–19)
- Glenelg Hopkins Regional Floodplain Management Strategy (2018–2028)
- Glenelg Hopkins Climate Change Strategy (2016–23)
- Glenelg Hopkins Waterway Strategy (2014–22)
- Integrated Catchment Management in Victoria (2016–19).

5.4 GUIDELINES

The guidelines relevant to surface water considerations during detail design and construction phases on Beaufort Bypass project, include:

- Australian Rainfall and Runoff 2016/2019
- Austroads Guide to Road Design
- VicRoads Supplements to AGRD
- Integrated Water Management Guidelines, VicRoads 2013
- Urban Stormwater: Best Practice Environmental Management Guidelines, (CSIRO Publishing, 1999)
- Beaufort Township Structure Plan (Network Planning Consultants Pty Ltd, October 2005)
- Beaufort Flood Study (Water Technology Pty Ltd, June 2008)
- Beaufort Floodplain Management Plan (Water Technology Pty Ltd, May 2011)
- Guidelines for cut and fill within the Glenelg Hopkins CMA Region (Glenelg Hopkins Catchment Management Authority, July 2008)
- Guidelines for Fencing in Flood prone Areas (Glenelg Hopkins Catchment Management Authority, September 2012)
- Victoria Floodplain Management Strategy, Department of Natural Resources and Environment, 1998
- Technical Guidelines for Waterway Management, Department of Sustainability and Environment 2007
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, ANZECC 2000
- EPA Publication No. 275. Construction Techniques for Sediment Pollution Control (1991)
- EPA Publication No. 480. Environmental Guidelines for Major Construction Sites (1996).

6 EXISTING CONDITIONS

The 2016 scoping requirements for the Beaufort Bypass Project EES identified the priorities for characterising the existing environment as:

- undertake a hydrology assessment of the study area for the proposed project consistent with the outcomes of the GHCMA catchment and modelling study for Beaufort
- identify and characterise surface water environments and floodplain environments that could be affected by relevant alternatives, including an analysis of drainage features and flood behaviour.

This section summarises the characteristics of the existing Yam Holes Creek catchment.

6.1 STUDY CATCHMENT

The study catchment is within the Glenelg Hopkins Catchment Management Region. The Hopkins River Basin covers an area of approximately 9,680 km^2 in the eastern half of the Glenelg Hopkins Catchment Management Region (DJPR, 2017). On a regional scale, the Hopkins River Basin is entirely cleared for pasture and other agriculture, except for a small area of forest in the north. The main products of the Hopkins River Basin are wool, prime lambs and beef. Cropping is practised in the north and market gardening in the south, where potatoes are a major produce. Dairying, common in the past, declined over the 1980s (DJPR, 2017).

The Study Catchment of Yam Holes Creek comprises hills (relative elevation 90–300 m), low hills (relative elevation 30–90 m) and plains (relative elevation <9 m) (DJPR, 2017). Slopes in the upper catchment are typically around 10% whereas the lower catchment is flat and subject to flooding. The Yam Holes Creek catchment mainly comprises pasture dryland, remnant native vegetation and public land.

The township of Beaufort is located near the centre of the Yam Holes Creek catchment. The township of Beaufort is situated within a circle of hills, at the confluence of Ding Dong, Cemetery, Cumberland and Yam Holes Creeks. Yam Holes Creek is the main waterway through the town and a major tributary of Mount Emu Creek to the east. The confluence of Yam Holes Creek with Mount Emu Creek is approximately 10 km downstream of the Beaufort township. Mount Emu Creek is a major tributary of the Hopkins River which flows into the Southern Ocean just east of Warrnambool. The Yam Holes Creek catchment area is approximately 70.1 km^2 to the confluence with Mount Emu Creek.

Yam Holes Creek flows south into Beaufort from the west of Camp Hill. Then at a point below Camp Hill, Yam Holes Creek turns to the east where at the confluence of Ding Dong Creek it joins Mount Emu Creek at Trawalla. A catchment plan for Yam Holes Creek is provided in Figure 6.1. The Yam Holes Creek catchment is considered by the GHCMA to be a flash flood catchment in which flooding can occur in 6 hours or less from rainfall.

The sub catchment area breakdown is provided in Table 6.1. The Yam Holes Creek tributaries vary significantly in size, from the smallest (Ding Dong Creek) which is only about 3% of the total catchment area to the largest (Cemetery Creek) which is about 21% of the total catchment area.

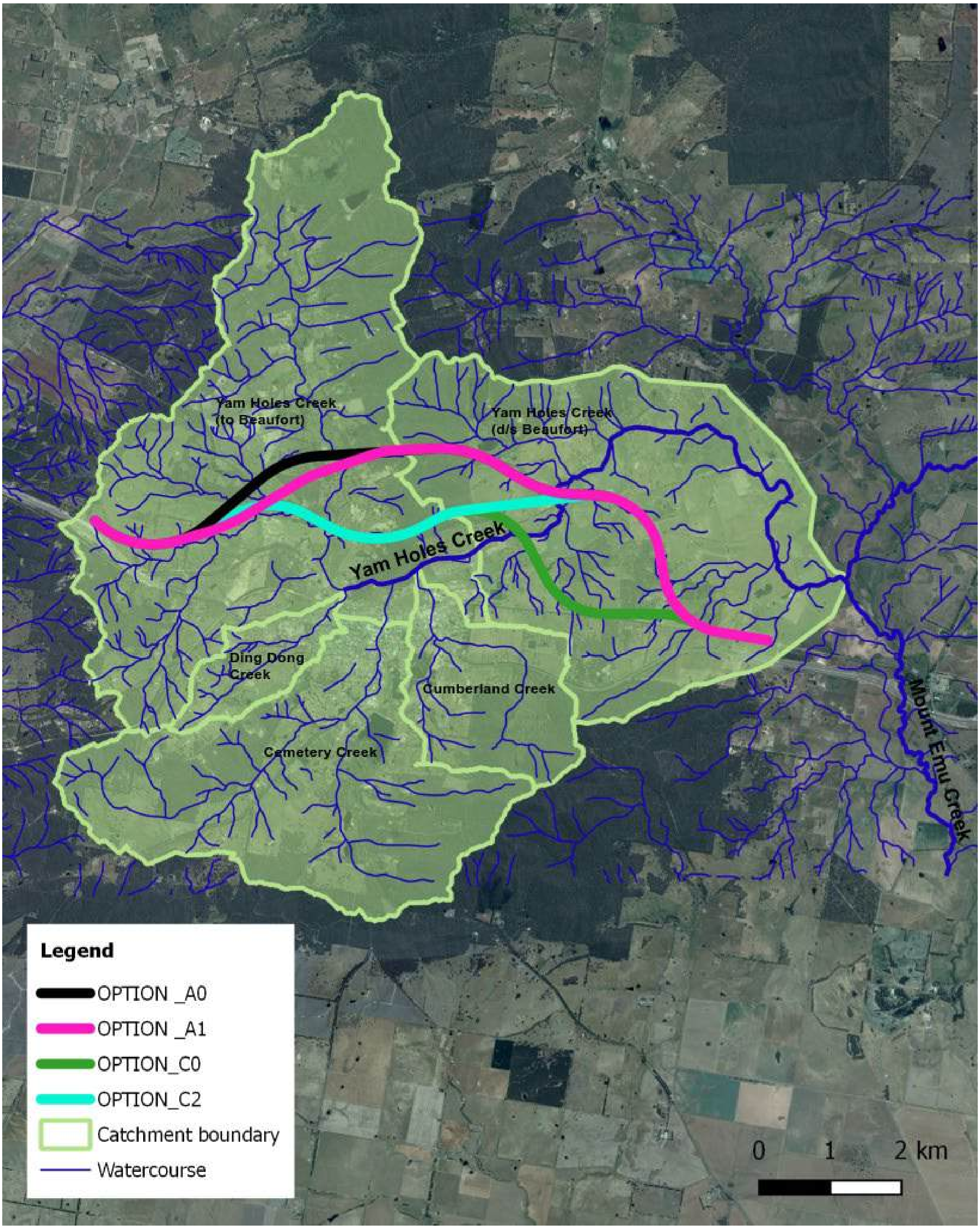

Figure 6.1 Yam Holes Creek catchment plan

Table 6.1 Yam Holes Creek sub catchment areas

WATERWAY	CATCHMENT (km²)
Ding Dong Creek	2.2
Cemetery Creek	14.5
Cumberland Creek	5.1
Yam Holes Creek to Beaufort	27.2
Yam Holes Creek downstream of Beaufort	21.1
Yam Holes Creek total (to confluence with Mount Emu Creek)	**70.1**

6.2 RAINFALL DATA

Daily rainfall data is available from the Bureau of Meteorology (BoM) for the Beaufort Station (No. 89005) for the period from 1922 to present. The Beaufort Station is located 2.4 km from the centre of the Beaufort township (latitude: 37.25°S, longitude: 143.37°E). The Beaufort Station is the only station located within the Yam Holes Creek catchment. Mean monthly rainfall data is summarised in Table 6.2.

Table 6.2 Mean monthly rainfall data for Beaufort Station (No. 89005)

MONTH	MEAN RAINFALL (mm/month)
January	40.1
February	39.0
March	39.9
April	53.0
May	62.2
June	66.5
July	66.5
August	73.3
September	70.6
October	67.5
November	55.2
December	47.5
Total	**681.3**

6.3 STREAMFLOW DATA

The streamflow data, water level and flow duration curves for Yam Holes Creek and Mount Emu Creek provides a description of the existing hydrometric conditions for the catchment. Daily streamflow data is available from DELWP.

As the streamflow data from Yam Holes Creek is limited to 2.5 years, the streamflow data at Mount Emu Creek station is also presented. Mount Emu Creek station is the nearest hydrometric station within the wider catchment with long-term flow records. Due to the limited flow records on Yam Holes Creek a comparative study between Mount Emu Creek data and Yam Holes Creek was not carried out.

6.3.1 YAM HOLES CREEK STATION NO. 236229

Streamflow data for Yam Holes Creek downstream of Beaufort (Station No. 236229) is available for the 2.5-year period from May 2000 to November 2002. This station is located just downstream of the township of Beaufort (latitude: 37°25'18.5"S, longitude: 143°24'25.4"E) and has a contributing catchment of 33 km^2. The location of the hydrometric gauge is presented in Figure 6.2.

Figure 6.2 236229 Yam Holes Creek D/S Beaufort

A plot of the daily streamflow and water level data for Yam Holes Creek downstream of Beaufort (Station No. 236229) is provided in Figure 6.3 and a flow duration curve is provided in Figure 6.4. The flow duration curve shows the percentage of time that flow in Yam Holes Creek equals or exceeds a specific value based on the available historical record. The flow duration curve shows that the maximum recorded streamflow is 72 ML/day for the period from May 2000 to November 2002. A rating curve, showing the streamflow versus water level, is provided in Figure 6.5.

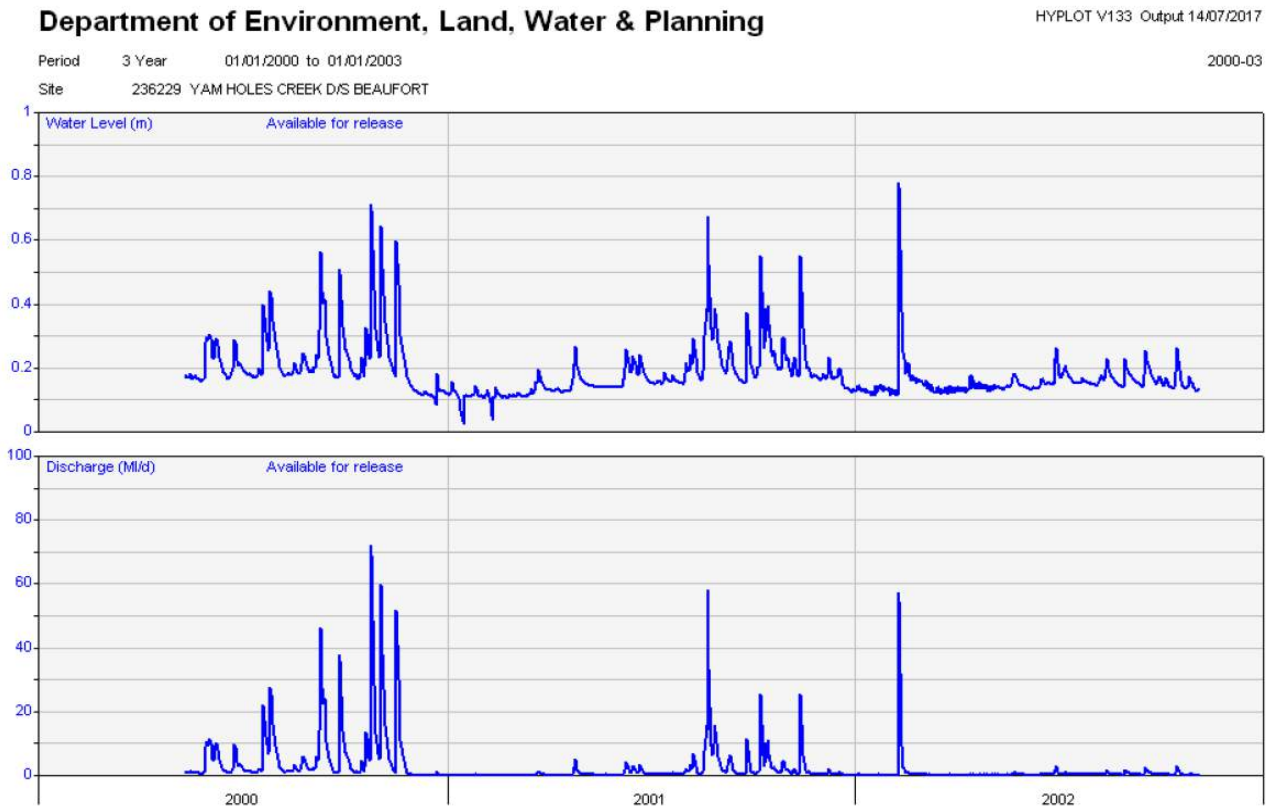

Figure 6.3 Daily water level and streamflow for Yam Holes Creek Downstream Beaufort (Station No. 236229)

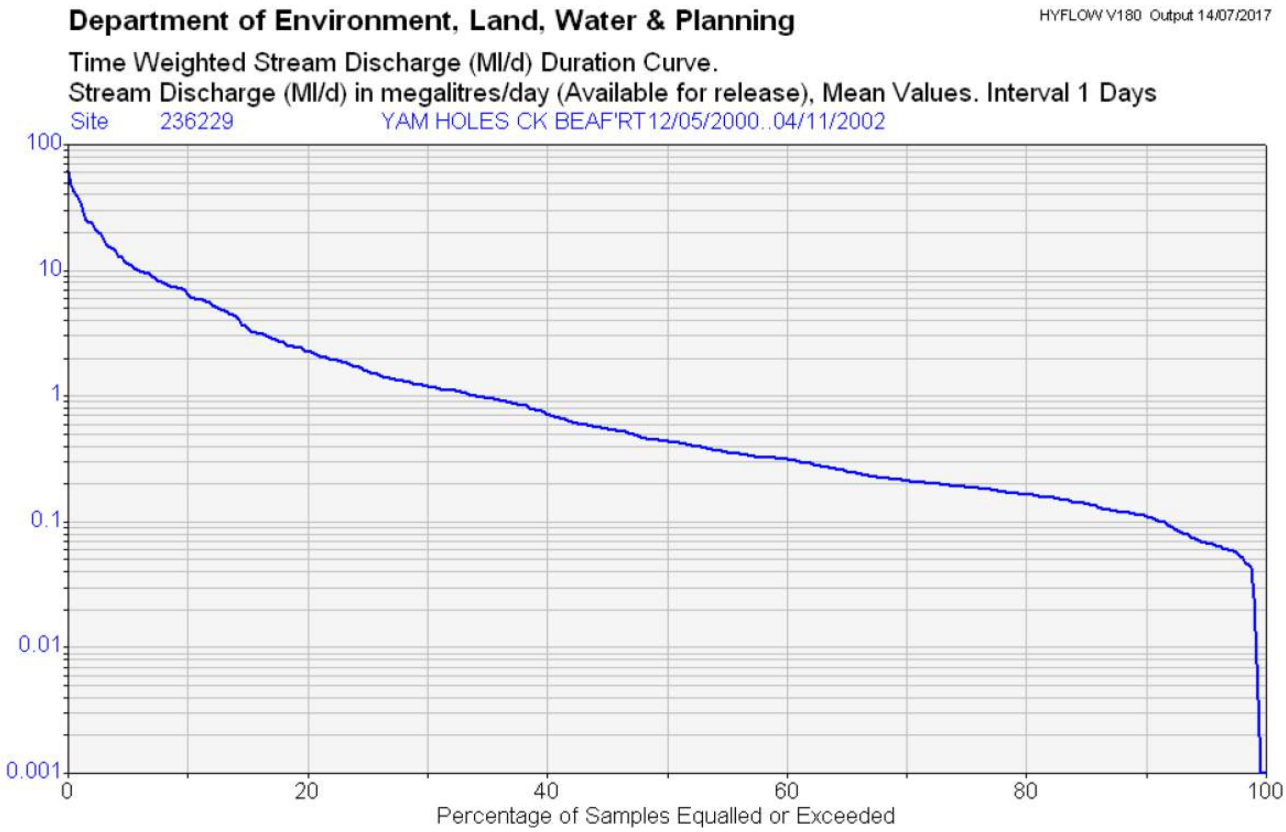

Figure 6.4 Daily flow duration curve for Yam Holes Creek Downstream Beaufort (Station No. 236229)

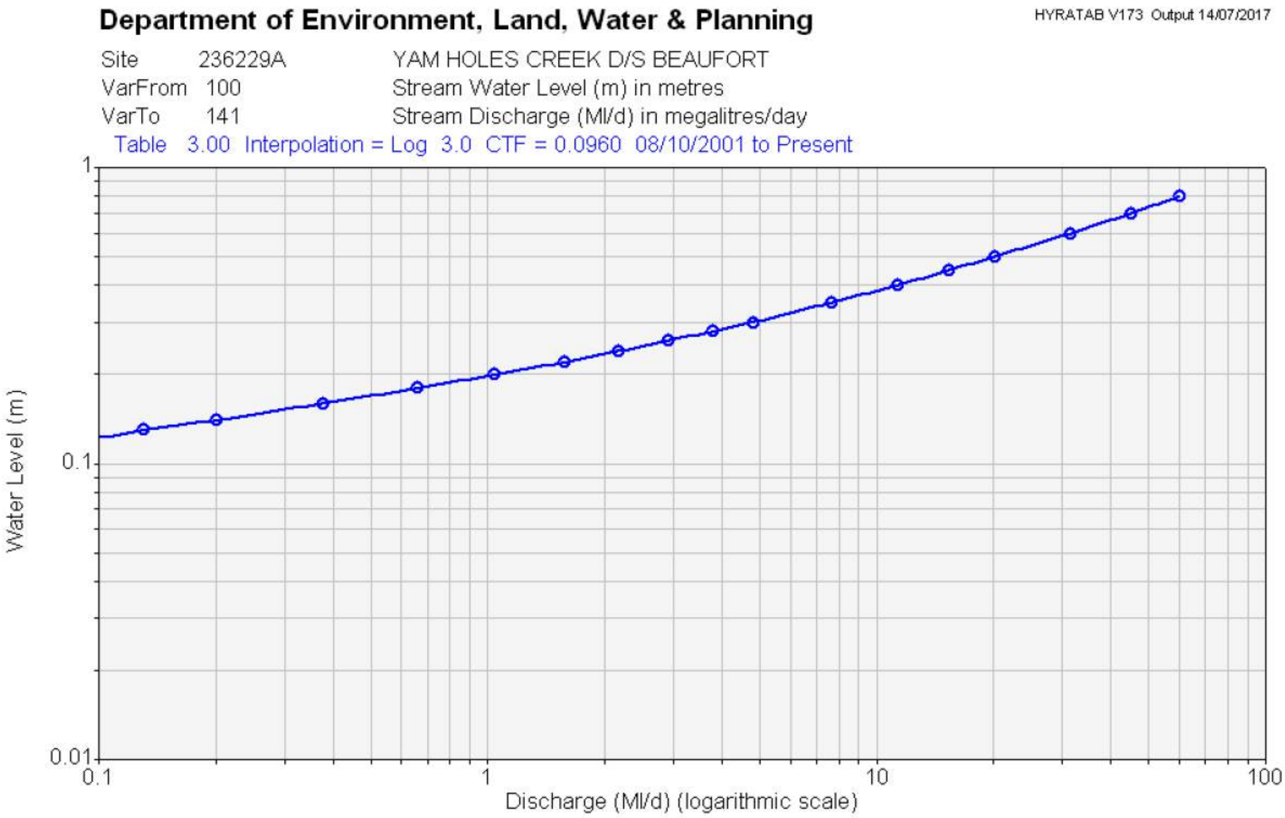

Figure 6.5 Rating curve for Yam Holes Creek Downstream Beaufort (Station No. 236229)

6.3.2 MOUNT EMU CREEK STATION NO. 236213

Streamflow data for Mount Emu Creek at Mena Park (Station No. 236213) is available for the 52-year period from 1966 to 2017. This station is located approximately 17 km downstream of the confluence of Yam Holes Creek and Mount Emu Creek (latitude: 37°31'49.4"S, longitude: 143°27'54.6"E) and has a contributing catchment of 452 km^2. Whilst this station is not located within the Yam Holes Creek catchment, it is the closest station to the study area with long term streamflow data. Yam Holes Creek is a tributary of Mount Emu Creek and therefore contributes flow to this gauging station. The Yam Holes Creek catchment is approximately 15.5% of the total catchment of Mount Emu Creek to Mena Park.

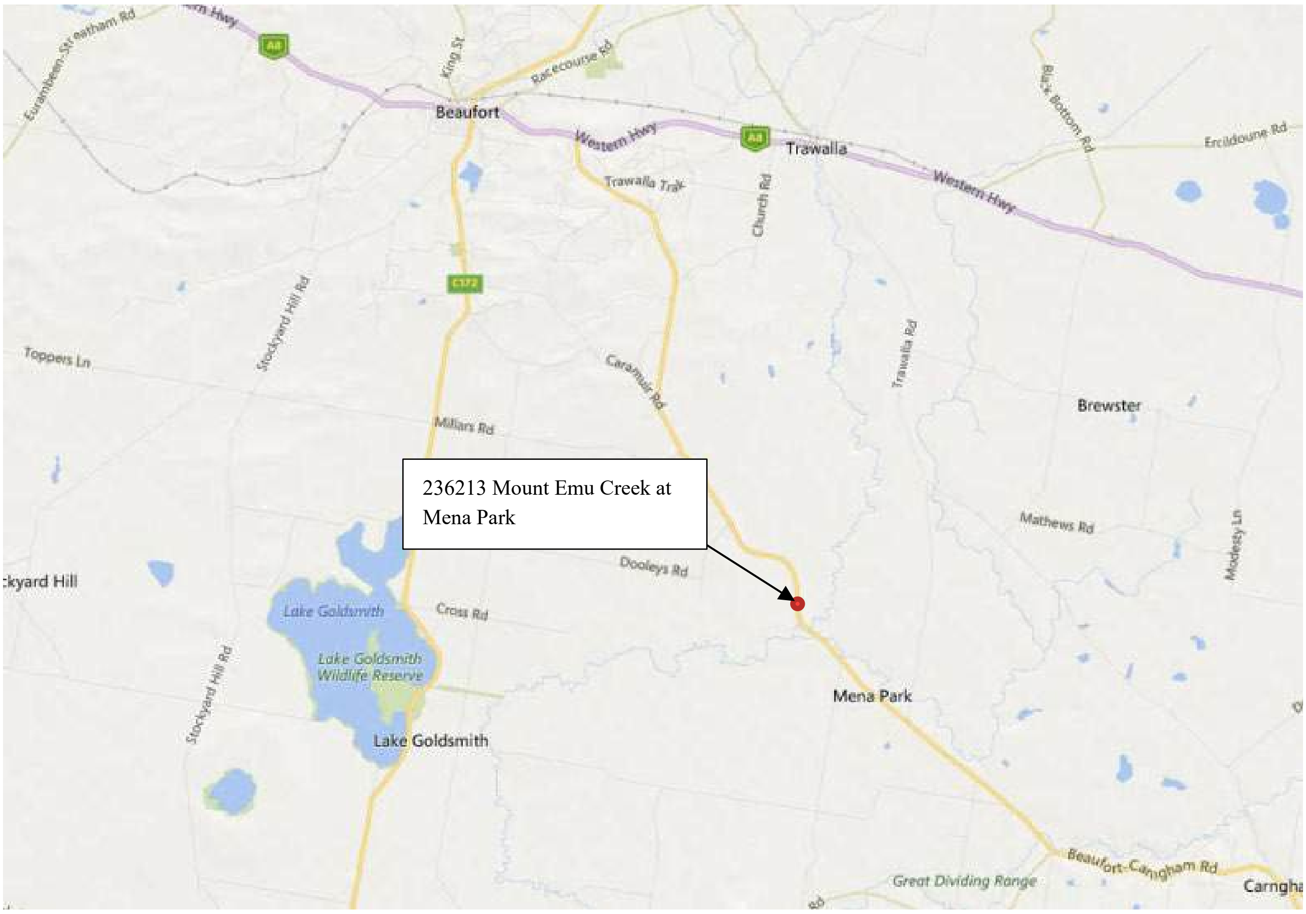

Figure 6.6 236213 Mount Emu Creek at Mena Park

A plot of the daily streamflow and water level data for Mount Emu Creek at Mena Park (Station No. 236213) is provided in Figure 6.7 and a flow duration curve is provided in Figure 6.8. The flow duration curve shows that the maximum recorded streamflow is 21,740 ML/day for the period from 1966 to 2017.

Flows exceeding 55 ML/day can be expected approximately 10% of the time and flows exceeding 0.01 ML/day can be expected approximately 50% of the time. A rating curve, showing the streamflow versus water level is provided in Figure 6.9.

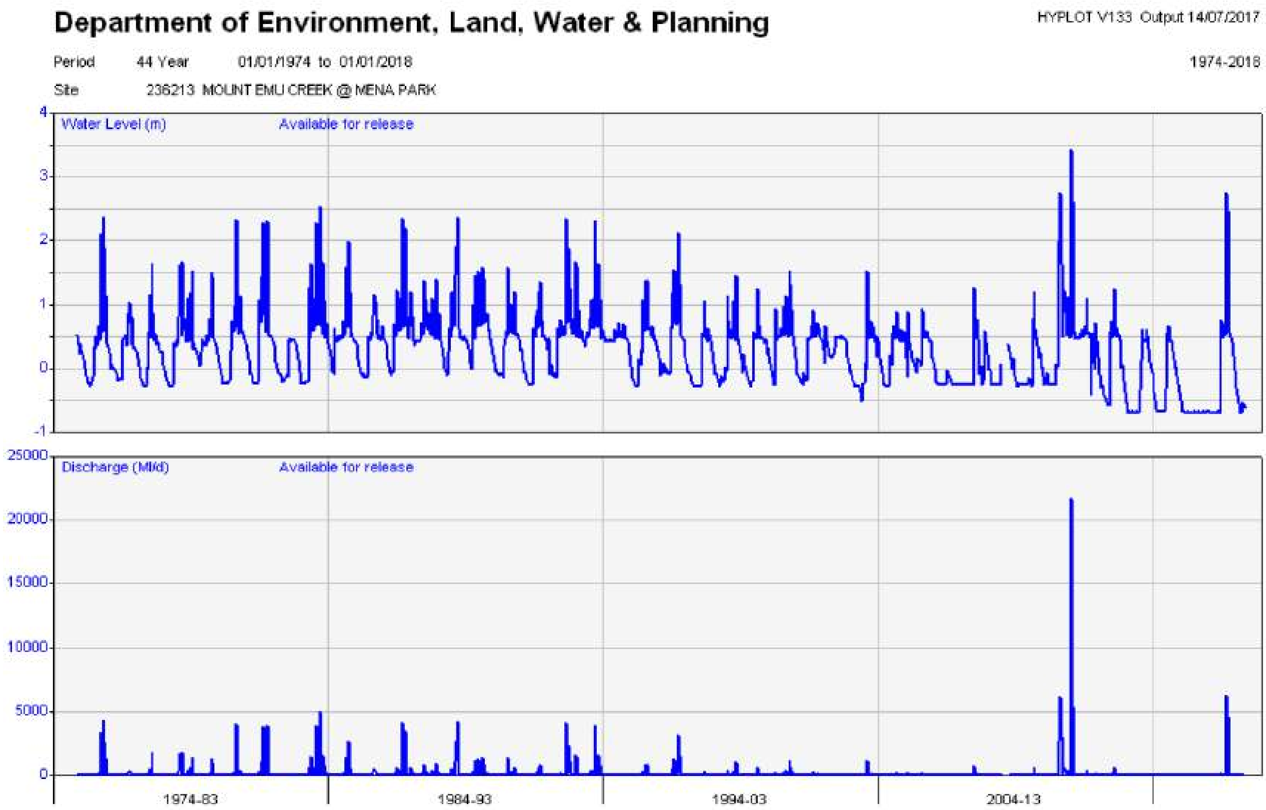

Figure 6.7 Daily water level and streamflow for Mount Emu Creek at Mena Park (Station No. 236213)

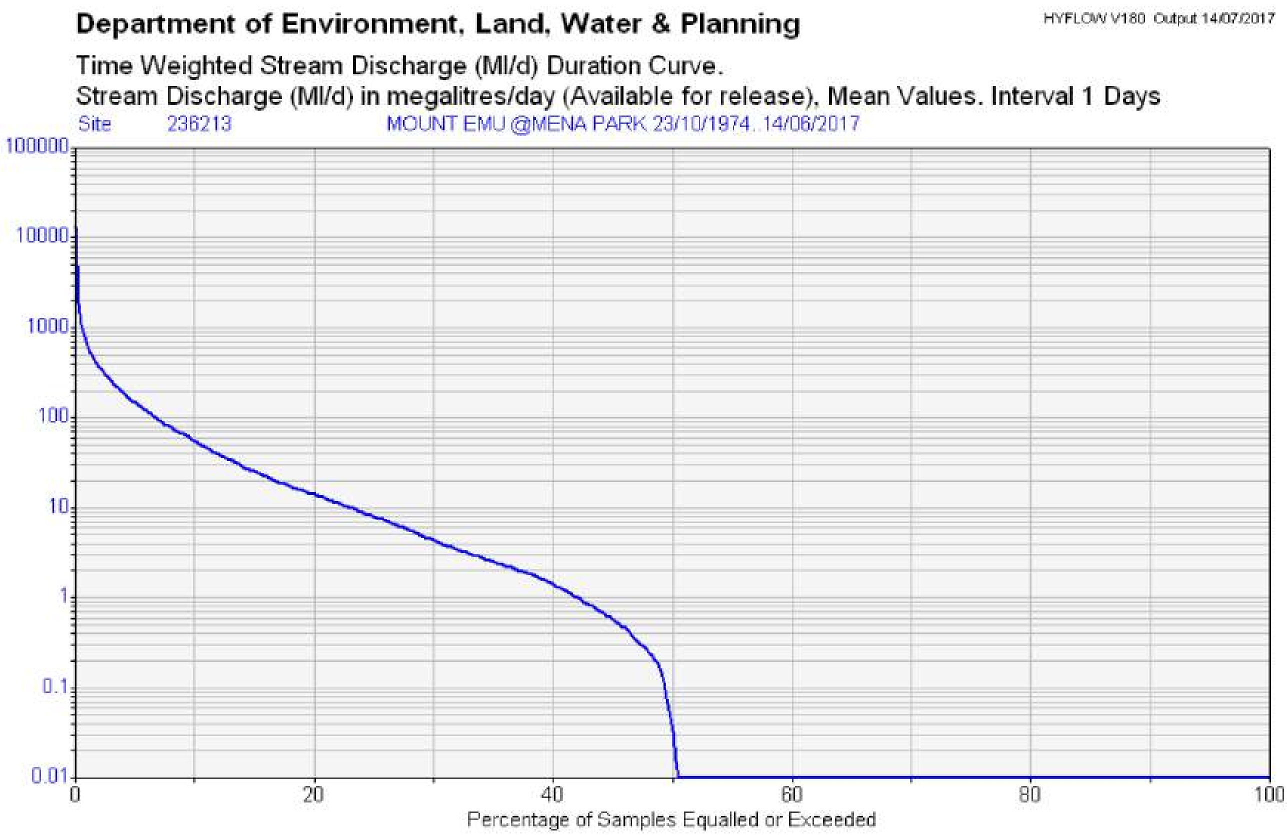

Figure 6.8 Daily flow duration curve for Mount Emu Creek at Mena Park (Station No. 236213)

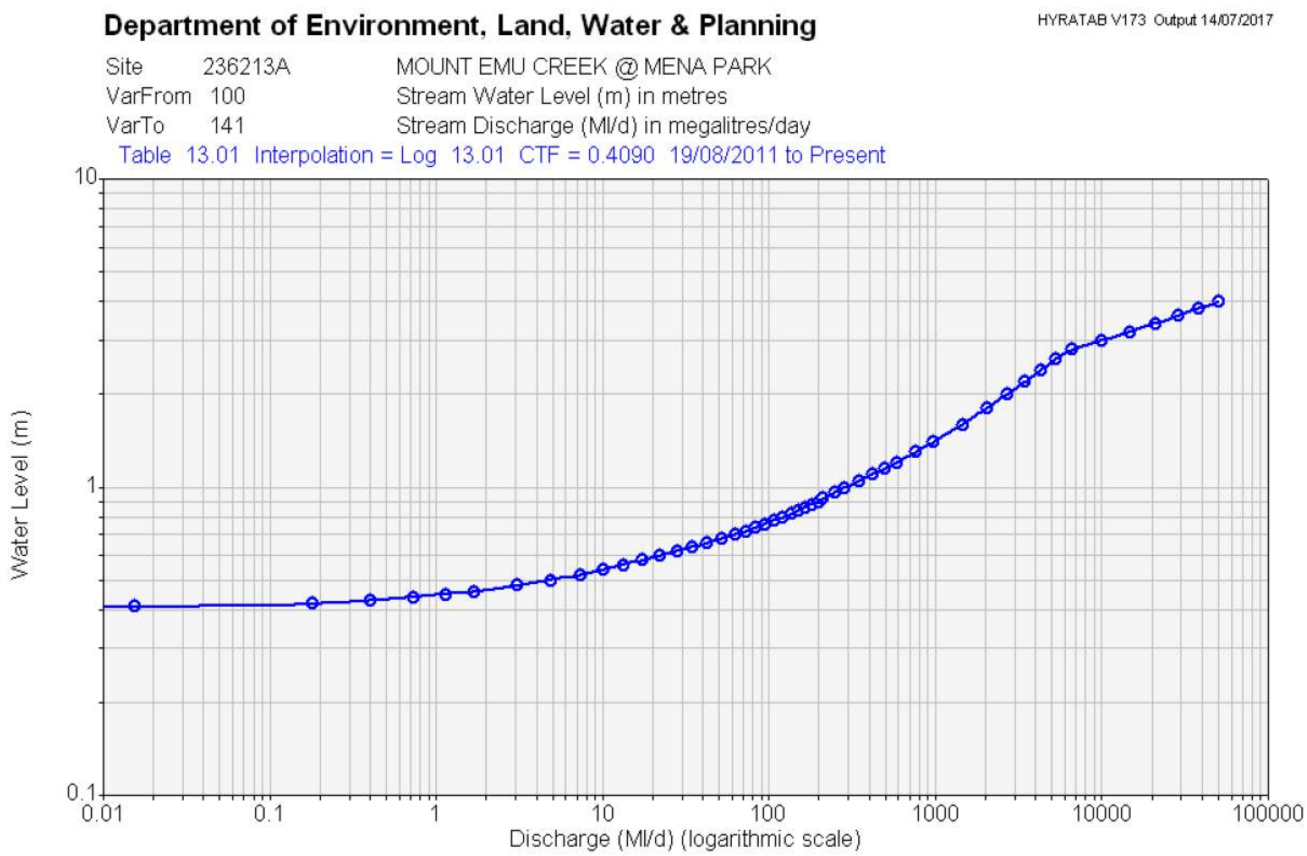

Figure 6.9 Rating curve for Mount Emu Creek at Mena Park (Station No. 236213)

6.4 WATERWAY CHARACTERISTICS

An assessment of the waterway conditions located in the project area was undertaken, which included desktop assessment review of the available information and a field assessment of selected watercourse crossings. All watercourse crossings were in the sub-catchments of:

- Yam Holes Creek to Beaufort; and
- Yam Holes Creek downstream of Beaufort.

A site visit carried out on 22 March 2018, which included a visual inspection of the floodplain characteristics at proposed crossing locations, subject to land accessibility. The sections below summarise the condition of the watercourses as observed during the site visit. Maps indicating the location of each watercourse crossing is provided below in Figure 6.10 and Figure 6.11 (also see Appendix A). As the tributaries of Yam Holes Creek are unnamed, the following naming convention has been assigned for describing the existing conditions:

- Tributary A – Located to the south of the existing Western Highway. Highlighted in green in Map 1.1
- Tributary B – Located north of Martins Lane. Highlighted as yellow in Map 1.1
- Tributary C – Located south of Back Raglan Road. Highlighted as orange in Map 1.1
- Tributary D – Located west and parallel to Main Lead Road. Highlighted as dark red in Map 1.1
- Tributary E – Located north of Beaufort-Lexton Road. Highlighted as pink in Map 1.2.

Works and activities on or near a Designated Waterway require a licence from the GHCMA.