Preface – DJPR Cover Note

Latrobe Valley Regional Rehabilitation Strategy: Water-Related Metrics and Thresholds for Impact Assessment on Recognised Regional Receptors

February 2021

The *Latrobe Valley Regional Rehabilitation Strategy: Water-Related Metrics and Thresholds*, authored by Jacobs and commissioned by the Department of Jobs, Precincts and Regions (DJPR), was largely developed over the period of August 2017 – March 2018. It was undertaken at an early stage in the process of preparing the *Latrobe Valley Regional Rehabilitation Strategy* (LVRRS), and its primary purpose was to inform the scope of the three regional studies that would inform the LVRRS: the regional geotechnical study, the regional water study and the regional land use study.

Parts of this report have therefore been superseded by these and other regional studies and the LVRRS itself. Specifically with references to the previous environmental flow study by EarthTech (2007) for the Assessment of Environmental Flow Requirements for the Latrobe River that is now superseded by the Environmental Water Requirements Report: Latrobe environmental water requirements investigation, Alluvium, Prepared for the West Gippsland Catchment Management Authority May 2020. This report has also increased knowledge and awareness of how flow in the Latrobe River System provides for Traditional Owner cultural values. The LVRRS was released by the Minister for Resources in June 2020 and is currently being implemented.

The regional receptors in this report were identified based on a *scenario* in which the three coal mine voids of the Latrobe Valley would be filled with water from local water sources (i.e. the Latrobe River system and Latrobe Valley aquifers) to create waterbodies as final rehabilitated landforms. This particular scenario was used in this study because, in response to the findings of the Hazelwood Fire Mine Inquiry (HMFI), the Victorian Government committed to further investigating the feasibility of water-based rehabilitation options. It is unlikely that all receptors that may be relevant to the scenario at hand have been identified. The receptor inventory may also need to be re-visited in the future if different options are explored or put forward by mine licensees. This will especially be the case where rehabilitation proposals include the use of resources from outside the study area featured in this report.

This report provides guidance for assessing potential water impacts of regional rehabilitation scenarios. The report is focused on physical receptors (e.g. environmental assets, Aboriginal heritage places, infrastructure, land or water resources). Social and economic receptors (e.g. rehabilitated mine land amenity and use, employment and jobs growth, industry, tourism and recreation), valued by stakeholders and communities in the Latrobe Valley that could potentially be affected by mine rehabilitation are being further considered, including as part of the LVRRS implementation.

Latrobe Valley Regional Rehabilitation Strategy

Department of Jobs, Precincts and Regions

Water-Related Metrics and Thresholds

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Latrobe Valley Regional Rehabilitation Strategy

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Contents

Executive Summary

In 2014, the Victorian Government established the Hazelwood Mine Fire Inquiry (HMFI) in response to the largest and longest burning mine fire in Victorian history. As part of the recommendations handed down by the HMFI in 2016 a number related to the planning and preparation for closure of the Hazelwood, Yallourn and Loy Yang coal mines. The HMFI concluded that for each of the three coal mines, the most feasible post-mining land-form would be a mine void waterbody (pit lake) of some type. However, it was recognised that there were knowledge gaps that needed to be investigated to confirm that pit lakes are a feasible outcome.

In June 2016, the Victorian Government released the 'Hazelwood Mine Fire Inquiry: Victorian Government Implementation Plan' which committed to develop a Latrobe Valley Regional Rehabilitation Strategy (LVRRS) by June 2020. The Implementation Plan set out that Department of Jobs, Precincts and Regions (DJPR) and the Department of Environment, Land, Water and Planning (DELWP), in collaboration with the operators of the Latrobe Valley coal mines and the community, and with input from technical experts, undertake investigations to address knowledge gaps relating to mine rehabilitation, such as geotechnical stability, hydrogeological risks and water availability.

This report forms part of foundation studies undertaken to inform the development of the Strategy prepared by DJPR in partnership with DELWP.

The report builds on the Identification of Recognised Regional Receptors work undertaken to identify and describe regional receptors (environmental asset, Aboriginal heritage and values, infrastructure, land or water resources) within the LVRRS study area that are potentially directly or indirectly impacted by water-based mine rehabilitation.

The objective of this report is to define the measures (called metrics) and the limits or constraints (called thresholds) that can be used to determine the water-related effects of rehabilitation on recognised regional receptors.

This study involved the assessment of:

- metrics that can be used to assess the degree of effect of rehabilitation, on water-related receptors, with consideration of the possible appropriate range of values for each receptor;
- the available information on the documented status of the water-related receptors so that likely effects and the degree to which a receptor status changes (threshold) can be assessed with respect to the defined metrics; and
- qualitative assessment guidelines to assess the degree of effect (both negative and positive) of rehabilitation on water-related receptors identified for qualitative effects assessment.

Table E1-1 summarises the metrics and thresholds for water-related receptors for each of the identified recognised regional receptor categories.

Table E1.1: Summary of Metrics and Thresholds for Water-related Receptors

Receptor Category	Sub-Category	Assessment Type	Metric	Threshold
Aboriginal and non-Aboriginal cultural heritage	Aboriginal cultural heritage	Quantitative/Qualitative	Avoidance of harm and protection of cultural values	Receptors remain in their current condition during implementation of the rehabilitation strategy and thereafter
	Non-Aboriginal cultural heritage	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
Environment	Rivers, waterways and natural lakes	Quantitative	Changes to water volume and flow patterns, and water quality (including sediment) effects	Latrobe River flow recommendations - Reach 3 (Lake Narracan to Scarnes Bridge), Reach 4 (Scarnes Bridge to Rosedale), Reach 5 (Rosedale to Thomson River), Reach 6 (Latrobe River Estuary), Reach 10 (Morwell River) and Reach 11 (Traralgon Creek) Latrobe River flow recommendations - Ecohydrologic metrics in waterways without flow recommendations SEPP Waters - Schedule 3 Environmental Quality Indicators and Objectives – Table 1 and Table 9
	Terrestrial Habitats	Qualitative	Altered flow rates – reduction in environmental flows Decrease in water quality – increased salinity and other WQ indicators	No specific threshold has been able to be defined on the available information. Recommend that any change in condition be assessed when required
	Listed Species	Quantitative (EPBC) and Qualitative (FFG)	Altered flow rates – reduction in environmental flows	Latrobe River flow recommendations - Ecohydrologic metrics in waterways without flow recommendations
	Water Dependant Habitats	Qualitative	Altered flow rates – reduction in environmental flows Decrease in water quality – increased salinity resulting in change of SEPP segment	No specific threshold has been able to be defined on the available information. Recommend that any change in condition be assessed when required
	Wetlands	Quantitative	Altered flow rates – reduction in environmental flows Decrease in water quality – increased salinity resulting in change of SEPP segment	SEPP Waters - Schedule 3 Environmental Quality Indicators and Objectives – Table 1 and Table 3 Latrobe River flow recommendations - Ecohydrologic metrics in waterways without flow recommendations

Receptor Category	Sub-Category	Assessment Type	Metric	Threshold
Infrastructure	Airports	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
	Alternate Energy sources	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
	Bridges	Qualitative	altered flow rates (increased flood frequency) and water level heights in these receiving creeks and rivers	Thresholds for individual structures have not been able to be defined from available information. Recommend effect risk be calculated at the time of effect quantification.
	Coal Fired Power Generation	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
	Electricity Transmission Network	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
	Extractive Industry	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
	Gas Fired Power Generation	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
	Gas Pipelines	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
	Industry and Manufacturing	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
	Rail	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
	Road - Freeway/State maintained	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
	Road – Local Council maintained	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified

Receptor Category	Sub-Category	Assessment Type	Metric	Threshold
	Telecommunications	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
Land	Townships/Settlements	Qualitative	Altered flow rates – increased flood frequency Decrease in water quality – increased salinity	To be qualitatively assessed if an effect is formally identified
	Coal Reserve	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
	Cropping	Qualitative	Altered groundwater level – groundwater rise Decrease in water quality – increased salinity	To be qualitatively assessed if an effect is formally identified
	Dairying	Quantitative	Altered flow rates – decreased water availability/entitlement Decrease in water quality – increased salinity resulting in change of SEPP segment	To be qualitatively assessed if an effect is formally identified
	Forestry plantations	Qualitative	Altered groundwater level – groundwater rise Decrease in water quality – increased salinity	To be qualitatively assessed if an effect is formally identified
	Grazing	Qualitative	Altered groundwater level – groundwater rise Decrease in water quality – increased salinity	To be qualitatively assessed if an effect is formally identified
	Intensive agriculture	Qualitative	Altered groundwater level – groundwater rise Decrease in water quality – increased salinity	To be qualitatively assessed if an effect is formally identified
	Irrigated agriculture and horticulture	Quantitative	Altered flow rates – decreased water availability/entitlement Decrease in water quality – increased salinity resulting in change of SEPP segment	To be qualitatively assessed if an effect is formally identified

Receptor Category	Sub-Category	Assessment Type	Metric	Threshold
	Multiple use public	Qualitative	Altered groundwater level – groundwater rise Decrease in water quality – increased salinity	To be qualitatively assessed if an effect is formally identified
	Primary production support infrastructure	Qualitative	Altered groundwater level – groundwater rise Decrease in water quality – increased salinity	To be qualitatively assessed if an effect is formally identified
	Protected public land	Qualitative	Altered flow rates – increased flood frequency Decrease in water quality – increased salinity	To be qualitatively assessed if an effect is formally identified
	Recreation	Qualitative	Altered flow rates – decreased water availability/entitlement Decrease in water quality – increased salinity resulting in change of SEPP segment	To be qualitatively assessed if an effect is formally identified
	Specialist Facilities	Qualitative	Altered groundwater level – groundwater rise Decrease in water quality – increased salinity	To be qualitatively assessed if an effect is formally identified
	Waste management	Qualitative	Altered groundwater level – groundwater rise Decrease in water quality – increased salinity	To be qualitatively assessed if an effect is formally identified
Water	Aquifers and Groundwater Use	Quantitative	Maintenance of groundwater quality at an inter-mine and catchment scale Maintenance of groundwater levels, pressures and volumes, such that changes do not materially affect the beneficial use of the aquifers	In accordance with SEPP (Waters) and the statistical range of historical background/pre-mining data
	Dams, artificial lakes and reservoirs	Quantitative	Decrease in water quality – increased salinity resulting in change of SEPP segment	SEPP Waters - Schedule 3 Environmental Quality Indicators and Objectives
	Drains	Quantitative	Changes to water volume and flow patterns, and water quality (including sediment) effects	Latrobe River flow recommendations - Reach 10 (Morwell River)

Receptor Category	Sub-Category	Assessment Type	Metric	Threshold
				SEPP Waters- Schedule 3 Environmental Quality Indicators and Objectives
	Fisheries	Qualitative	As per Rivers, Waterways and Natural Lakes	To be qualitatively assessed if an effect is formally identified
	Wastewater Infrastructure	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
	Water Delivery Infrastructure	Regional water effect pathways not relevant	Not defined because effect pathway not identified	Not defined because effect pathway not identified
	Water Rights and Entitlement Holders	Quantitative	Change to flow volumes and patterns Decrease in water quality – increased salinity resulting in SEPP segment change	No change in the volume or timing of water that can be accessed by existing water users.
	Environmental Water Reserve (including passing flows, Environment Entitlements, and above cap water)	Quantitative	Change to flow volumes and patterns – reduction in environmental flows	No change in volume and reliability of environmental entitlement delivery objectives.
	Water Supply Catchment	Qualitative	As per Dams, Artificial Lakes and Reservoirs	To be qualitatively assessed if an effect is formally identified

Important note about this report

The sole purpose of this report and the associated services performed by Jacobs is to develop and describe metrics that can be used to evaluate regional effects of water-based rehabilitation scenarios and to define appropriate thresholds that estimate the limits of tolerance for the already defined recognised regional receptors, in accordance with the scope of services set out in the contract between Jacobs and the Victorian Government Department of Jobs, Precincts and Regions (DJPR) ('the Client'). That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

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1. Introduction

The Latrobe Valley Regional Rehabilitation Strategy (LVRRS) is part of the Victorian Government's response to the Hazelwood Mine Fire Inquiry (HMFI), which found that there were significant uncertainties and gaps in knowledge surrounding the closure and rehabilitation of the Latrobe Valley's three brown coal mines. The LVRRS will address some of these knowledge gaps through a series of technical studies leading to a final LVRRS report to be completed by June 2020.

The Department of Jobs, Precincts and Regions (DJPR) and the Department of Environment, Land, Water and Planning (DELWP) are jointly responsible for preparing and delivering the LVRRS. Development of the Strategy will involve technical studies covering hydrology, hydrogeology, geomechanics, water quality, geochemistry, and statutory/regulatory issues, and environmental, socioeconomic and cultural issues.

1.1 Background

The Latrobe Valley, 150 km east of Melbourne, Victoria, hosts one of the world's largest brown coal deposits and is the site of three coal mines – known as Yallourn, Hazelwood and Loy Yang – with associated power stations. The three mine voids are very large, each up to 12 km^2 in area and up to 200 m deep and are close to each other (within a ~20 km zone) and to local towns. The mines have been in operation for 40-90 years, and at closure are expected to have a combined void volume of more than 3,000 Mm^3.

The Hazelwood mine and power station ceased operations in March 2017. Yallourn has plans to continue operating until 2032, and Loy Yang until 2048.

A major fire at the Hazelwood Coal Mine in 2014 triggered by local bushfires resulted in significant effects to the local community. In response, the Victorian Government established an inquiry into the Hazelwood mine fire. Among other issues, the inquiry considered the options for rehabilitation of all three mines in a regional context and identified that there are significant knowledge gaps around the feasibility of the mine operator's proposed rehabilitation plans and the cumulative effects of those plans. The LVRRS aims to address these knowledge gaps.

To fill the regional knowledge gaps the Victorian Government committed to investigating the feasibility of water-based rehabilitation options identified by the HMFI for the Latrobe Valley mines, and to prepare the LVRRS to guide regional, and influence site-scale, rehabilitation planning, taking into account the interactions between the mine voids. Specifically the LVRRS committed to undertake regional studies to investigate geotechnical and water considerations:

- Latrobe Valley Regional Geotechnical Study - to investigate the regional stability and fire risks associated with the coal mine voids, and whether those risks can be mitigated if water was used to fill or partly fill the voids.

- Latrobe Valley Regional Water Study - to investigate whether, and to what extent, the proposed filling or partial filling of the mine voids with water taken from the Latrobe River system and Latrobe Valley aquifers would result in adverse ecological, social, cultural and economic impacts to the region.

1.2 LVRRS Development Context for Study

An important task of the LVRRS is to assess the biophysical feasibility of water-based mine void rehabilitated landforms as regional rehabilitation 'scenarios' based on the findings of technical studies and an assessment of cumulative effects.

The LVRRS considers the mines individually and collectively (cumulatively) in the context of potential impacts on the environment, Aboriginal and non-Aboriginal cultural heritage values, infrastructure and land uses in the Latrobe Valley, with a focus on water and land-stability issues, noting that the primary objective of rehabilitation is to achieve a safe, stable and sustainable landform for the closed mine voids.

The biophysical feasibility assessment incorporates an assessment of cumulative impacts, defined as the collective effects of activities and pressures on regional receptors, being the environment (e.g. rivers, lakes, flora, fauna), major infrastructure (e.g. roads, residential property) and other land uses (e.g. agricultural), both direct and indirect, including present and reasonably foreseeable future pressures.

To support assessing the degree of water-related effects on recognised regional receptors, this report defines:

- the metrics (that is, the measures) that could be used to assess the degree of effect of rehabilitation on water-related receptors, with consideration of a range of values for each receptor;
- the available information on the status of the water-related receptors so that likely effects and the degree to which a receptor status changes can be assessed with respect to the defined metrics; and
- qualitative assessment guidance that can be used to assess the degree of effect of rehabilitation on water-related receptors identified for qualitative effects assessment.

The materiality assessment of the link of regional rehabilitation scenarios to recognised regional receptors was undertaken based on end state regional rehabilitation scenarios, particularly related to water and/or geotechnical related effects. This included the filling process, the landform that is in place once the mine void waterbody level has reached an equilibrium state, the water quality the waterbody is approaching, connectivity of a void waterbody with the other two or adjacent/receiving waterways, as its long-term status.

The results of the biophysical assessments can then be used to inform an assessment of the potential environmental, social and economic effects and opportunities of land uses resulting from or supported by the rehabilitation scenarios.

1.3 Objectives

The objective of this study is to define metrics and thresholds that can be used to determine the material[1] effects of rehabilitation scenarios on recognised water-related receptors within the LVRRS study area.

The objectives involve:

- Identification of measures or metrics that describe the potential effect of concern (e.g. tolerance level to water quality variation to ensure maintenance of dependant ecosystems). These are measures for defining unwanted consequences, not the actual potential level of effect that may arise from mine rehabilitation.
- Identification of the most suitable metrics to measure current condition and trend for each receptor (e.g. for water commonly used measures such as level, flow and quality).
- Define, where possible with available information, the current status, trend and effect thresholds for recognised regional surface water and groundwater receptors.

1.4 Scope

The following activities were undertaken to define the metrics and thresholds:

- Collation and determination of the recognised water-related receptors identified from the previous work Identification of Recognised Regional Receptors (Jacobs 2020a)
- Review of literature regarding the metrics of each water-related receptor
- Analysis of current receptor status
- Recommendation of the metrics and thresholds that define material effects on water-related receptors
- A stakeholder workshop with custodians of water-related receptors
- Preparation of a draft report on water-related receptor metrics and thresholds, including compilation of an electronic database[2]
- Draft revision and preparation of a final report on water-related receptor metrics and thresholds.

[1] As defined during previous bioregional assessments in Victoria (Yates et al., 2015) as the *"likely or potential cumulative impact on receptors based on contextual information and is based on judgement following consideration of proximity, causal pathway and expected level of exposure. Where receptors are not linked to events, are too far away, only briefly exposed or only impacted by one mine the impacts may not be material to this regional cumulative impact assessment*".

[2] To be compiled within the Work Package 1 spatially-enabled database

1.4.1 Out of Scope

This report is focused on bio-physical receptors only. Social and economic receptors, that are valued by stakeholders and communities in the Latrobe Valley and that are potentially affected by mine rehabilitation will require consideration as part of the mine operators' development and government approval of Declared Mine Rehabilitation Plans.

This task is primarily restricted to compiling existing information on the metrics and thresholds of receptors which maintain their primary and interdependent values, and therefore is not required to undertake original research.

As the intent of this study work is to ultimately inform an assessment of the regional effects of rehabilitation, by determination of potential effects on recognised receptors, the thresholds for material effects are absolute: either no effect is predicted, or, an effect is predicted. The determination of 'trigger values' for receptor metrics as early warning of potential effects is therefore out of scope and should be completed if required during later studies.

1.5 Report Structure

The report structure is as follows:

- Description of the approach to defining water-related metrics and thresholds.
- Overview of water-related effects for receptors which may require to have those potential effects quantitatively or qualitatively assessed to inform the development of the Strategy.
- Description of the relevant standards, guidelines and legislation.
- Definition of metrics and thresholds for receptors requiring quantitative assessment, including:
    - receptor description
    - status and projected trajectory of receptor.
- Definition of recommended metrics for receptors requiring qualitative assessment, including:
    - receptor description.

2. Approach to Identifying Metrics, Thresholds and Status

2.1 Initial Assessment

The hydrological and hydrogeological considerations of the LVRRS project focus on the effects on receptors associated primarily with alterations in water quality and water quantity, as a response to water-based rehabilitation scenarios.

Recognised regional receptors (Jacobs, 2020a) were defined through an initial stakeholder contribution process, using workshops, followed by analysis of pathways and effects by subject matter specialists. Notes from these workshops are included in Appendix A. Receptors were recognised as having a bio-physical value and a subsequent analysis divided the receptors into two effect assessment groups:

- Quantitative effect assessment – receptors which met all the following criteria:
    - recognised for their values at a regional scale
    - assessed as having a likely causal pathway with one or more mine voids
    - assessed as having a reasonable potential for a material effect from regional rehabilitation.
- Qualitative effect assessment – receptors which met one of the following criteria:
    - a pathway for effect is not clear or cannot be quantified based on current knowledge, but for which the possibility of effect needs to be assessed
    - there is a low likelihood of a causal pathway
    - the consequence of effect is of interest to stakeholders but is not considered to make any significant change to the LVRRS feasibility assessment.

Figure 2.1 shows schematically the LVRRS biophysical feasibility assessment process for regionally recognised receptors. Through this process it is expected that receptors may move between the requirement for a qualitative or quantitative effect assessment as more information is collected during the LVRRS investigations.

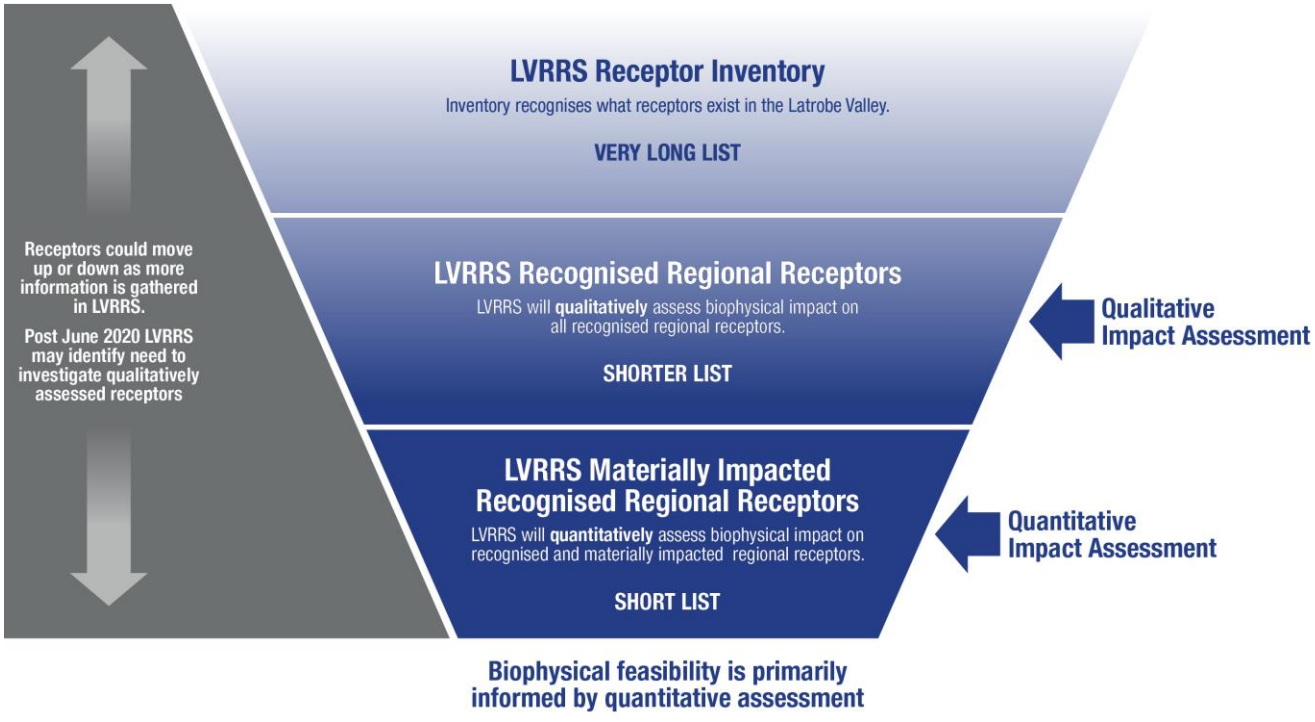


Figure 2.1 : Screening of receptors for qualitative and quantitative assessment

2.2 Materiality Assessment – Water-related effects

To determine the most appropriate metric and threshold to be applied to each receptor, a further materiality assessment was required to refine whether a material linkage or pathway was specifically likely due to water-related effects (i.e. could a change in water quality and/or quantity occur). This process concluded in four types of actions being taken for each recognised receptor:

- Material linkage and pathway of water-related effects confirmed – specific metrics and thresholds assigned
- Material linkage or pathway of water-related effects unlikely – receptor reassigned to qualitative effect assessment and general metrics proposed
- Material linkage and pathway of water-related effects unlikely – receptor reassigned to not require effect assessment and no metrics proposed
- Metrics and thresholds cannot be determined (usually because of a lack of data) for a receptor requiring quantitative assessment – so the receptor is reassigned to qualitative effect assessment and general metrics proposed.

For example, if a Latrobe Valley infrastructure receptor was recommended requiring a quantitative assessment but has no upstream or downstream linkages to surface water/groundwater systems that interact with mine void waterbodies and cannot plausibly be affected by water-related effects from a void waterbody (either during filling or the final form), it is deemed to not be materially affected and therefore not included for either quantitative or qualitative assessment.

2.3 Determination of Metrics and Thresholds

Upon confirmation of the water-related materiality assessment of each receptor, a literature review was completed to identify the measures or metrics that could be used to assess the degree of effect of the rehabilitation scenarios, with consideration of a range of values for each receptor. The literature reviews (discussed further in Section 5) primarily were of standards, guidelines and legislation which govern water quality and water quantity in natural hydrological systems. In general, each literature review provided specific metrics and thresholds for determination of effect on each receptor.

A diagram of the decision tree utilised in completing the water-related materiality assessment and in determining applicable metrics, thresholds and status is detailed in Figure 2.2.

2.4 Current and Projected Receptor Status

To identify the current or baseline condition of the receptors, prior to the assessment of effect or effect of the rehabilitation scenarios, a comparison of each recognised receptor to the defined metrics and thresholds was completed. Utilising the data from the metrics and thresholds assessment, the projected status of each receptor was assessed considering the likely effects over three key time frames of the regional rehabilitation program of works, namely:

- Short Term – at cessation of mining operations
- Medium Term – at achievement of the target void waterbody water levels, and the time at which lake levels have stabilised and,
- Long Term – 100 or more years from 2020.

2.5 Gaps and Uncertainties – Metrics and Thresholds

The assignment of metrics and thresholds has been undertaken to effectively assess the water-related effects on receptors, during the assessment of LVRRS rehabilitation scenarios. In the first instance, the assignment of receptor metrics and thresholds is consistent with relevant standards, guidelines or legislation which maintains the receptors value. Where these documents which stipulate details on the maintenance of receptor values are used as the basis of receptor metrics and thresholds, then there is little uncertainty in their assignment.

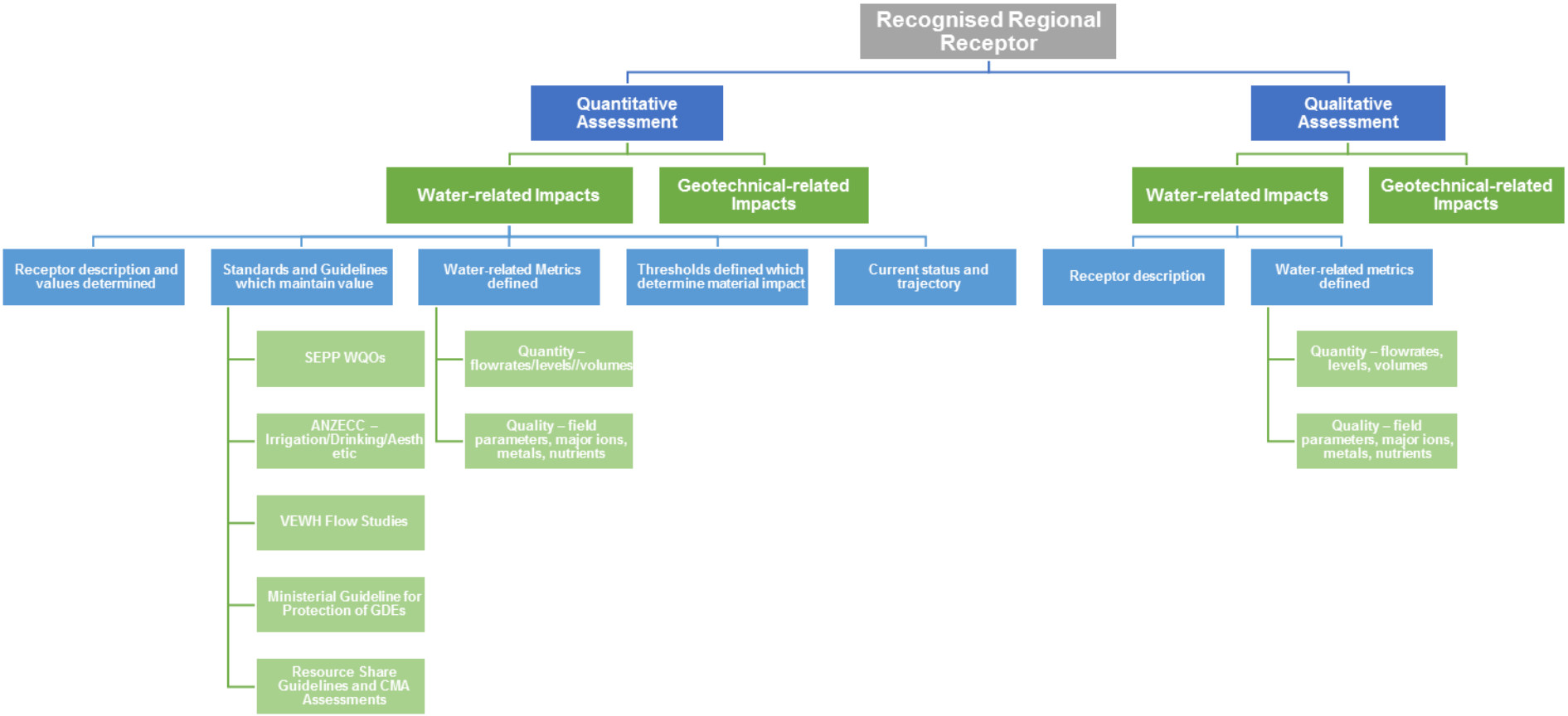
There were uncertainties associated with the current/projected status of receptors, primarily due to the absence or limited access to relevant datasets, which in turn effected the ability to assign applicable metrics and

thresholds. Uncertainty in this context refers to the ambiguities and knowledge gaps that prevent a good understanding of each receptor's water-related values which need to be maintained. Where limited datasets and/or knowledge gaps exist, uncertainty is highlighted, and recommendations are provided to increase data confidence in the document sections below (i.e. in the form of additional monitoring).

Furthermore, no additional work has been conducted to assess or control the quality of data used to assign receptor metrics and thresholds. Data and information, provided in the documents which stipulate details on the maintenance of receptor values, are assumed to be accurate.

Notably, whilst the metrics and thresholds are presented for material effect there is potential for them be refined as further data becomes available in subsequent work for developing the LVRRS and thereafter as deemed necessary.

Figure 2.2 : Decision tree for defining water-related metrics and thresholds



3. Overview of Water-Related Effects on Recognised Regional Receptors – Quantitative Assessment

Recognised regional receptors were previously identified for quantitative analysis and are specified in the report "Identification of Valued Regional Receptors" (Jacobs, 2020a). For further details regarding the identification and definition of each recognised receptor readers are referred to that report. The following section outlines the water-related effects and materiality of recognised receptors that may require metrics and thresholds, for which recommended values are quantified in later sections.

3.1 Aboriginal Cultural Heritage

Table 3.1 – Aboriginal Cultural Heritage Receptors

Sub-Category	Receptor	Water-related effect pathways (with commentary)

Aboriginal cultural heritage	• Over 500 Aboriginal Places (tangible values) recorded within the Latrobe Valley
	• Tangible cultural heritage receptors cannot be specifically detailed due to the confidentiality associated with these sacred sites, however, comprise the following site types:
	  ○ Artefact scatters
	  ○ Earth features
	  ○ Scarred trees
	  ○ Quarries
	• Broader/regional values including the intangible values (cultural values) of the area.
		Surface Water-related effect pathway is possible
		• Further investigation and consultation with the relevant Registered Aboriginal Party (RAP) would be required to determine the extent of potential effect.
		
		Water Quality/Groundwater-related effects uncertain

3.2 Environment

Table 3.2 – Environmental Receptors

Sub-Category	Receptors[1]	Water-related effect pathways (with commentary)
Rivers, waterways and natural lakes	• Morwell River Yallourn to the east • Latrobe River Yallourn to the north and lower reaches • Tanjil River (feed to Latrobe River) (Declared Water Supply Catchment) • Tyers River (feed to Latrobe River) (Declared Water Supply Catchment) • Traralgon Creek (near Loy Yang) • Flynn's Creek (near Loy Yang) • Sheepwash (near Loy Yang) • Bennett's Creek • Lake Wellington • Lake Victoria • Merriman's Creek (Seaspray) (Declared Water Supply Catchment) • Billy's Creek (Declared Water Supply Catchment)	**Surface Water/Water Quality-related effect pathway is possible** • Altered flow rates, watercourse and runoff volumes • Flooding events • Changes in water quality • Effects downstream of the potential mine void waterbodies in the Latrobe River will depend on the presence (or not) of return flows from any void waterbody. **Groundwater-related effects uncertain**
1. During stakeholder workshops the Thomson River was identified as potential receptor for mine rehabilitation if additional water would need to be released from dams on this river to offset the impacts on the Gippsland Lakes caused by increased diversions from the Latrobe River for mine rehabilitation. As this is an option that is not proposed for mine rehabilitation it was not considered further.		

Sub-Category	Receptors[1]	Water-related effect pathways (with commentary)
Listed species (under the EPBC Act)	• Fish (Australian Grayling, Eastern Dwarf Galaxias) • Frogs (Bell Frog, Growling Grass Frog, Burrowing Frog, Spotted Tree Frog) • Birds (Musk Duck, Eastern Great Egret)	**Surface Water/Water Quality-related effect pathway is possible:** • Disruption to flows (wetland/river connectivity and flow) • Changes in temperature regimes • Changes in water quality (potential for increased nutrient and sediment loads) • Changes in water quantity • Potential competition and predation from introduced fish species such as trout **Groundwater-related effect pathway uncertain**
Wetlands	• Lower Latrobe Wetlands (Sale Common, Dowd Morass, Heart Morass) • Gippsland Lakes Ramsar site(s) inclusive of Lake Wellington and Lake Victoria Wetlands • Morwell River Wetlands bordering Yallourn	**Surface Water/Water Quality-related effect pathway is possible** • Changes to water quality, flows, sediment transport • Linkage and effect less likely with increasing distance and wetland volume. Unlikely to materially affect entire Gippsland Lakes site. **Groundwater-related effect pathway uncertain**

3.3 Infrastructure

Table 3.3 – Infrastructure Receptors

Sub-Category	Receptors	Water-related effect pathways (with commentary)
Bridges	• All bridges on roads in the inter-mine area. This excludes culverts.	**Water Quality/Groundwater-related effect pathway uncertain** • Effects related primarily to potential ground movement caused by subsidence/rebound resulting from mine void waterbody filling. • Clear geotechnical pathway from large scale failures of mine void walls • Geotechnical metrics and thresholds defined by Jacobs (2020b). **Surface Water-related effect pathway is possible** • Bridges over waterways are materially-linked due to water clearance levels – defined as a quantitative assessment.
Electricity transmission network	• High Voltage Transmission Line – South of Hazelwood • High Voltage Transmission Line – Morwell to Traralgon	
Extractive industry	• Operating coal mines Yallourn • Operating coal mines Loy Yang • Yallourn North mine void	
Gas fired power generation	• Jeeralang Power Station • Snowy Hydro Power Station (adjacent to Loy yang B)	
Gas pipelines	• APA VTS Australia Pipeline • Australian Gas Networks Pipeline • Energy Australia (Yallourn) Pipeline • Esso Australia Resources Pipelines • Proposed CarbonNet CO_2 Pipeline	
Rail	• Melbourne to Traralgon (adjacent to Yallourn and past Morwell)	
Road – Freeway State maintained	• Princess Highway (southern urban boundary of Morwell and northern boundary of Hazelwood to Yallourn mine) • Strzelecki Highway (adjacent to Hazelwood) • Traralgon Bypass (between Loy Yang and Traralgon)	

	• Hyland Highway (adjacent to Loy Yang)	
Road – Local Council maintained	• Latrobe Road (adjacent to Yallourn)	
Telecommunica-tions	• Telecommunications Infrastructure (e.g. base stations) in the Hazelwood and Yallourn zone	

3.4 Land

Table 3.4 – Land receptors

Sub-Category	Receptors	Water-related effect pathways (with commentary)
Townships/ settlements	• Southern urban boundary of Morwell (zoned General Residential) • Urban buffer between Yallourn coal mine and Morwell which includes open space and existing urban areas • Current and proposed future land south of Traralgon and north of the Loy Yang mine	**Groundwater-related effect pathway is possible** • Effects related primarily to potential ground movement caused by subsidence/rebound resulting from void waterbody filling. • Potential risks associated with rising groundwater levels. **Surface Water/Water Quality-related effect pathway uncertain**
Irrigated agriculture and horticulture	• Irrigated agriculture and horticulture	**Surface Water/Water Quality-related effect pathway is possible:** • Potential for water take to affect reliability or access to entitlement. • Changes in water quality (potential for increased nutrient and sediment loads) • See also sub-category - Water rights and entitlement holders.
Dairying	• Dairying	**Surface Water/Water Quality-related effect pathway is possible:** • Potential for water take to affect reliability or access to entitlement. • Changes in water quality (potential for increased nutrient and sediment loads) • See also sub-category - Water rights and entitlement holders.

3.5 Water

Table 3.5 – Water Receptors

Sub-Category	Receptors	Water-related effect pathways (with commentary)
Aquifers and groundwater use	• Near-surface shallow aquifer system • The Morwell Formation aquifer system • The Traralgon Formation aquifer system • Moe Groundwater Management Area • Rosedale Groundwater Management Areas - Zone 1 and 2 • Stratford Groundwater Management Areas - Zone 1 and 2. • Sale WSPA • Boisdale Aquifer management areas	**Groundwater/Water Quality-related effects are possible** • Altered groundwater levels/pressures/elevations • Changes in water quality **Surface Water-related effect pathway uncertain**
Dams, artificial lakes and reservoirs	• Buckley's Hill Reservoir • Rehabilitated mine void waterbodies • Yallourn Weir • Lake Narracan • Blue Rock Reservoir	**Surface Water/Water Quality/Groundwater-related effect pathways are possible** • Potential for water take and use to affect available water for these receptors.

Sub-Category	Receptors	Water-related effect pathways (with commentary)
	• Moondarra Reservoir	• In the case of mine voids, three voids could potentially compete for water supply in some circumstances.
Drains	• Morwell Main Drain	**Surface Water/Water Quality-related effect pathways are possible** • Effects related primarily to potential ground movement caused by subsidence/rebound resulting from void waterbody filling. • Potential for water take and use to affect available water for these receptors. **Groundwater-related effects are uncertain**
Water Rights and Entitlement Holders	• Water Entitlement Holders as listed in the Victorian Water Register (this includes Environmental Entitlements but see below for Environmental Water Reserve) • Riparian rights holders	**Surface Water/Groundwater-related effects possible** • Potential for water take for mine rehabilitation to affect reliability or access to entitlement. • Changed flows in the main rivers, climate change. **Water Quality-related effects pathway uncertain**
Environmental Water Reserve	• Including passing flows, Environmental Entitlements, and above cap waters[3]	**Surface Water/Water Quality-related effects likely** • Potential for water take to affect amount of water within the Environmental Water Reserve and reliability of Environmental Entitlements. • Potential for material impact to receptor from changed flows in the Latrobe River system.

[3] This receptor could be considered in the environmental category or in the water category. It has been included in water as it defined by the flow (volume and rate) rather than by a specific environmental feature

4. Overview of Water-Related Effects on Recognised Regional Receptors – Qualitative Assessment

Recognised regional receptors were previously identified for qualitative analysis in the Identification of Valued Regional Receptors (Jacobs, 2019a). The following section outlines the water-related effects and materiality of recognised receptors that may require metrics and are recommended for qualitative descriptions as outlined in later sections.

4.1 Aboriginal and non-Aboriginal Cultural Heritage

Table 4.1 – Aboriginal and non-Aboriginal Cultural Heritage Receptors

Sub-Category	Receptor	Water-related effect pathways (with commentary)
Aboriginal cultural heritage	**Tangible** • Aboriginal Places are recorded in all three mine licence areas. **Intangible** • Aboriginal cultural significance attached to water places and forms • Water flow and availability patterns that support specific social activities	**Surface Water-related effect pathway possible** • Surface water erosion of individual archaeological/physical Aboriginal Places (e.g. stone artefact scatters, scarred trees, etc.) would only be potentially affected by one mine rehabilitation. • Responsibility of each mine to manage, not materially linked by two or more mines. • May more likely relate to intangible values associated with water use. **Water Quality/Groundwater-related effect pathways unclear**
non-Aboriginal cultural heritage	• 152 individual historical heritage places of local significance • 14 heritage precincts • 6 Victorian Heritage Register places of state significance • 38 places of potential significance to be further investigated • The Great Morwell Brown Coal Mine • Yallourn North Open Cut • Yallourn Open Cut • Yallourn North Extension • Morwell Open Cut • Hazelwood Open Cut • Loy Yang Open Cut • La Mode Factory • Morwell Power Station • Australian Paper Mill (APM Staff House 2, APM Staff Housing group, APM Staff House 3, APM Staff House 1) • Yinnar Butter Factory (former) • St Marks Anglican Church • Horseshoe Vale Homestead • Hoyles Residence (former) • Cairnbrook Farm Complex • Morwell National Park (original) • Eastern Railway Line • Traralgon Courthouse and Post Office • Gormandale Cooperative Creamery and Butter Building (former) • Burn Brae • Traralgon Park Homestead • Traralgon Hotel • Star Hotel (former) • Lilitree • Arva	**Surface Water/Water Quality/Groundwater-related effects pathways unclear:** • The historical heritage places/precincts as individual places/precincts would only be affected by surface waters from one of the mine void waterbodies. • These places/precincts and their related heritage values (particularly for the Yallourn and Loy Yang mines) would need to be assessed and the effects to each individual mine managed. • The overall heritage values related to mining in the Latrobe Valley more broadly could potentially be subject to cumulative effects by void waterbodies, but if the heritage effects are managed and minimised at an individual mine level, this cumulative effect to mining heritage would also be minimised.

4.2 Environment

Table 4.2 – Environment Receptors

Sub-Category	Receptor[1]	Water-related effect pathways (with commentary)
Rivers, waterways and natural lakes[1]	• Rintoul's Creek (feed to Latrobe River)	**Surface Water/Water Quality-related effect pathways unclear** • There is no clear pathway. • Not linked to source from which water for mine rehabilitation is likely to be sourced. Flows into the Latrobe River downstream of mine voids. **Groundwater-related effect pathways uncertain** • Some uncertainty on groundwater / surface water interactions.
Terrestrial habitats (under the FFG Act)	• Native vegetation in West Gippsland • Four threatened ecological communities in the Gippsland Basin (Gippsland Red Gum grassy woodland, Littoral Rainforest and Coastal Vine Thicket, Seasonal Herbaceous wetlands, and White Yellow-Box grassy woodland) • Gippsland Red Gum Community	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • No specific groundwater dependent ecosystems are known from the area • Few receptors remain on the Latrobe Valley floor • BioSites (reflecting natural areas) are scarce on the Valley floor, other than the local natural waterways that are listed as BioSites. • For threatened species, the likelihood of pathway for threatened species is generally low. Several threatened tree species are known from around the mining areas, some may be remnant but more likely these have been planted. These have been mapped so a spatial appreciation can be determined. • Potential for some of the aquatic bird species to benefit from the mine void waterbody creation.
Listed species (under the FFG Act)	• Plant species/aquatic flora (Matted Flax Lilly, Strzelecki Gum, Aniseed Boronia, Dwarf Kerrawang, Leafy Greenhood, Maroon Leak-orchid, River Swamp Wallaby-grass Swamp Everlasting and Swamp Greenhood)	
Listed species (under the FFG Act)	• Mammals (Australian Fur Seal, Blue Whale, Grey-headed flying fox, Long-footed potaroo, Humpback Whale and Southern Right Whale) • Gippsland Dolphin	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • Generally limited area of total habitat affected by water management • Possible effects relate to ground movement
	• Reptiles (Green Turtle, Leatherback Turtle and Loggerhead Turtle) • Invertebrates (Giant Gippsland Earthworm)	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • No clear evidence of critical water requirements
	• Birds (55 of the 83 listed species)	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • Mostly marine/intertidal/migratory and are therefore unlikely to be linked
Water Dependent Habitats	• Groundwater Dependent Ecosystems	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • Groundwater effect is likely to be increased groundwater level returning to previous levels.
Wetlands (under the FFG act)	• 24 water dependent wetlands in the Gippsland Basin (excluding Lake Victoria and Lake Wellington)	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • The effect pathway is unclear at this time as it may be either quality or flow-related and the exact mine void effects on these features are not known. Hence the materiality of mine void waterbodies impact is not clear. Once the void effects are described then materiality can be assessed and this receptor may move to a quantified category on future review- dependent on effects relating to

Sub-Category	Receptor[1]	Water-related effect pathways (with commentary)
		changes in Latrobe River - primarily changes to water quality, flows, sediment transport – which then flow into wetlands with associated effect on wetland water levels and water regime, water quality, algal bloom risk, supported habitat and species. The extent of these effects are not clear at the time of this report. • Additional mine void waterbodies will add to the likelihood of effect in the Latrobe River, and associated wetland systems.

1. During stakeholder workshops the Macalister and Thomson Rivers were identified as potential receptors for mine rehabilitation if additional water would need to be released from dams on this rover to offset the impacts on the Gippsland Lakes caused by increased diversions from the Latrobe River for mine rehabilitation. As these options were not proposed for mine rehabilitation, they were not considered further.

4.3 Infrastructure

Table 4.3 – Infrastructure Receptors

Sub-Category	Receptor	Water-related effect pathways (with commentary)
Airports	• Latrobe Regional Airport	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • Changes to groundwater levels may affect infrastructure but the extent of recovery of groundwater is not expected to be close enough to the surface to make this very likely so is classed as unclear.
Alternate energy sources	• Future biofuels facility for the processing of agricultural or timber residuals located in the mine scale or inter-mine scale • Future waste to energy facility located in the mine scale or inter-mine scale	
Coal fired power generation	• Yallourn Power Station • Loy Yang Power Station • Carbon Capture Storage Site • Yallourn North mine void and rehabilitated land	
Industry and manufacturing	• Future logistics and manufacturing (undertaken in existing industrial use zones in Traralgon and Morwell)	
Tele-communications	• Telecommunications Infrastructure (Base Stations) across the Latrobe basin • Network cables	

4.4 Land

Table 4.4 – Land Receptors

Sub-Category	Receptor	Water-related effect pathways (with commentary)
Coal reserve	• Driffield East, Churchill, Churchill North, Loy Yang East, Coalville (black coal), Corridor, Driffield, Maryvale East, Fernbank, Flynn, Gormandale, Latrobe River, Morwell Township, Rosedale, Tyres, Traralgon Creek, Yinnar • Defined by the strategic coal reserve overlays	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • Minimal biophysical effects in terms of accessing the coal. May have economic effects in terms of reducing access to coal and limiting future coal mine rehabilitation options.
Protected public land	• Tyers Park • Woorabinda Education Area • Traralgon South Flora and Fauna Reserve	**Surface Water/Groundwater/Water Quality-related effect pathways unclear**

Sub-Category	Receptor	Water-related effect pathways (with commentary)
	• Coalville G219 Bushland Reserve • Sayers Trig Bushland Reserve • Jeeraland North Education Area • Gormandale Flora Reserve • Narracan State Forest • Moondarra State Park • National Parks in West Gippsland Catchment • Current Tenements – Extractives • Current Tenements – Retention Licences • Current Tenements – Mining Licences	• Given the protected public land is located generally at catchment scale unlikely to be materially linked • Qualitative assessment required for effects that may result from changes in hydrological circumstances.

Townships/ settlements	• Traralgon, Morwell, Yallourn North, Moe, Churchill, Newborough inclusive of zones:
	  ○ Central Business District/Activity Centre
	  ○ Existing urban areas, future urban use
	  ○ Existing industrial areas, future industrial, future bulky goods
	  ○ Proposed public Open Space, Existing Open Space, Amenity Lifestyle Precinct
		Surface Water/Groundwater/Water Quality-related effect pathways unclear
		• These areas are generally located significant distances from the mine sites due to residential use being a sensitive use and not suitable to neighbour a mine thus making material link less likely.
		• Effects to recreational land to be qualitatively assessed.

Intensive agriculture	• Future intensive agricultural activities (such as broiler farms or piggeries) • Intensive Agriculture • Potential future intensive agriculture such as non-soil-based vegetable herb growing (in greenhouses) located near mine void waterbodies • Potential future processing of vegetables located near mine void waterbodies	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • No specific location identified with material linkage. Land uses not considered sensitive to water-related effects.
Cropping	• Cropping	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • Rainfall dependent and therefore unlikely to have a causal pathway. • Without pathway unlikely to be materially affected by changes in water quality and quantity
Grazing	• Grazing	
Forestry plantations	• Timber production and plantations	
Multiple public use	• Future tourism (arts and culture) and recreation (e.g. bikes paths) at Yallourn • Future tourism (arts and culture) and recreation (bike paths) at Hazelwood • Future tourism (arts and culture) and recreation (bike paths) at Loy Yang	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • Located within the inter-mine scale (likely to only affect large assets close to the mine voids) Inter-mine scale is vulnerable to ground movement caused by subsidence/settlement rebound resulting from void waterbody filling, resulting in heave, cracking and seismic movement
Primary production and support infrastructure	• Future non-soil-based vegetable herb growing (in greenhouses) located near proposed void waterbody (lightweight structure) • Future processing of vegetables in the mine scale or inter-mine scale	
Specialist facilities	• Potential future education and training facilities (relating to land rehabilitation, mining, environmental science and clean energy technologies) located near the potential mine void waterbodies	
Waste management	• Future waste process	

Sub-Category	Receptor	Water-related effect pathways (with commentary)
	• Future organics recycling and composting facility located in the mine scale or inter-mine scale • Landfills	
Recreation	• 92 recreation areas related to water in Gippsland Basin • Fishing and hunting • Future fishing	**Surface Water/Water Quality-related effect pathways possible** • Receptor materially linked to connection to rivers and waterways – noting recreational use patterns unlikely to materially change in response to changes in flows except at the extremes. **Groundwater-related effect pathways unclear**

4.5 Water

Table 4.5 – Water Receptors

Sub-Category	Receptor	Water-related effect pathways (with commentary)
Dams, artificial lakes and reservoirs	• Loy Yang High Water Level Storage	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • Changed flow is unlikely to affect the structure. • Potential for ground movement due to void waterbody filling
	• Hazelwood Pondage • Yallourn North Extension Open Cut pit lake	**Surface Water/Groundwater/Water Quality-related effect pathways possible** • Proximity to changes leads to possible effects
Wastewater infrastructure	• Moe and Morwell Waste Water Treatment Plant • Gippsland Water Factory – water treatment	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • Significant distance to mine void waterbodies
Water delivery infrastructure	• Irrigation Infrastructure – Publicly and Privately Owned	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • No clear water-related pathway or effect
	• Gippsland Water Factory – recycled water production • Groundwater monitoring bore network • Potable Infrastructure (pipes and tanks etc.) – Public and Privately owned • Town water bores • Other licenced bores	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • Flows generally unrelated to river flow and more related to town water use. • Receptors located outside area of expected material effect.
Drains	• Drains associated with railway line and embankment	**Surface Water/Groundwater/Water Quality-related effect pathways unclear** • No clear water-related pathway or effect • Flooding and flow changes not clear effect on drains
Fisheries	• Gippsland Lakes Fishery	**Surface Water/Groundwater/Water Quality-related effect pathways unclear**

Sub-Category	Receptor	Water-related effect pathways (with commentary)
		• Changes to water quality and flows sediment transport • No direct causal link has been defined to the scale and extent of fisheries. However, note that if water from mine rehabilitation does disrupt the Environmental Water Reserve such that spawning triggers aren't provided, it could potentially causally affect fisheries within the Gippsland Lakes.

5. Relevant Standards, Guidelines and Legislation which protect receptor value

5.1 Key Legislation

The sections below identify the primary Acts that provide protection for biophysical (largely environmental) receptor status. This list is not exhaustive but covers the main legislation.

5.1.1 Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Commonwealth)

The *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (the Commonwealth Act) protects Aboriginal cultural property that is significant to Aboriginal people. Cultural property includes any places, objects and folklore that 'are of particular significance to Aboriginals in accordance with Aboriginal tradition'. This includes intangible cultural heritage values; these sites may not necessarily have an archaeological component. Where Aboriginal cultural heritage places have cultural significance in accordance with Aboriginal tradition and are registered under the State's *Aboriginal Heritage Act 2006*, these would also be Aboriginal places subject to the provisions of the Commonwealth Act.

There is no cut-off date and the Commonwealth Act may apply to contemporary Aboriginal cultural property as well as ancient sites. The Commonwealth Act takes precedence over State cultural heritage legislation where there is conflict. Under section (s) 9 and 10 of the Commonwealth Act, the responsible Minister may make a declaration in situations where state or territory laws do not provide adequate protection of heritage places. The declaration can be made in response to verbal or written communication to the Minister, which seeks to protect or preserve a specified area from injury or desecration. Declarations can result in stop work activities and override other approvals that may be in place.

5.1.2 Native Title Act 1993 (Commonwealth)

The *Native Title Act 1993* recognises and protects native title and provides that native title cannot be extinguished contrary to the Act. The National Native Title Tribunal is a Commonwealth Government agency set up under this Act, and mediates native title claims under the direction of the Federal Court of Australia.

The National Native Title Tribunal maintains the following registers:

- National Native Title Register
- Register of Native Title Claim
- Unregistered claimant applications
- Register of Aboriginal land use agreements.

GLaWAC have been determined to have native title over part of their claim area (Tribunal number VCD2010/001).

5.1.3 Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

The *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) includes 'national heritage' as a Matter of National Environmental Significance and fully protects listed places under the Constitution. It also establishes the National Heritage List, the Commonwealth Heritage List as well as protecting water related and dependent biodiversity.

5.1.4 Aboriginal Heritage Act 2006

In 2006, the Victorian Parliament passed the *Aboriginal Heritage Act 2006*, which came into operation on 28 May 2007. In 2016, the Act was amended (*Aboriginal Heritage Amendment Act* 2016) and is the principal piece of legislation dictating Aboriginal cultural heritage management in Victoria. The purpose of the Aboriginal Heritage Act 2006 is:

- To provide for the protection of Aboriginal cultural heritage and Aboriginal intangible heritage in Victoria
- To empower traditional owners as protectors of their cultural heritage
- To strengthen the ongoing right to maintain the distinctive spiritual, cultural, material and economic relationship of traditional owners with the land and waters and other resources with which they have a connection under traditional laws and customs.

Of the many objectives of the Aboriginal Heritage Act, the most significant for this project is that it aims to recognise, protect and conserve Aboriginal cultural heritage within Victoria. It also aims to provide sanctions and penalties to prevent harm to Aboriginal cultural heritage.

5.1.5 Flora and Fauna Guarantee Act 1988

The Victorian Flora and Fauna Guarantee Act 1988 provides the main legal framework for the protection of Victoria's biodiversity, native plants and animals, and ecological communities. Under the Act, species, ecological communities and potentially threatening processes are listed. When listed, an action statement is prepared - this identifies actions that have been or will be taken to conserve the species/community or manage the potentially threatening process.

5.1.6 Planning and Environment Act 1987

The Planning and Environment Act 1987 sets out procedures for preparing and amending the Victoria Planning Provisions and planning schemes. It also sets out the process for obtaining permits under schemes, settling disputes, enforcing compliance with planning schemes and permits, and other administrative procedures.

5.1.7 Water Act 1989

The Water Act 1989 provides the legal framework for managing Victoria’s water resources. The act promotes integrated water management, equitable and efficient water use, conservation and sustainability of water resources. Rights to water defines that the Crown has the right to use, flow and control of all water in a waterway and all groundwater. Under the act, water is issued to individual users by the relevant water corporation nominated by the Crown, via a water share or a licence.

5.1.8 Environment Protection Act 1970

The Environment Protection Act 1970 provides a legal framework to protect the environment in Victoria. It applies to noise emissions and the air, water and land in Victoria, the territorial sea along the coast of Victoria. The Act outlines the powers, duties and functions of the EPA, including administration of orders made pursuant of the Act, such as the State Environment Protection Policies, industrial waste management policies and implementation of National Environment Protection Measures (NEPM).

5.2 Guidelines

There are several standards and guidelines relevant to the protection of values in receiving waterways and groundwater. These are relevant to all river and groundwater receptors identified for the LVRRS study, and primarily relate to water ***quality***, or to water ***quantity*** in the context of flow requirements to support environmental values.

The key standards and guidelines relevant to setting water quality metrics and thresholds for river and groundwater receptors are the State Environment Protection Policy (Waters) and the *Australian and New Zealand guidelines for fresh and marine water quality* (ANZECC 2000). These guidelines set specific water quality objectives designed to protect waterway and groundwater values that are dependent on water quality.

Water quantity – or flow volume and pattern – is also critical to maintaining environmental values in waterways. Environmental flow studies have been completed by the Victorian Government for many waterways in the study area. These studies define the required flow regime to achieve agreed ecological objectives. These guidelines

can be used to set metrics aligned to specific environmental values that can be used for assessment against current and future conditions.

5.2.1 State Environment Protection Policy (Waters)

The State Environment Protection Policy (Waters) (SEPP Waters) provides a legal framework for State and local government agencies, communities and business to work together to protect waterways, and sets out responsibilities of bodies such as the West Gippsland CMA, to develop waterway management strategies to achieve the objectives of the Schedule.

The SEPP (Waters) sets out the Beneficial Uses of waterways in particular areas. As set out in SEPP, a beneficial use is defined in the *Environment Protection Act 1970* and includes a current or future environmental value or use of surface waters that communities want to protect. A beneficial use requires that surface waters are of a suitable quality and quantity to support that use or value.

Schedule 1 of the SEPP (Waters) outlines the segments in which the waterways in LVRRS study area are covered. The most relevant of these segments are:

- Gippsland Lakes (which includes Lake Wellington, Lake Victoria, Lake King, Lake Reve and the exchange of surface waters bounded by the entrance to Gippsland Lakes and the entrance to Lake King in the west)
- Highlands (covering the mountain river and stream reaches in the Latrobe, Thomson, Macalister, Mitchell, Tambo and Snowy basins, being the mountain river and stream reaches in the generally alpine and sub-alpine environments above 1,000 m in altitude)
- Uplands A (covering the uplands of the Upper Thomson, Latrobe, South Gippsland basins)
- Central Foothills and Coastal Plains (covering the lowlands of the South Gippsland, Latrobe, Thomson, Mitchell, Tambo and Snowy basins)

Schedule 2 of the SEPP (Waters) sets out the beneficial uses of the waters, the following of which apply to the Gippsland Lakes segment:

- Maintenance of water dependent ecosystems and species (slightly to moderately modified ecosystems)
- Recreation: Primary contact, Secondary contact, Aesthetic enjoyment
- Fishing and aquaculture
- Traditional Owner cultural values, Cultural and Spiritual values

The beneficial uses of the waters of Highlands, Upland A and Central Foothills and Coastal Plains segments are set out by the SEPP (Waters) Schedule 2 as:

- Maintenance of water dependent ecosystems and species (slightly to moderately modified ecosystems)
- Recreation: Primary contact, Secondary contact, Aesthetic enjoyment
- Fishing and aquaculture
- Industrial and commercial use
- Traditional Owner cultural values, Cultural and Spiritual values

Schedule 3 of the SEPP (Waters) sets out the environmental quality indicators and objectives required to protect beneficial uses of the waters for a given region, and these are appropriate metrics with which to assess

effects from the LVRRS. Schedule 3 sets acceptable ranges/limits for several water quality indicators, and a specified allowable variation from background levels for some indicators, where background water quality does not meet the specified objectives. For other indicators, if the WQOs are not met then maintenance of the background water quality becomes the objective. These WQOs are reproduced in Table 5.1 and Table 5.2.

Table 5.1: SEPP (Waters) - Schedule 3 - Gippsland Lakes Segment - Environmental Quality Indicators and Objectives.

Environmental quality indicator		Segment							
		Lake Wellington	Lake Victoria		Lake King		Lake Reeve	Exchange	
		Surface	Surface	Bottom	Surface	Bottom	Surface	Surface	Bottom
Total phosphorous (µg/L)	75th Percentile	120	90	110	50	70	R75[1]	50	30
Total nitrogen (µg/L)	75th Percentile	1,000	600	600	500	500	R75	500	300
Dissolved Oxygen (% saturation)	25th Percentile-Max	95-130	95-130	50-130	95-130	50-130	R25-R75	95-130	80-130
Chl-a (µg/L)	75th Percentile	25	20	15	10	5	R75	10	5
Dissolved Inorganic Phosphorus (µg/L)	75th Percentile	15	20	50	10	30	R75	10	15
Dissolved Inorganic Nitrogen (µg/L)	75th Percentile	15	10	50	10	100	R75	10	40
TSS (mg/L)	75th Percentile	30	10	10	5	5	R75	5	10
Salinity (PSU)	25th Percentile	NA	15	21	20	25	R25	20	30
	75th Percentile	15	25	28	30	30	R75	30	35
Light Attenuation (m-l)	75th Percentile	2.5	1.5	N/A	0.7	N/A	R75	0.5	N/A
pH	25th-75th Percentile	7.5-8.5	7.5-8.5	N/A	7.5-8.5	N/A	R25-R75	7.5-8.5	N/A
Toxicants Water	% protection	95	96	97	98	99	100	101	102
Toxicants Sediment		Low	Low	Low	Low	Low	Low	Low	Low

[1]R75 and R25 means that a single objective value could not be specified due to a lack of data or variability of data collected in a segment and, for these areas, the environmental quality objective must be calculated as the 75th percentile and 25th percentile of the data collected at a reference site.

Table 5.2: SEPP (Waters) - Schedule 3 - Highlands, Uplands A, Central Foothills and Coastal Plains Segments - Environmental Quality Indicators and Objectives.

Environmental quality indicator		Segment		
		Highlands	Uplands A	Central Foothills and Coastal Plains
Total phosphorous (µg/L)	75th Percentile	≤20	≤35	≤55
Total nitrogen (µg/L)	75th Percentile	≤150	≤900	≤1100
Dissolved Oxygen (% saturation)	25th Percentile	≥85	≥80	≥75
	Maximum	130	130	130
Turbidity (NTU)	75th Percentile	≤3	≤15	≤25
Electrical Conductivity (µS/cm@ 25°C)	75th Percentile	≤30	≤100	≤250
pH	25th Percentile	≥5.9	≥6.4	≥6.7
	75th Percentile	≤6.9	≤7.6	≤7.7
Toxicants Water	% protection	95	95	95
Toxicants Sediment		Low	Low	Low

5.2.2 Assessment of Environmental Flow Requirements for the Latrobe River

Environmental flow studies involve the development of objectives for water dependant values and processes (i.e. fish, vegetation, frogs, wetlands, water quality, macroinvertebrates, channel form etc.) as well as the determination of specific flow recommendations required to enable those objectives to be met. Recommendations include advice on the magnitude of different flow components (low flows, freshes, high flows, overbank flows), and the timing, frequency and duration of various components. A hydrological assessment of how well the current (or defined future scenario) flow regime complies with the flow recommendation can be undertaken and inference made as to the effects poor compliance has on values reliant on non-compliant flow regimes. Even where non-compliance occurs, comparisons can be made between different flow scenarios to identify which scenarios or flow management outcomes represent the greatest or lowest levels of risk.

The flow study report (EarthTech 2007) that was current at the time of preparing this report sets specific flow recommendations for different reaches of the Latrobe. This report is likely to be updated in the near future so a review of these thresholds may be required as a result. Those reaches of the most relevance to the LVRRS recognised receptors are:

- Reach 3 – Latrobe River (Lake Narracan to Scarnes Bridge)
- Reach 4 – Latrobe River (Scarnes Bridge to Rosedale)
- Reach 5 - Latrobe River (Rosedale to Thomson River Confluence)
- Reach 6 – Latrobe River (Thomson River to Lake Wellington) (Discussed in Latrobe Wetlands section)
- Reach 8 – Tanjil River
- Reach 9 – Tyers River
- Reach 10 – Morwell River
- Reach 11 – Traralgon Creek.

These flow recommendations for each receptor are provided under the relevant receptor chapters.

Where specific flow recommendations have not been determined for a specific receptor/waterway, the effects of altered hydrology can be assessed using a range of eco-hydrological metrics. There is a significant body of literature that has evaluated a range of hydrological metrics to identify those that are ecologically relevant (e.g. Marsh et al 2012).

The most relevant eco-hydrological metrics to assess the changes in groundwater levels effects the severity of ‘cease to flows’ and ‘low flows’ would be those relating to frequency and duration of ‘cease to flow’ and ‘low flow’. Other relevant metrics that might be appropriate are those that relate to frequency of high flows and flow variability.

Examples of relevant eco-hydrological metrics are provided in Table 5.3.

Table 5.3 : Eco-hydrologic metrics that could be used as appropriate measures of effect in waterways without flow recommendations

Hydrologic metric	Definition
Magnitude of flow events - average flow conditions	
Low flow discharge (75th %ile)	Percentiles from flow duration curve
Low flow discharge (90th %ile)	

Hydrologic metric	Definition
Low flow discharge (95th %ile)	
Low flow discharge (99th %ile)	
Low flow index 1	The lowest and second lowest monthly flows in a year
Low flow index 2	7-day minimum flow / water year mean daily flow, calculated each year then averaged
Magnitude of flow events - high flow conditions	
High flow discharge (1st %ile)	Percentiles from flow duration curve
High flow discharge (5th %ile)	
High flow discharge (10th %ile)	
High flow discharge (25th %ile)	
Specific mean annual maximum runoff	Mean annual maximum flow divided by catchment area
High flow volume (>1xMDF)	Mean of the high flow volume (calculated as the area between the hydrograph and the upper threshold defined as 1, 3, and 7 times MDF, respectively) divided by MDF
High flow volume (>3xMDF)	
High flow volume (>7xMDF)	
Frequency of flow events - low flow conditions	
Low flow spell count (<75th %ile)	Mean number of annual occurrences during which the magnitude of flow remains below a lower threshold defined by the percentile (from the flow duration curve)
Low flow spell count (<90th %ile)	
Low flow spell count (<99th %ile)	
High pulse count	
CV of low flow spell count (<75th %ile)	Coefficient of variation in number of annual occurrences during which the magnitude of flow remains below a lower threshold defined by the percentile (from the flow duration curve)
CV of low flow spell count (<90th %ile)	
CV of low flow spell count (<99th %ile)	
Frequency of flow events - high flow conditions	
High flow spell count (>25th %ile)	Mean number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by the percentile (from the flow duration curve)
High flow spell count (>10th %ile)	
High flow spell count (>1st %ile)	
CV of high flow spell count (>25th %ile)	Coefficient of variation in number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by the percentile (from the flow duration curve)
CV of high flow spell count (>10th %ile)	
CV of high flow spell count (>1st %ile)	

Hydrologic metric	Definition
High flow spell count (>3xMDF)	Mean number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by multiple of MDF
High flow spell count (>7xMDF)	
Zero flow index Mean duration of zero flow periods	The proportion of time that the stream is dry (or nearly so) Zero flow days in full record divided by zero flow periods in full record

Table 5.4 : Summary flow recommendations – Latrobe River Reach 3 (Lake Narracan to Scarnes Bridge). Compliance point – Latrobe River at Scarnes Bridge

Flows recommendation				Rationale
Period	**Magnitude**	**Frequency**	**Duration**	
Dec-May	Low flow > 560 ML/d (or natural)	Continuous	Continuous	Inundation of bed for provision of Macroinvertebrate habitat, average depth of pools >0.4m for provision of habitat for Grayling and Blackfish
Dec-May	Low flow freshes >1380 ML/d	3 per period	6 days	Inundation of in-stream bars to maintain channel form and provide watering of vegetation, riffle thalweg >0.4m for movement of River Blackfish, minimum reach velocity >0.3m/s for bed disturbance
June-Nov	High flow >1380 ML/d or natural	Continuous	Continuous	Inundation of in-stream bars to maintain channel form and prevent Vegetation encroachment, >0.4m over thalweg between pools for migration of Grayling
June-Nov	High flow freshes >7780 ML/day	2 per season	3 days	Bench inundation to maintain channel form and provide watering of bench vegetation, pool velocity >1m/s for scour hole formation and maintenance
June-Nov	Overbank flow >17300 ML/day	1 every 2 years	2 days' average duration with variation between 1 and 3 days	Channel maintenance and watering of floodplain and wetland vegetation

Table 5.5 : Summary flow recommendations – Latrobe River Reach 4 (Scarnes Bridge to Rosedale). Compliance Point: Latrobe River at Rosedale (anabranch) and (main stream)

Flows recommendation				Rationale
Period	**Magnitude**	**Frequency**	**Duration**	
Dec-May	Low flow >520 ML/d (or natural)	Continuous	Continuous	Inundation of bed for provision of macroinvertebrate habitat, average depth of pools >1.0 m for provision of habitat for Bass

Flows recommendation				Rationale
Period	Magnitude	Frequency	Duration	
Dec-May	Low flow freshes >1470 ML/d	3 per season	7 days	Inundation of in-stream bars to maintain channel form and provide watering of aquatic vegetation, riffle thalweg >0.5m for movement of Bass, minimum reach velocity >0.3m/s for bed disturbance
June-Nov	High flow >1470 ML/d or natural	Continuous	Continuous	Inundation of in-stream bars to maintain channel form and prevent vegetation encroachment, riffle thalweg >0.5m for migration of Bass
June-Nov	High flow freshes >6900 ML/day	3 per season	5 days	Maintain channel form through bed disturbance and scour hole formation
June-Nov	Overbank flow >12960 ML/day	1 per season	2 days	Channel maintenance and watering of floodplain and wetland vegetation
June-Nov	Wetland watering flow >8640 ML/d	2 per season	3 days	Wetland inundation

Table 5.6 : Summary flow recommendations – Reach 5 - Latrobe River (Rosedale to Thomson River)

Flows recommendation				Rationale
Period	Magnitude	Frequency	Duration	
Dec-May	Low flow > 690 ML/d (or natural)	Continuous	Continuous	Inundation of bed for provision of habitat to macroinvertebrates, average depth of pools >1.0 m for provision of habitat for Bass
Dec-May	Low flow freshes >1296 ML/d	3 per season	7 days	Inundation of in-stream bars to maintain channel form and provide watering of aquatic vegetation, riffle thalweg >0.5m for movement of Bass, minimum reach velocity >0.3m/s for bed disturbance
June-Nov	High flow >1470 ML/d or natural*	Continuous	Continuous	Inundation of in-stream bars to maintain channel form and prevent vegetation encroachment (based on upstream reach), riffle thalweg >0.5m for migration of Bass
June-Nov	High flow freshes > 6900 ML/day	3 per season	5 days	Maintain channel form through bed disturbance and scour hole formation
June-Nov	Overbank flow > 12960 ML/day	1 per season	2 days	Channel maintenance and watering of floodplain and wetland vegetation
Sep-Nov	Wetland watering flow >8640 ML/day	2 per season	3 days	Wetland inundation

**The absence of benches and bars in this reach has meant that all relevant high flow criteria for this reach are met at very low recommendations. The adopted high flow recommendation of 1470 ML/d for this reach is based on the Reach 4 (upstream) high flow recommendation. Provision of this flow will assist in the maintenance of bars at this level as they form during the process of channel recovery*

Table 5.7 : Summary flow recommendations – Reach 8 Tanjil River

Flows recommendation				Rationale
Period	**Magnitude**	**Frequency**	**Duration**	
Dec-May	Low flow > 140 ML/d (or natural)	Continuous	Continuous	Inundation of bed for provision of habitat to macroinvertebrates, average depth of pools >0.4 m for provision of habitat for Grayling and Blackfish
Dec-May	Low flow freshes >432 ML/d	2 per season	4 days	Inundation of bars to maintain channel form and provide watering of vegetation communities, riffle thalweg >0.4m for movement of River Blackfish and Australian Grayling, minimum reach velocity >0.3m/s for bed disturbance
June-Nov	High flow >432 ML/d or natural*	Continuous	Continuous	Inundation of in-stream bars to maintain channel form and prevent vegetation encroachment, >0.4m over thalweg between pools for migration of Grayling
June-Nov	High flow freshes > 1035 ML/day	2 per season (including additional high flow fresh >1470 ML/d)	3 days (including additional high flow fresh >1470 ML/d for 2 days)	Bench inundation to maintain channel form and provide watering of bench vegetation, pool velocity >1m/s for scour hole formation and maintenance
June-Nov	Overbank flow > 3024 ML/day	1 every 2 years	2 days	Channel maintenance and watering of floodplain and wetland vegetation

Table 5.8 : Summary flow recommendations – Reach 9 Tyers River

Flows recommendation				Rationale
Period	**Magnitude**	**Frequency**	**Duration**	
Dec-May	Low flow > 150 ML/d (or natural)	Continuous	Continuous	Average depth of pools >0.4m for provision of habitat for Grayling and Blackfish, **inundation of bed for macroinvertebrate habitat**
Dec-May	Low flow freshes >432 ML/d	2 per season	3 days	Inundation of in-stream bars to maintain channel form and provide watering of aquatic vegetation communities, riffle thalweg >0.4m for movement of River Blackfish, **minimum reach velocity >0.3m/s for bed disturbance**
June-Nov	High flow >345 ML/d or natural*	Continuous	Continuous	**Inundation of in-stream bars to maintain channel form and prevent vegetation encroachment**, >0.4m over thalweg between pools for migration of Grayling
June-Nov	High flow freshes > 690 ML/day	2 per season	3 days	**Bench inundation to maintain channel form and provide watering of bench vegetation,** pool velocity >1 m/s for scour hole formation and maintenance
June-Nov	Overbank flow > 2070 ML/day	1 per 2 years	2 days	**Enables ongoing channel evolution and maintenance of open channel**
June-Nov	Wetland watering flow >3456 ML/day	2 per 5 years	1 days	**Maintenance and watering of terrace vegetation**

Table 5.9 : Summary flow recommendations – Reach Ten - Morwell River

Flows recommendation				Rationale
Period	**Magnitude**	**Frequency**	**Duration**	
Dec-May	Low flow >60 ML/d (or natural)	Continuous	Continuous	Average depth of pools >0.4m for provision of habitat for Blackfish, inundation of bed for macroinvertebrate habitat
Dec-May	Low flow freshes >260 ML/d	2 per season	3 days	Inundation of in-stream bars to maintain channel form and provide watering of aquatic vegetation communities, riffle thalweg >0.4m for movement of River Blackfish, minimum reach velocity >0.3m/s for bed disturbance
June-Nov	High flow >260 ML/d or natural	Continuous	Continuous	Inundation of instream bars to maintain channel form and prevent vegetation encroachment, >0.3m over thalweg between pools for migration of small bodied diadromous species
June-Nov	High flow freshes >1380 ML/day	4 per season	4 days	Bench inundation to maintain channel form and provide watering of bench vegetation, pool velocity >1m/s for scour hole formation and maintenance
June-Nov	Overbank flow >3456 ML/day	1 per year	2 days	Channel maintenance and watering of floodplain and wetland vegetation.

Table 5.10 : Summary flow recommendations – Reach 11 – Traralgon Creek. Compliance Point – Traralgon Creek at Traralgon (Princes Highway)

Flows recommendation				Rationale
Period	**Magnitude**	**Frequency**	**Duration**	
Dec-May	Low flow > 35 ML/d (or natural)	Continuous	Continuous	Inundation of bed for provision of macroinvertebrate habitat, average depth of pools >0.4m for provision of habitat for Blackfish
Dec-May	Low flow freshes >210 ML/d	1 per season	3 days	Inundation of in-stream bars to maintain channel form and provide watering of aquatic vegetation, riffle thalweg >0.4m for movement of River Blackfish, minimum reach velocity >0.3m/s for bed disturbance
June-Nov	High flow > 130 ML/d or natural	Continuous	Continuous	Inundation of in-stream bars to maintain channel form and prevent vegetation encroachment
June-Nov	High flow freshes > 520 ML/day	3 per season	3 days	Bench inundation to maintain channel form and provide watering of bench vegetation, pool velocity >1 m/s for scour hole formation and maintenance

Flows recommendation				Rationale
Period	Magnitude	Frequency	Duration	
June-Nov	Overbank flow > 1555 ML/day	1 per 2 years	2 days	Channel maintenance and watering of floodplain and wetland vegetation

Specific SEPP objectives have been set for wetlands, under SEPP *Schedule 3, Table 3: Environmental Quality Objectives for Physical and Chemical Indicators for Wetlands and Table 4: Environmental Quality Objectives for Biological Indicators for Wetlands*. The ANZECC guidelines also include default trigger values for wetlands in south-eastern Australia. These are the appropriate WQOs for the wetlands.

5.2.3 Beneficial Uses for Groundwater

The State Environment Protection Policy (Waters) provides a legal framework for the protection of groundwater systems, and sets out responsibilities of bodies such as the West Gippsland CMA to develop groundwater management strategies to achieve the objectives of each segment (see below) of the groundwater environment as determined by the background level of TDS in the aquifer as defined in Table 5.11.

Table 5.11 : SEPP (Waters) – Groundwater Segments

Segment	A1	A2	B	C	D	E	F
TDS range (mg/L)	0 - 600	601 – 1,200	1,201 – 3,100	3,101 – 5,400	5,401 – 7,100	7,101 – 10,000	>10,001

The SEPP (Waters) sets out the Beneficial Uses of groundwater based on the segment to which it falls under. A beneficial use is defined in the *Environment Protection Act 1970* and includes a current or future environmental value or use of groundwater that communities want to protect. Subject to TDS range of the groundwater, the beneficial uses specified in Table 5.12 will be protected in each segment marked.

Table 5.12 : SEPP (Waters) – Protected Beneficial Uses of the Segments

Beneficial Uses	Segments (TDS mg/L)						
	A1	A2	B	C	D	E	F
Maintenance of Ecosystems							
Potable Water Supply							
desirable							
acceptable							
Potable mineral water supply							
Agriculture and irrigation (irrigation)							
Agriculture and irrigation (stock watering)							
Industrial and commercial							
Water-based recreation (primary contact recreation)							
Traditional owner cultural values							
Cultural and spiritual values							
Building and structures							
Geothermal properties							

6. Metrics and Thresholds – Aboriginal and Non-aboriginal Cultural Heritage Receptors

6.1 Aboriginal cultural heritage

Over 500 different Aboriginal Places are recorded within a 10 km buffer surrounding the towns of Moe, Traralgon, Morwell, and Churchill, within the Latrobe Valley. These Aboriginal Places have been defined as 'tangible sites' for this assessment. These tangible sites have also been separated into different receptors, due to the diverse management requirements and effect pathways associated with each type. It should be noted that there will be additional, unrecorded tangible sites within the Latrobe Valley, however, these cannot be accounted for as their number is unknown.

The receptors are categorised as follows:

- Artefact scatters (n=502)
- Earth features (n=12)
- Object collections (n=8)
- Scarred trees (n=29)
- Quarries (n=1)

6.1.1 Tangible values

Tangible Aboriginal cultural values may be materially linked due to:

- Close proximity – Aboriginal Places are often recorded near water sources, such as rivers, waterways and lakes
- Groundwater and surface water interactions which may have an effect on the health of scarred trees
- Erosional effects resulting from the change in flow and runoff volumes.

Receptors have been assessed as likely to have effected pathways:

- Altered flow rates and runoff volumes
- Flooding events
- Changes in water quality.

The following provides a brief description of each of the receptors:

- **Artefact scatters** generally consist of a small number of artefacts on the surface (or sub-surface) within the vicinity of a watercourse. Depending upon location in the landscape, artefact scatters can have varying degrees of integrity. In areas subject to repeated inundation, artefacts can be dispersed across a large area. Artefact scatters which are found in more intact deposits are likely to have a fair degree of integrity.
- **Earth features** can comprise a number of site types, however, within the Latrobe Valley, they are recorded as 'soil deposits'. Generally, these indicate that there are sub-surface artefact scatters suspected within an area which has not been subject to test-excavation.
- **Object collections** comprise a collection of artefacts that are reburied or stored at a location.
- **Scarred trees** are the result of Aboriginal people harvesting bark for various uses such as canoes, shields, shelters and containers. Aboriginal people also cut toe holds into trees when hunting possums or for access to other resources, such as honey. Within the region, scars will generally be found on gums species such as Red Gum (*E camaldulensis*) and Stringybark (*E obliqua*), although several trees were on unidentified eucalypt species.
- **Quarries** comprise can native sources of stone that were mined by Aboriginal people in the past. Rock from these sites could be used to make artefacts.

6.1.2 Defined metrics and thresholds

Based on the legislative review, there are no specific water-related metrics for Aboriginal cultural heritage, however, avoidance of harm and protection of cultural values will need to be qualitatively assessed. Therefore, the thresholds for intangible and tangible Aboriginal cultural values within the Latrobe Valley is that they remain in their current condition during implementation of the rehabilitation strategy and thereafter. These metrics are stated formally in Appendix B.

6.1.3 Current Status and Possible Trajectory

The status of tangible value receptors cannot be specifically defined at this stage, although further work is being undertaken by DEWLP (and others) to define this. In absence of a clear statement of status we have assumed that they are currently in such a status as to require continued protection.

As these tangible-value cultural heritage sites receive indirect volumes of runoff from the respective mines and surrounding waterways, changes in the runoff regime which might occur under the LVRRS could be of significant to these sites. Depending on the changes, this could have positive or negative effects on the sites. An increase of runoff in these areas could increase the exposure and erodibility of earthen sites, and therefore contravene the metrics of harm avoidance.

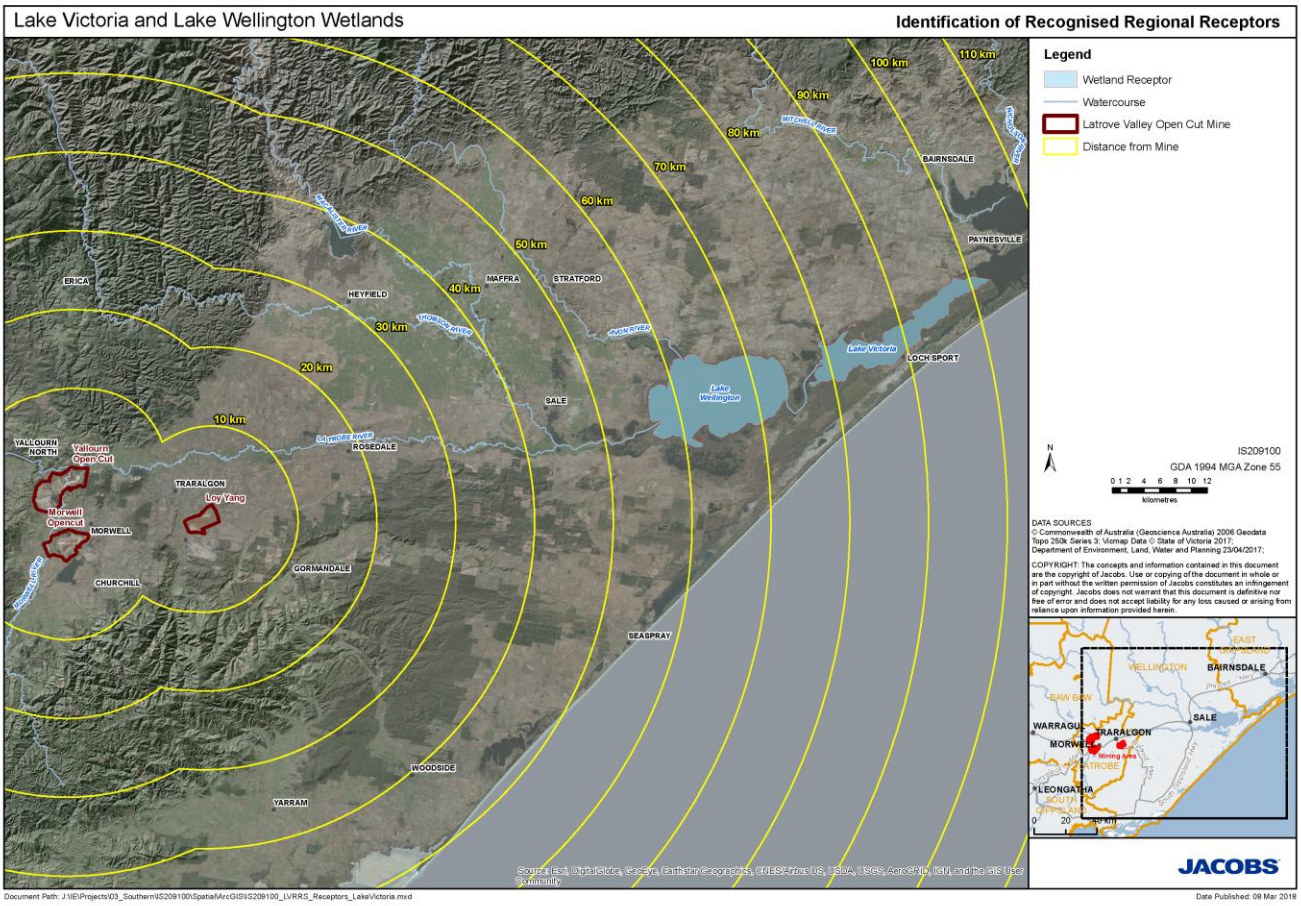
7. Quantitative Metrics and Thresholds – Environment Receptors

7.1 Wetlands

The wetland receptors are materially linked due to connection to rivers and waterways, with changes in water quality and quantity leading to associated effects on wetland water levels and water regime, water quality, algal bloom risk, supported habitat and species.

Receptors are likely to have material effect pathways via changes to water quality, flows, and sediment transport; linkage and effect less likely with increasing distance and wetland volume.

Figure 7.1 : Location of Wetlands



7.1.1 Lower Latrobe Wetlands (Sale Common, Dowd Morass, Heart Morass)

The lower Latrobe Wetlands are a floodplain wetland system on the Latrobe River, comprising Sale Common, Heart Morass and Dowd Morass. Parts of Heart Morass were previously privately owned and used for grazing. Most of the site is now under management as part of the Heart Morass Restoration Project, with a large proportion (1,125 hectares) covered by a protective covenant with Trust for Nature (WGCMA). Sale Common and Dowd Morass are managed by Parks Victoria for environmental and recreational use. The wetlands have been modified by increasing salinity from Lake Wellington and reduced freshwater inflows from the Thomson and Latrobe Rivers. The wetlands are a component of the Gippsland Lakes Ramsar site and provide habitat for a range of colonial waterbirds and migratory shorebirds.

7.1.2 Gippsland Lakes Ramsar site inclusive of Lake Wellington and Lake Victoria Wetlands

The Gippsland Lakes are one of twelve wetlands in Victoria listed under The Ramsar Convention on Wetlands of International Importance ('Ramsar Convention'), which provides the framework for national action and international cooperation for the conservation and 'wise use' of wetlands. Member countries are encouraged to nominate sites containing representative, rare or unique wetlands, or those are important for conserving biological diversity, to the List of Wetlands of International Importance (Ramsar sites). Ramsar sites are a matter of national environmental significance (MNES) under the Commonwealth *Environment Protection and Biodiversity Act 1999*.

The Gippsland Lakes are located east of the Latrobe Valley and comprise a group of coastal lagoons and marsh environments, separated from the sea by a barrier system of sand dunes and fringed on the seaward side by the Ninety Mile Beach. The Lakes are a single site but comprise several distinct lake and wetland areas, contain a diverse range of wetland habitats, including coastal lagoons, subtidal seagrass and algal beds and a variety of saline, brackish and freshwater marsh environments.

The lakes support a broad range of ecological processes and values, including nationally and internationally threatened wetland species, and are particularly valued for the large numbers of waterbirds supported at the site. The ecological diversity of the lakes is shaped by hydrology and hydrodynamics, and heavily influenced by both freshwater catchment inflows and marine saline inflows. Water quality, sediment nutrient dynamics, geomorphology, coastal processes and a range of biological processes also underpin the ecological values of the site.

Key threats to the lakes include altered water regimes and salinity, both of which are connected to the decline in freshwater inflows from the catchment because of water extraction from the Latrobe, Thomson and Macalister Rivers. Water quality – particularly regarding catchment nutrient loads and algal blooms – is also a key concern.

7.1.3 Morwell River Wetlands bordering Yallourn

The Morwell River wetlands are constructed wetlands situated upstream of the Morwell River diversion through the Yallourn mine. There is very limited information available for these wetlands and the effect of the LVRRS on the wetlands is difficult to assess. It should be noted that the Gippsland Water's Morwell Waste Water Treatment Plant supplies 600 ML/year of treated effluent to these wetlands.

7.1.4 Metrics

Several metrics could be relevant to the assessment of effects from the project on the Gippsland Lakes. The '*Ecological Character Description of the Gippsland Lakes Ramsar Site*' report[4] outlines the ecological character and key components of the site and identifies Limits of Acceptable Change (LACs). LACs describe the level of change in a key ecosystem component that would represent a change to the extent of compromising the ecological character of the wetland. While some of these metrics are relevant, there are a large number, and assessment of these metrics requires good baseline data and regular, in depth survey effort. The LACs are also set for broad ecological processes or conditions that are affected by many factors occurring at a range of scales from local to catchment, and therefore determining the specific effects from the LVRRS cannot be achieved.

The key pathway to effect from the mines to the Lakes is through changes to water volume and flow patterns, and water quality (including sediment) effects. These effects can therefore be effectively measured through the SEPP/ANZECC WQOs and flow recommendations as previously discussed.

7.1.5 Defined Thresholds and Rationale

Schedule F5 (Segment E) of SEPP is relevant to the Latrobe River as it forms a major inflow to the Gippsland Lakes. In addition, Segment C and Segment D of Schedule F3, respectively cover the surface waters of Lake

[4] BMT WBM. (2011). Ecological Character Description of the Gippsland Lakes Ramsar Site – Final Report. Prepared for the Australian Government Department of Sustainability, Environment, Water, Population and Communities. Canberra

Wellington and the eastern lakes (including Lake Victoria) of the of the Gippsland Lakes and Catchment. The schedule includes Upper and Lower reaches of the other key river inflows (Tambo, Nicholson, Mitchell), and for the key lakes within the site including Lake Wellington, Eastern Lakes (including Lake Victoria, Lake King, Cunningham Arm), Lake Reeve, Lake Coleman, and McLeod's Morass.

This schedule sets beneficial uses and specific water quality objectives to protect them, as for Schedule F5.

The SEPP WQOs can be used as a threshold to measure water quality changes that could affect the Gippsland Lakes (Appendix C.9). Water quality in the lakes is, of course, affected by a myriad of factors but comparison of water quality from baseline as measured against SEPP for all river reaches downstream of the site and into the Gippsland Lakes could still provide a useful threshold.

Similarly, flow recommendations and changes from a baseline of the current condition provide a useful threshold for determining changes in water volume and timing in the Latrobe River, and for potential effects on the Gippsland Lakes after the river reaches the mouth.

Relevant LACs should also be considered. There are several LACs relating to presence, diversity and abundance of waterbirds, frogs and threatened flora and fauna species. The most relevant LACs in terms of potential pathways and effects from this project are summarised in Table 7.1. There are three LACs that are closely linked to hydrology and applicable to the lower Latrobe wetlands; and one applicable to this receptor (Lake King, Lake Victoria, Lake Wellington).

Table 7.1 : Limits of acceptable change (LAC) for the Gippsland Lakes Ramsar site (BMT WBM 2011).

<table>
<tr><th>Component</th><th>Relevant timescale</th><th>Limit of Acceptable Change</th></tr>
<tr><td>Hydrological regime</td><td>Short term – long term</td><td>Wetland wetting frequency, flushing frequency and flushing volume are maintained as follows:
<table>
<tr><th>Wetland</th><th>Wetting Frequency</th><th>Flushing Frequency</th><th>Required flushing volume</th></tr>
<tr><td>Sale Common</td><td>Annual with 100% reliability</td><td>2-3 times/decade</td><td>4 GL</td></tr>
<tr><td>Dowd Morass</td><td>5-7 times/decade</td><td>2-3 times/decade</td><td>15 GL</td></tr>
<tr><td>Heart Morass</td><td>5-7 times/decade</td><td>2-3 times/decade</td><td>15 GL</td></tr>
</table></td></tr>
<tr><td>Fringing wetlands – predominantly freshwater marsh at Macleod Morass and Sale Common</td><td>Long Term

Short term</td><td>No change in wetland typology from the 1980 classification (Corrick and Norman 1980, See Figure 2-3). The conversion of vegetation communities at Sale Common and Macleod Morass from a predominantly freshwater character to those of a brackish water character will represent a change in ecological character.

The total mapped area of freshwater marshes at Sale Common and Macleod Morass will not decline by greater than 50% of the baseline value (that is, 50% of 402 hectares = 201 hectares) in two successive decades.

In existing freshwater wetland areas, the annual median salinity should not be greater than 1g/L in two successive years</td></tr>
</table>

Component	Relevant timescale	Limit of Acceptable Change
Fringing wetland – brackish marsh (for example, Dowds Morass, Heart Morass, Clydebank Morass, Lake Coleman	Long term	**For all fringing brackish wetlands:** No change in wetland typology from the 1980 classification
	Medium term	**For Dowd Morass and Heart Morass:** Annual median salinity will be less than 4g/L in 5 successive years
	Long term	The total area of common reed at Dowd Morass will not decline by greater than 50% of the 1982 baseline value (that is, 50 % of 480 hectares = 245 hectares) in two successive decades.
Coastal brackish or saline lagoons (for example, Lake King, Lake Victoria, Lake Wellington, Lake Tyers)	Long term	No change in wetland typology from the 1980 classification of Corrick and Norman (as presented in Figure 2-3).
	Long term	A long-term change in ecosystem state at Lake King, Lake Victoria or Lake Tyers from relatively clear, seagrass-dominated estuarine lagoons to turbid, algae dominated system (characteristic of Lake Wellington) will represent a change in ecological character
	Short term	No single cyanobacteria algal bloom event will cover greater than 10% of the combined area of coastal brackish/saline lagoons (that is, Lake King, Victoria, Wellington and Tyers) in two successive years).

7.1.6 Current Status and Possible Trajectory

The wetlands vary in condition but are affected by a range of processes relating to hydrological regime and water quality that affect condition.

Salt water intrusion from the Gippsland Lakes, exacerbated by reduction of freshwater inflows because of water extraction / rainfall-runoff reduction in the catchment, is a key current threat to environmental values in the Lower Latrobe Wetlands (EGCMA 2015).

Heart Morass has been the target of extensive restoration works in recent years, including planting of more than 60,000 indigenous trees, shrubs and grasses, weed control, management of drain entrances to maintain water levels, and carp removal[5]. Environmental water entitlements have also been secured and these entitlements, fundamental to the restoration of the wetland, would need to be maintained. Encouraging seasonal weather patterns have contributed to the best ecological conditions seen within the wetland for many decades, over 30,000 water birds of many species have returned to the wetland in what has been described as a remarkable ecological transformation (West Gippsland CMA website accessed March 2020). Concerns still remain regarding PFAS presence in the area and the EPA maintains a warning against consuming animals taken from the area (EPA website accessed March 2020).

As part of its Natural Resource Management Climate Change Strategy, the West Gippsland CMA (WGCMA) has been conducting studies into climate change management in the region, including decisions about future environmental flows. Part of the studies relate specifically to water management in Heart Morass and Dowd's Morass. Climate change is predicted to exacerbate the shortfall of freshwater inflows currently affecting the wetlands. To mitigate already declining fresh water flows into the Heart and Dowd Morass, environmental water

[5]East Gippsland Catchment Management Authority (2015) Gippsland Lakes Ramsar Site Management Plan (2015), Bairnsdale

allocations have been secured for diversion from the Latrobe River to the wetlands. However, current infrastructure (i.e. control and diversion structures used to divert river water into the wetlands) is inadequate to cope with the future requirements and environmental water allocations. New water control gates, designed to provide adequate inflows under a variety of future climate change scenarios, have been designed and constructed (EGCMA 2015)[5].

7.2 Rivers, waterways and natural lakes

River and waterway receptors are materially linked to the proposed water-based mine rehabilitation strategy due to:

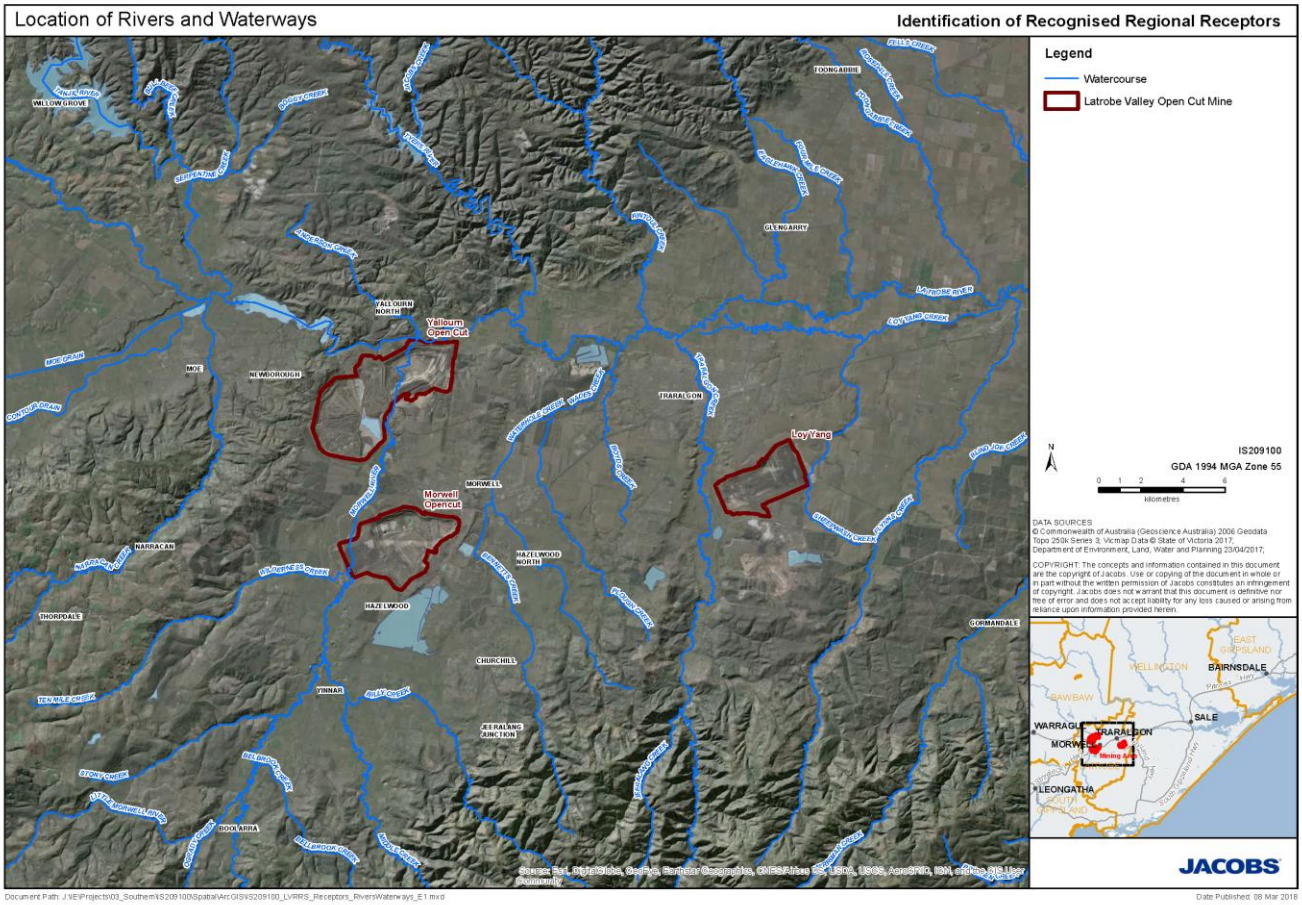
- Close proximity - Rivers and waterways are adjacent to potential mine void waterbodies
- Groundwater and surface water interactions
- Scale of void waterbody filling required.

Receptors that are likely to have effected pathways via:

- Altered flow rates and runoff volumes, including due to interactions with groundwater
- Altered flooding extent and frequency
- Changes in water quality.

Effect pathways are likely to predominantly occur downstream of the potential mine void waterbodies, with decreasing magnitude of effects as the distance downstream increases. Similar effect pathways may occur at greater distances downstream or upstream of the mines.

Figure 7.2 : Location of Rivers and Waterways



7.2.1 Morwell River (Yallourn to the east)

7.2.1.1 Receptor Description

The Morwell River rises in the Strzelecki Ranges, below Boolarra, and is formed by the confluence of the West Branch and East Branch of the River. The river flows in a generally northerly direction and is joined by two minor tributaries and diverted around mines before joining the Latrobe River south of Yallourn North. The headwaters flow through forested catchment, before land clearing and agricultural pressures increase downstream of Mirboo. The river has experienced historical diversions and the course of the river has most recently changed at the Yallourn mine by the Morwell River Diversion, which carries the river on an embankment across the centre of the mine, before it joins the Latrobe River. The course of the diverted river is approximately 40 kilometres.

7.2.1.2 Defined Metrics

The key aspects for assessing effects to the river are water quality and water quantity, in terms of changes to natural flow volumes and patterns.

Appropriate metrics are SEPP and ANZECC objectives as applicable for water quality, and flow recommendations for the Morwell River are as set out in the Latrobe River flow study. The river is relatively short, and the same metrics can apply for the length of the river.

7.2.1.3 Defined Thresholds and Rationale

The existing SEPP and ANZECC water quality objectives define appropriate water quality thresholds. Where the current water quality does not meet these objectives, the guidelines outline appropriate methods for comparison to background water conditions. This means that potential effects can be measured against background conditions (i.e. upstream of the mines) where appropriate, while the WQOs provide an indication of a level of water quality that would protect environmental values in the river.

Relevant flow recommendations provide a suitable metric for assessment of how well the current and future flow scenarios comply with flow recommendations. Even where current flows do not meet recommended flows, a comparison of the differences in compliance are still an appropriate assessment approach

The appropriate metrics for the Morwell River are therefore the SEPP and ANZECC WQOs, and the flow recommendations from the Latrobe River flow study, Reach 10 (Morwell River) (refer to Appendix C.1). The compliance point for the recommended flows is the Morwell River at Yallourn, gauge 226408. A summary of the flow recommendations is provided in Table 5.9.

7.2.1.4 Current Status and Possible Trajectory

Available water quality data for the Morwell River shows that condition varies along the river, being better in the upper, less disturbed, forested reaches and worse in the lower reaches where the river is affected by land clearance and industrial effects. There are three Index Stream Condition (ISC) sites on the Morwell River (DELWP, 2018). The uppermost site on the river is rated as excellent; further down river, near the confluence of Middle Creek, the site condition is moderate, and the condition at the site closest to the confluence with the Latrobe is poor (WGCMA 2014)[6]..

The Morwell River flows through the centre of the Yallourn mine and receives significant discharge volumes from the site. The diversion through the mine and the pattern of water extraction and discharge has a significant influence on current flow and water quality in the river

[6] West Gippsland CMA (2014) West Gippsland Waterway Strategy 2014-2022

7.2.2 Latrobe River (Yallourn to the north and lower reaches)

7.2.2.1 Receptor Description

The Latrobe River originates near Powelltown, flowing through the southern slopes of the Great Dividing Range then past the northern outskirts of the major Latrobe Valley towns of Moe and Traralgon and down to its mouth at Lake Wellington.

The upper reaches of the river flow through state forest and flows are unregulated. The middle and lower reaches are regulated with water storages, including Lake Narracan. Mid reaches of the Latrobe provide water supply for the Latrobe Valley mining industry. The river provides a significant source of flows to the lower Latrobe Wetlands and the Gippsland Lakes.

The upper section of the river contains largely intact riparian vegetation (including Damp, Wet and Riparian Forest) and supports a range of species including Barred Galaxias, River Blackfish, Gippsland Spiny Crayfish and Nankeen Night Heron. It is one of the few catchment areas to be unaffected by fire in recent years and is valued for its visual amenity and recreational fishing values. Lake Narracan has a surface area of nearly 300 ha and is a popular recreational asset used for various power boating (jet skiing, water-skiing) and sail boating activities, swimming and walking.

7.2.2.2 Defined Metrics

The Latrobe River supports values across a range of categories, including environmental, social/cultural and economic. For example, the environmental values include aquatic habitat, aquatic ecosystem values, and flow to floodplain and significant downstream wetlands. Social and cultural values include recreational use of the river, and amenity. The water that is extracted from the Latrobe and provided to domestic, agricultural and industrial users has significant economic value. These values need to be protected and the metrics are designed such that unacceptable changes to the river that would affect these values can be identified.

The focus of this study is the biophysical assessment of the river and social and economic values are not explored in depth. However, key metrics that are relevant to environmental values (i.e. river flow and water quality) are also suitable for the protection of other values.

As for the Morwell River (Section 7.2.1.2), the appropriate metrics for the Latrobe River are the SEPP and ANZECC WQOs (for water quality) and the applicable flow recommendations (thresholds) as set out in the Latrobe River flow study.

7.2.2.3 Defined Thresholds and Rationale

The existing SEPP and ANZECC water quality objectives define appropriate water quality thresholds. Where the current water quality does not meet these objectives, the guidelines outline appropriate methods for comparison to background water conditions. This means that potential effects can be measured against background conditions (i.e. upstream of the mines) where appropriate, while the WQOs provide an indication of a level of water quality that would protect environmental values in the river.

Relevant flow recommendations provide a suitable metric for assessment of how well the current and future flow scenarios comply with flow recommendations. Even where current flows do not meet recommended flows, a comparison of the differences in compliance are still an appropriate assessment approach. The combination of water quality and flow thresholds provides a meaningful assessment of effects on the river and the ecological values it supports.

The appropriate thresholds for the Latrobe River are therefore the SEPP and ANZECC WQOs from Schedule F5, Segment E, and the flow recommendations for the Latrobe River as set out in the Latrobe River flow study (refer to Appendix F). The relevant Latrobe River reaches, and the relevant compliance points are:

- Reach 3 – Latrobe River (Lake Narracan to Scarnes Bridge; Gauge Number 226401)

- Reach 4 – Latrobe River (Scarnes Bridge to Rosedale; Gauge Number 226228)
- Reach 5 – Latrobe River (Rosedale to Thomson River; Gauge Number 226227)
- Reach 6 – Latrobe River (Rosedale to Thomson River; Gauge Number 226802)

The appropriate metrics for water quality (SEPP/ANZECC) and flow recommendations from the Latrobe River flow study) do not vary with the mine/inter-mine/catchment scales set out for considerations in this project. However, the specific thresholds vary between river reaches, as flow recommendations and in some cases WQOs are established for the specific environmental objectives of each river reach and these vary. In many cases, the broad environmental objectives are consistent between reaches, but some variation exists due to the characteristics of the river in each reach and the associated environmental values. The flow recommendations for relevant reaches of the Latrobe River are shown in Table 5.4, Table 5.5 and Table 5.6.

Reach 6 - Latrobe River (Thomson River to Lake Wellington)

The flow study report states that "This reach has been found to have the attributes of an estuary. Criteria adopted for the FLOWS method and applied to upstream reaches of this investigation were found to be inappropriate and not relevant to this reach" (EarthTech 2007)[7]. As such, there are no specific flow recommendations for this reach, which is bordered by the floodplain wetland system comprising Sale Common and Heart Morass to the north and Dowd Morass to the south. These wetlands are discussed separately.

7.2.2.4 Current Status and Possible Trajectory

The Latrobe River varies in condition between its unregulated, upland forested headwaters and its lower reaches which are affected by land clearing, industrial activity, and flow regulation and extraction. The condition of waterways across the state is assessed through the Index of Stream Condition system. Summary results for the Latrobe Basin show that 34% of stream length in the basin is in good or excellent condition, 44% in moderate condition, 9% in poor condition and 13% in very poor condition (WGCMA 2014). Condition assessments from sites on the Latrobe River downstream of the confluence with the Moe River show that the river is in poor or very poor condition; all sites on the Latrobe River upstream of the Moe River confluence are rated as good or excellent.

7.2.3 Traralgon Creek (near Loy Yang)

7.2.3.1 Receptor description

Traralgon Creek is a waterway in the mid-Latrobe reaches which is valued by the community for amenity and recreational values. The creek rises to the south of the Loy Yang site at Traralgon South. The stream is unregulated but receives significant volumes of licenced industrial discharge and is affected by land clearing and willows infestation, as well as stormwater runoff from the Traralgon urban area.

7.2.3.2 Metrics

The SEPP and ANZECC WQOs and Latrobe River flow study recommendations are also suitable metrics for the assessment of effects on Traralgon Creek, as they are directly applicable to a gauging station upstream of inflow contributions from Loy Yang power station.

7.2.3.3 Defined Thresholds and Rationale

Schedule F5 Segment E of SEPP also includes Traralgon Creek and its tributaries (downstream of Jones Lane) meaning the specific WQOs that apply to the Latrobe and Morwell rivers in the mines region are also applicable to Traralgon Creek.

[7] EarthTech (2007) Assessment of Environmental Flow Requirements for the Latrobe River,

The Latrobe River flood study includes specific flow recommendations for Traralgon Creek, which is designated as Reach 11 of the Latrobe River, applicable to the compliance point at Gauge Number 226023, located downstream of Loy Yang. The specific flow recommendations for Traralgon Creek are an appropriate threshold against which to measure future changes to the creek (Table 5.10, also Appendix C.3). This may be measured as a change from the current (baseline) level of compliance with the flow recommendations.

7.2.3.4 Current Status and Possible Trajectory

Traralgon Creek rises to the south of Loy Yang and is affected by mine operations and urban runoff in its lower reaches. It is valued by the community for amenity and recreational values. There are two ISC sites on the creek; the site in the forested upper catchment has a rating of excellent, while the other site (in a cleared area further downstream towards the confluence with the Latrobe River) is rated as moderate.

Traralgon Creek currently receives significant volumes of discharge from Loy Yang and if this changes under rehabilitation then there could be effects on the creek. Depending on the changes, this could have positive or negative effects on the creek.

7.2.4 Flynn's Creek (near Loy Yang), Sheepwash Creek (near Loy Yang), Merriman's Creek, Billy's Creek and Bennett's Creek

7.2.4.1 Receptor Description

These creeks are small waterways near the mines. While they are likely to be materially affected, there is limited data on their values and condition.

7.2.4.2 Metrics

The metrics applied to the larger waterways are still appropriate for these smaller creeks. However, as there are no defined flow recommendations for these waterways, key eco-hydrological metrics (as per Table 5.3) will be the most useful tool.

This involves consideration of the key characteristics and values of each waterway, and the critical flow components that would be required to protect those values. As previously discussed, the most relevant metrics are likely to include low flows/cease to flow and high flows. Metrics could be further refined following more detailed research into the specific requirements of these waterways.

7.2.4.3 Defined Thresholds and Rationale

For WQ, the same SEPP guidelines as are applicable to the major rivers apply to the minor creeks and tributaries in the area. Schedule F5, Segment E specifically mentions Bennetts Creek and its tributaries, and Sheepwash Creek and its tributaries (refer to Appendix C.4). Toxicant values specified under ANZECC apply by default for waterways or indicators without SEPP WQOs, and these can also be used here.

7.2.4.4 Current Status and Possible Trajectory

Due to the limited data on these streams condition an accurate assessment of their current condition cannot be provided.

These creeks are located to the east of Loy Yang (with exception to Billy's Creek which is west) and are to varying degrees effected by mine operations (based on their closeness to the Loy Yang operation). These creeks are valued by the community for amenity and recreational values.

There are four ISC sites on Merriman's Creek; all sites are rated to be in moderate condition, however the site closest to Loy Yang is rated poorly. A single ISC site is located on Flynn's Creek and is similarly rated to be in a moderate condition. All creeks are identified as being affected by drought.

As these creeks receive indirect volumes of runoff from Loy Yang, changes in runoff occur under the rehabilitation strategy there could be effects on each creek. Depending on the changes, this could have positive or negative effect.

7.2.5 Tanjil River

7.2.5.1 Receptor Description

The Tanjil River flows from Blue Rock Reservoir and downstream to the Latrobe River. It enters the Latrobe River just upstream of Lake Narracan. The River is highly regulated by flows released from Blur Rock Reservoir. This receptor was identified as potentially impacted late in the development of this report and the key features and elements are not as well defined as for other receptors. Accordingly, additional work may be required in the future to refine and develop relevant metrics as determined necessary.

7.2.5.2 Defined Metrics

The SEPP and ANZECC WQOs and Latrobe River flow study recommendations are also suitable metrics for the assessment of effects on the Tanjil River. Further study to refine the flow and water quality considerations based on Blue Rock Reservoir data will be needed. A key place for defining metrics is the monitoring point for releases from Blue Rock Reservoir (Station 226203).

7.2.5.3 Defined Thresholds and Rationale

The SEPP Waters of Victoria defines segments and indicators for rivers and streams. These include nutrients (phosphorus and nitrogen), turbidity, salinity, pH, dissolved oxygen, toxicants (in water and sediments) and biological indicators. The suggested thresholds for the Tanjil River are the water quality objectives defined in the SEPP as measured at gauging station 226203 and the environmental flow requirements defined for this reach. This is an interim guidance and further assessment is likely to be required should a water-related rehabilitation option be determined to have an impact.

7.2.5.4 Current State and Possible Trajectory

The Tanjil River is generally in moderate condition, having been extensively cleared in the area downstream of Blue Rock Reservoir. The current condition is defined in the index of stream condition. The future trajectory is considered to be stable.

7.2.6 Tyers River

7.2.6.1 Receptor Description

The Tyers River flows from Moondarra Reservoir to the Latrobe River. Whilst heavily regulated by releases from the reservoir, it flows through areas of largely undisturbed forest. The Tyers River may be affected by water related rehabilitation should an option involve alteration of releases from the reservoir. This receptor was not initially identified in the stakeholder workshops and has been added late in the assessment process. Accordingly, further assessment of the receptor and any possible impacts will be needed to fully define the metrics and thresholds.

7.2.6.2 Defined Metrics

The SEPP and ANZECC WQOs and Latrobe River flow study recommendations are also suitable metrics for the assessment of effects on the Tanjil River. Further study to refine the flow and water quality considerations based on Moondarra Reservoir data will be needed. A key place for defining metrics is the monitoring point Tyers River at McMillan Highway (Station 226034).

7.2.6.3 Defined Thresholds and Rationale

The SEPP Waters of Victoria defines segments and indicators for rivers and streams. These include nutrients (phosphorus and nitrogen), turbidity, salinity, pH, dissolved oxygen, toxicants (in water and sediments) and biological indicators. The suggested thresholds for the Tyers River are the water quality objectives defined in the SEPP as measured at gauging station 226034 and the environmental flow requirements defined for this reach. This is an interim guidance and further assessment is likely to be required should a water-related rehabilitation option be determined to have an impact.

7.2.6.4 Current State and Possible Trajectory

The Tyers River is in good to excellent condition for most of its length, except of the lowers reaches near the confluence of the Latrobe River. The condition of the river is considered stable.

7.2.7 Lake Wellington and Lake Victoria

7.2.7.1 Receptor Description

Lake Wellington and Lake Victoria are two of the three main lakes which are collectively known as the Gippsland Lakes, and are interconnected by a long channel of water referred to as McLennan's Strait. Lake Wellington is a shallow saucer-shaped lake with an area of 150 km^2 and an average depth of 2.6 m (an approximate lake volume of 388 GL). Lake Victoria merges into Lake King, near Point Turner, with a discrete area of 79 km2 and an average depth 4.2 m (an approximate lake volume of 343 GL).

Surface water inflows are primarily provided by the Latrobe and Avon Rivers (received by Lake Wellington and the western portion of Lake Victoria via McLennan's Strait), and the Mitchell, Nicholson and Tambo Rivers (Lake Victoria near the merge with Lake King). The Gippsland Lakes system ultimately drains into Bass Strait via an artificial entrance, approximately 120 m wide and 6 m deep, cut through the sand barrier at Lakes Entrance.

River regulation and water extraction from the Latrobe and Thomson rivers has reduced the frequency of small to medium-sized floods that naturally inundate the Gippsland Lakes system. Furthermore, construction of levees and drains and the filling-in of natural depressions have also altered water movement in and through the Gippsland Lakes system.

7.2.7.2 Defined Metrics and Thresholds

The surface water bodies of Lake Wellington and Lake Victoria ultimately sustain the floodplain wetland ecosystem of the Gippsland Lakes. Therefore, the metrics and thresholds for determination of effects on the Gippsland Lakes wetlands, as detailed in Section 7.1.2 (namely SEPP WQOs outlined in Segment C of Schedule F3 for Lake Wellington and Segment D of Schedule F3 for Lake Victoria) are deemed most appropriate and no further metrics or thresholds will be defined. The flow (water quantity) objectives for the lakes are provides for in the flow objectives (see other sections) and no specific flow objectives have been set. It is likely that new, additional flow objectives could results from the detailed modelling once the requirements to achieved water quality are understood better (refer to Appendices C.6 and C.7). There is not enough information available at this stage to provide separate and new thresholds.

7.2.7.3 Current Status and Possible Trajectory

Lake Victoria and Lake Wellington are listed under the Ramsar Convention as a wetland system of international importance, in addition to having formal national and state conservation significance. They are also highly valued for boating and fishing, urban development, hunting and nature appreciation purposes. Since 1889, both lakes have been permanently connected to the ocean via a permanent artificial opening located at Lakes Entrance. This opening has changed the lakes from being naturally fresh/brackish to estuarine.

Land clearing, mining, farming, forestry, urban development, and river regulation and diversion have all affected the amount of freshwater, sediment, nutrients and other materials entering Lake Victoria and Lake Wellington.

This has had profound effects on their environmental condition and associated ecological, social and economic values.

Changes in flow or water quality in the Latrobe River as a result of rehabilitation activities may have a knock-on effect in the Gippsland Lakes. It is not clear what form these changes might take at this time.

7.3 Listed Species

The water-dependent species are linked to the waterways and wetlands in the mine region that might be affected by the LVRRS. This category of receptor includes species that depend on waterways and wetlands for habitat, and which are listed under the EPBC Act 1999. The definition of the relevant species was developed through the receptors definition process (Jacobs (2019a) and includes Victorian policies such as the Flora and Fauna Guarantee Act.

Receptors likely to be materially affected by:

- Disruption to flows (wetland/river connectivity, natural flow regimes)
- Changes in temperature regimes
- Changes in water quality (potential for increased nutrient and sediment loads, or toxicants)
- Changes in water quantity
- Potential competition and predation from introduced fish species such as trout

These effects are less likely with increasing distance from the mines and increasing wetland or waterway size/volume.

The current and projected status of these receptors are provided in the receptor descriptions below.

7.3.1 Fish (Australian Grayling, Eastern Dwarf Galaxias)

7.3.1.1 Receptor description

Australian Grayling *(Prototroctes maraena*) is a species endemic to south-eastern Australia, found in waterways draining from the southern and eastern flanks of the Great Dividing Range to the sea, from central NSW to western Victoria, and occurs widely in Tasmania. It is a species listed under Victoria's Flora and Fauna Guarantee Act and classified as Vulnerable under the EBPC Act. The Australian Grayling is a migratory species, migrating from estuary areas to breed in freshwater reaches with larvae returning to the estuary with the drift. Its migratory life cycle makes it vulnerable to threats associated with barriers to instream migration. The species is an opportunistic omnivore, with a mixed diet including algae and insects. In addition to instream barriers to migration, the species is vulnerable to changes in temperature and flow, increased nutrient and sediment loads, and poor water quality. They require specific flow and salinity conditions for breeding and for migration of juvenile from estuarine to freshwater habitats.

Eastern Dwarf Galaxias *(Galaxiella pusilla)* occurs in Tasmania, South Australia and Victoria. It is listed as Vulnerable under the Commonwealth EPBC Act (1999), designated as Vulnerable on the IUCN Red List of Threatened Animals (IUCN, 2003)[8], and Threatened under the Victorian *Flora and Fauna Guarantee Act* 1988, Although widely distributed, species populations are fragmented and patchy. Populations have declined due to loss of habitat, especially as a result of shallow freshwater wetland drainage.

7.3.1.2 Metrics

There are no specific guidelines set for fish populations in the region, but potential effects on fish can be indirectly assessed using the SEPP and ANZECC water quality guidelines and Latrobe River flow study recommendations.

Water quality objectives are set to protect beneficial uses of the waterways, including the protection of aquatic biodiversity – a decline in water quality threatens aquatic biodiversity. Toxicity trigger values in ANZECC provide a useful measure of acute water quality pollution that could have toxic effects on fish. Flow recommendations

[8] International Union for the Conservation of Nature (2003) Red List of Threatened Species

can also be used as an assessment of changes that could have an effect on valued fish species, particularly those that relate to the specific flow requirements of the two receptor-species.

7.3.2 Frogs (Bell Frog, Growling Grass Frog, Burrowing Frog, Spotted Tree Frog)

7.3.2.1 Receptor description

The species range of the Growling Grass Frog is broad and covers the entire study area. This species is found mostly amongst emergent vegetation in or at the edges of still or slow-flowing water bodies such as lagoons, swamps, lakes, and ponds, and depends upon permanent freshwater lagoons for breeding. The range and habitat preferences of the other species varies. The Green and Golden Bell Frog occurs mainly along coastal lowland areas of eastern NSW and Victoria, with the southernmost extent being near Lake Wellington, while the Spotted tree frog occurs in montane/alpine areas – possibly on northern fringes of study area but not in waterways likely to be materially affected. Frogs rely on a range or permanent and ephemeral wetland habitats for breeding and rely on flooding and flow regimes that provide suitable habitat.

Threats to frog species typically include habitat loss, fragmentation, and degradation, altered flooding regimes including a reduction in flood frequency, disease, predation by introduced fish, salinisation and water pollution, and drought.

7.3.2.2 Metrics

Generally, the SEPP WQOs/ANZECC trigger values, and flow recommendations for the Latrobe River system can be used to assess potential effects that may affect frogs. Frogs are highly dependent on specific hydrological regimes to provide required habitat and can be sensitive to changes in water quality. Monitoring of flow and water quality is therefore a suitable approach to monitoring water-related project effects that may affect frogs.

7.3.3 Birds (Musk Duck, Eastern Great Egret)

7.3.3.1 Receptor description

The Musk Duck (*Biziura lobata*) is found from north-western Western Australia around the southern and eastern coasts, and as far north as southern Queensland. It is classified as Vulnerable in Victoria and requires specific wetland habitat for feeding and breeding. It prefers wetlands with areas of both open water and beds of reedy vegetation. The Musk Duck is heavily dependent on aquatic habitat and is an excellent diver, searching underwater for its food which includes aquatic insects, crustaceans, fish, frogs, and some aquatic plants. Clearing and draining of wetlands has affected on Musk Duck numbers, though the species is not considered in danger. As the species is almost entirely aquatic and cannot walk well on land, drying of permanent wetlands is a threat.

The Eastern Great Egret (*Ardea modesta*) is a widespread species and occurs throughout mainland Australia and Tasmania. While widespread, population numbers in Victoria and eastern Australia appear to be trending downwards, thought to be because of water extraction and habitat loss. Its diverse diet includes fish, insects, crustaceans, molluscs, frogs, lizards, snakes and even small birds and mammals. They most commonly feed by foraging - wading through shallow to moderately deep water to locate prey. The species relies on the presence of water for breeding, and open wetland habitat for feeding.

7.3.3.2 Metrics

The SEPP/ANZECC WQOs and flow recommendations are still relevant metrics for birds. In many cases, birds require specific hydrological regimes to ensure that the habitat they require for breeding and feeding. Water quality also affects wetland health and the plant and animal species that the birds rely on for food sources.

Birds are also typically valued by the community and often form part of wetland and waterway health strategies and plans. However, objectives such as protection of bird populations (i.e. no decline in numbers) are difficult to

assess. Bird populations can fluctuate widely over time due to natural variability and environmental conditions and isolating the effects that are specific to the LVRRS would be very difficult.

7.3.4 Defined Thresholds and Rationale

Because of the range of areas used by fish, birds and frogs, the thresholds for more than one SEPP segment/Schedule may be relevant. Changes could be measured in each reach against current conditions or benchmarked against the WQOs that apply to that specific reach.

The flow components that are most directly relevant to wetland habitat requirements should be prioritised, with changes measured against current conditions and working towards the objective of achieving the published flow recommendations. The most relevant eco-hydrological measure is overbank flows, as this provides flows to connect the river and the wetland, fill floodplain wetlands (such as Hearts and Dowds Morass) and provide critical wetland habitat for birds.

Considering that the wetlands of the LVRRS study area are primarily fed by flow from the Latrobe River, the most applicable reach to consider the compliance of thresholds is Reach 5 at Gauge Number 226227, as outlined in the eco-hydrological measures outlined in Table 5.10.

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8. Quantitative Metrics and Thresholds – Infrastructure Receptors

The effects from rehabilitation scenarios on recognised infrastructure receptors are related primarily to potential ground movement caused by subsidence/rebound resulting from mine void waterbody filling. A clear geotechnical pathway exists, and material effects relate to large-scale failures of mine void walls and an increased risk of ground instability. The geotechnical metrics and thresholds relating to infrastructure receptors is discussed in Jacobs (2020b).

No material effect has been identified for the infrastructure receptor sub-categories described below – the effect pathway is shared with geotechnical effects and are deemed more likely to have a material effect on receptors. Water-related metrics and thresholds are not defined for the following sub-categories (also refer Appendix D):

- Extractive Industries (inclusive of operating coal mines)
- Electricity Transmission Network
- Gas Fired Power Generation
- Road – Freeway/State Maintained
- Road – Local Council Maintained
- Gas Pipelines
- Rail
- Bridges.

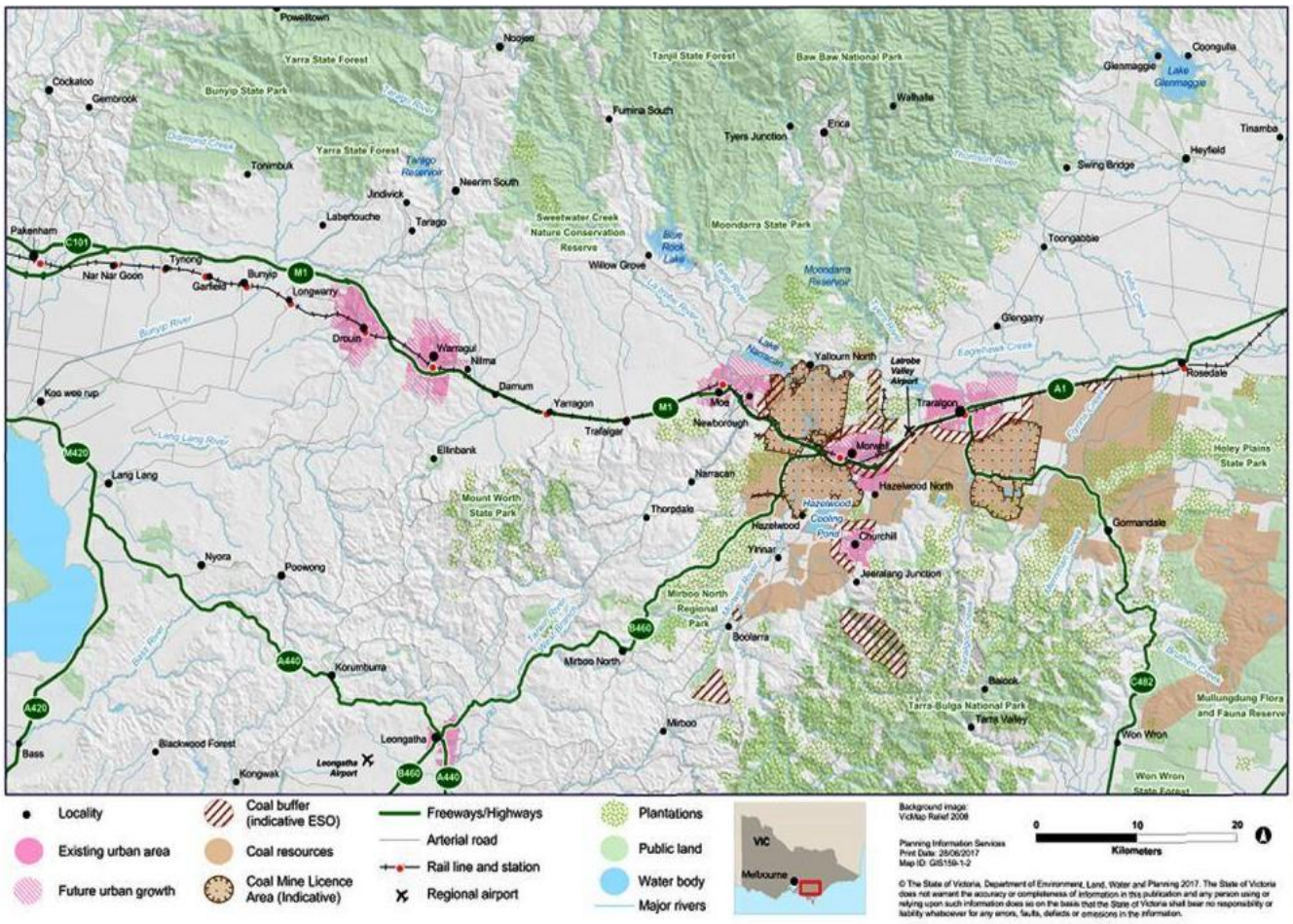
9. Quantitative Metrics and Thresholds – Land Receptors

9.1 Townships and Settlements

The Latrobe Valley is located within the Gippsland Region to the east of Melbourne, and north of the Strzelecki Ranges. The area has three major centres, from west to east, Moe, Morwell and Traralgon, with minor centres including Churchill, Yinnar, Glengarry and Tyers. The population of the Latrobe Valley is approximately 125,000.

As identified in the materiality assessment completed during receptor identification (Jacobs, 2019a), the southern urban boundary of Morwell and the urban buffer between Yallourn coal mine and Morwell were identified as having an effect pathway.

Figure 9.1 : Location of Latrobe Valley townships, between Pakenham and Rosedale[9]



9.1.1 Southern urban boundary of Morwell

9.1.1.1 Receptor Description

Morwell is a town in the Latrobe Valley area of Gippsland, in South-Eastern Victoria, approximately 149 km east of Melbourne. The population at the 2016 Australian Bureau of Statistics Census was 13,771. The city is known for its role as a major energy production centre for Victoria as the centre of a major coal mining and fossil-fuel power generation industry.

The Southern Urban boundary of Morwell is located north of the Princes Freeway and south of Princes Drive. The Princes Freeway also borders the site to the east. The Southern Urban boundary area measures

[9]"Hazelwood Mine Fire Inquiry Report 2015/16 Volume 4 – Mine Rehabilitation", Board of Inquiry Hazelwood Mine Fire Inquiry, April 2016, page 27

approximately 2.4 kilometres east to west in the north. The study area is identified below in Figure 9.2, Figure 9.3, and Figure 9.4.

Figure 9.2 : Southern Urban Boundary of Morwell Study Area

Figure 9.3 : Southern Urban Boundary of Morwell Study Area Zoning Map

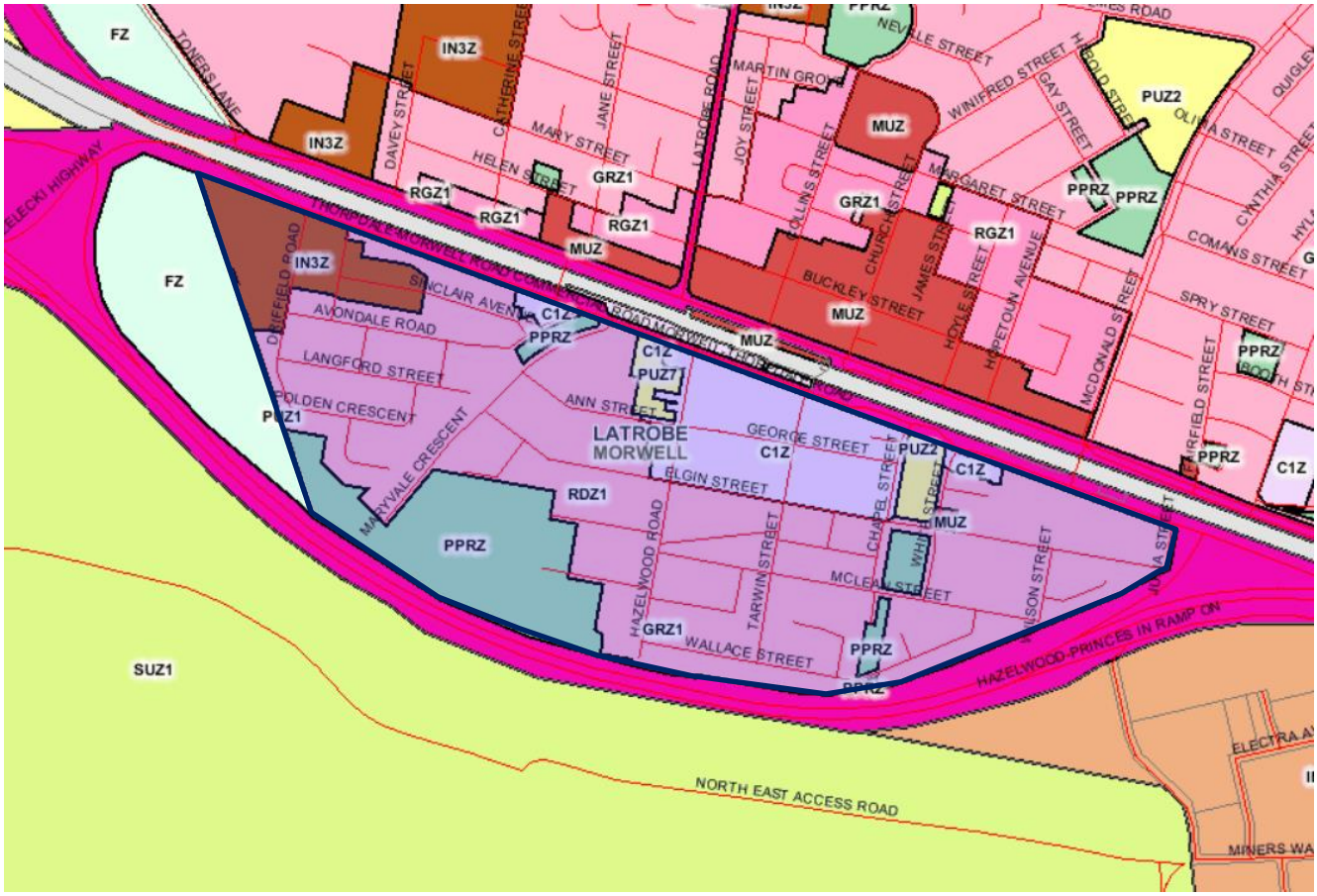
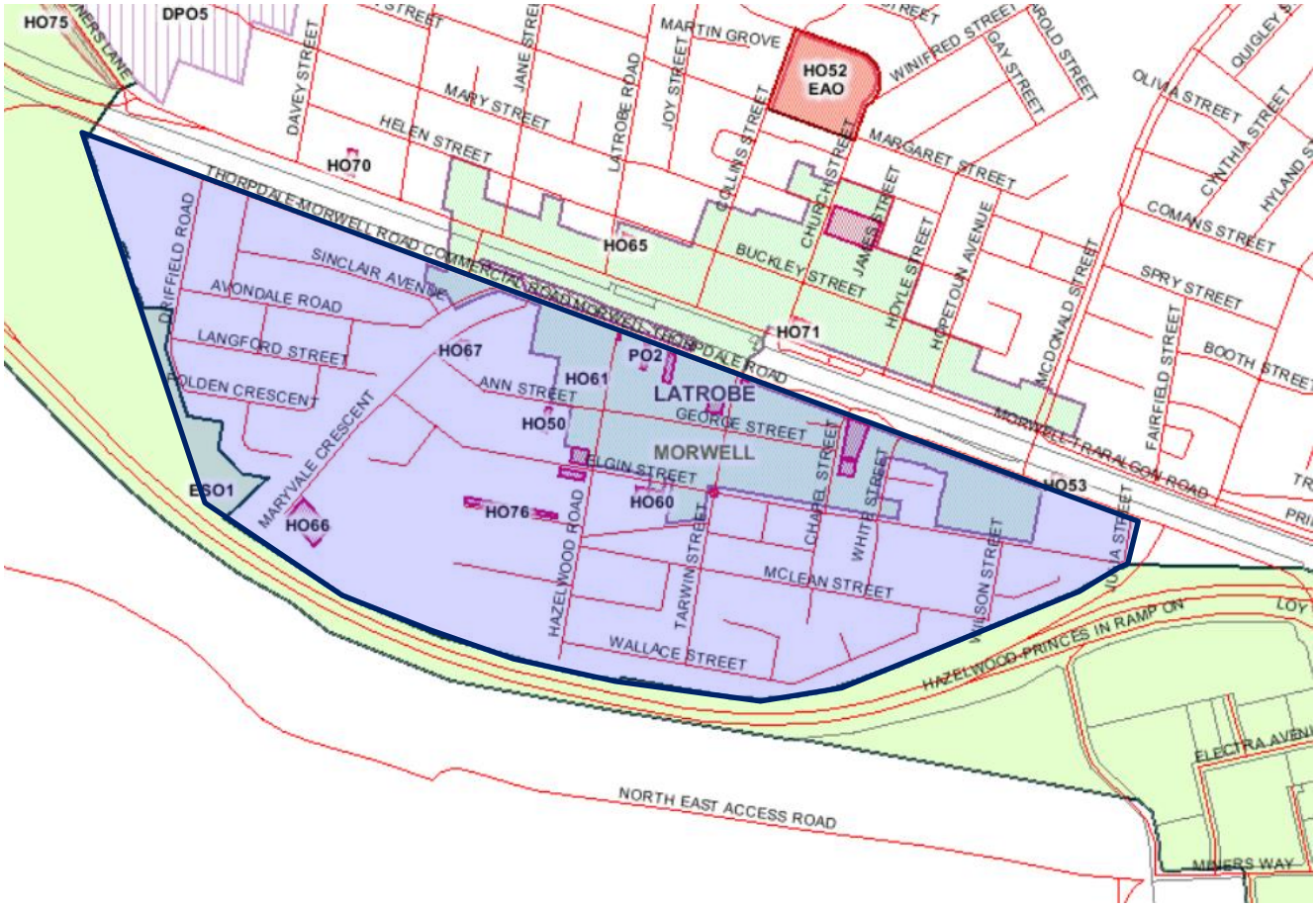


Figure 9.4 : Southern Urban Boundary of Morwell Study Area Overlay Map



The area is subject to the following zones:

- Public Park and Recreation (PPRZ)
- General Residential Zone (GRZ1)
- Commercial 1 Zone (C1Z)
- Mixed Use Zone (MUZ)
- Industrial 3 Zone (IN3Z)
- Public Use Zone
    - Public Use Zone 2- Education (PUZ2)
    - Public Use Zone 7 – Other Public Use (PUZ7).

The area is subject to the following overlays:

- Environmental Significance Overlay – Schedule 1
    - Urban Buffer
- Parking Overlay – Precinct 2
- Heritage Overlay.

The area is predominantly used for residential houses. These houses are low density and typically arranged as standalone houses on separate sections.

The area also includes a justice precinct which includes courts and a police station. There is a primary school located along the northern border of the study area.

To the west there is an industrial area which includes storage sites and automotive services.

Within the commercial area there are restaurants, banks and retail.

There are three areas of open space. These are predominantly for causal recreation and sport. There is a linear park in the south eastern area of the study area.

9.1.1.2 Groundwater Usage in Morwell

About 92 per cent of the water extracted for towns, industry and agriculture in Gippsland is sourced from waterways, with about 8 per cent sourced from groundwater[10].

Different land uses have different requirements for groundwater use. Industrial uses are likely to have a greater demand for groundwater than residential uses.

In the Gippsland Region Sustainable Water Strategy published in 2011, it was recognised that groundwater in the Gippsland area will become an increasingly important resource for the region.

Groundwater provides water for domestic and stock use, town, irrigation and industrial use. It is also pumped out of open-cut mines to enable safe coal mining in the Latrobe Valley, and as part of oil and gas extraction in Bass Strait.

Information is not currently available as to how much groundwater the land users in the Morwell area use. It is assumed that most of the area, particularly the residential development is connected to mains supply and therefore does not rely on groundwater. Further investigation is required to understand the use of water by industry in this area, if any.

Further information on the current and projected status of groundwater in Morwell is available in Section 10.1.

[10] Department of Sustainability and Environment (2011) Gippsland Region Sustainable Water Strategy (page 17)

9.1.1.3 Flood Events and Inundation

There ae no flood risks currently identified in this area. There is no land identified as subject to inundation. This area is outside of the 1 in 100-year flood area and therefore there are no controls relating to height of building above ground.

Planning schemes use overlays to identify areas that are prone to flooding. There are four overlays that indicate different flood risks. None of these apply to the study area and therefore there are no planning controls to determine floor heights above ground.

An explanation of the flood overlays is included below. There are the mechanisms used to protect development in flood prone areas from the effects of flooding. The Latrobe Valley has typically suffered water shortages and droughts rather than flood events and therefore it is uncommon that these overlays are present in this, or the wider area. There were unusual flood events in the period between August 2010 and April 2011 that were the result of unusual weather patterns.

There are four overlays that relate to flooding and inundation. None of these are present in the identified southern boundary of Morwell.

- **Special Building Overlays (SBO)**

  These are planning scheme controls that identify areas prone to overland flooding. The purpose of these overlays is to set appropriate conditions and floor levels to address any flood risk to developments. These overlays require a planning permit for buildings and works.

- **Land Subject to Inundation Overlays (LSIO)**

  These are planning scheme controls that apply to land affected by flooding associated with waterways and open drainage systems. Such areas are commonly known as floodplains. These overlays require a planning permit for buildings and works.

- **Floodway Overlays (FO)**

  These apply to land that's identified as carrying active flood flows associated with waterways and open drainage systems. This overlay is categorised by depths in excess of one metre.

- **Urban Floodway Zone (UFZ)**

  Unlike the overlays, the UFZ controls land use as well as development, with land use being restricted to low intensity uses such as recreation and agriculture. Development is generally not encouraged in the UFZ.

The rehabilitation of the mine, proposed by Engie (Engie, 2017), could result in effect pathways on groundwater levels and flood events at the southern urban boundary of Morwell. The following metrics and thresholds provide an analysis of the existing land uses at the southern urban boundary of Morwell (also refer to Appendix E.1).

9.1.1.4 Defined Metrics, Thresholds and Rationale

Land Use Zoning	Metrics	Threshold	Rationale
Public Park and Recreation (PPRZ)	Zone Description:		
	• The purpose of the PPRZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To recognise areas for public recreation and open space.* *To protect and conserve areas of significance where appropriate.* *To provide for commercial uses where appropriate.*		
	• The PPRZ enables the following uses to be established by a public land manager without a permit: - Informal outdoor recreation		

Land Use Zoning	Metrics	Threshold	Rationale
	- Open sports ground - Contractor's depot - Heliport - Office - Retail premise Store • The study area PPRZ land currently includes: - Morwell Recreation Reserve - Morwell Cricket Club - Keegan Street Reserve - Morwell Town Common - Morwell Centenary Rose Garden - Eric Lubcke Yarra Gum Conservation Reserve - Linear Park		
	Groundwater Rise		
	• Inability to achieve the purpose of the zone. • If these uses are not able to function without impediment, then the zone is no longer effectively functioning as intended.	• Minor groundwater level changes will not trigger a threshold creating a material change	• The PPRZ zone, specifically informal recreation, does not typically require groundwater to function as intended. • Further investigation is required to identify if groundwater is used for the watering of turfs or sports grounds
	Flooding and Inundation		
	• Inability to achieve the purpose of the zone. • If these uses are not able to function without impediment, then the zone is no longer effectively functioning as intended.	• The PPRZ zone cannot be subject to flooding in summer as it is utilised for sporting events that require a dry ground. Inundation to the PPRZ zone more than twice in the period September to March is considered an unacceptable level. • Requirement to place flooding or inundation overlay on land where it does not currently meet requirements	• Organised sport runs to strict weekly timetables, regular interruptions from flooding will mean that the season cannot be completed.
General Residential Zone (GRZ1)	Zone Description		
	• The purpose of the GRZ1 is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To encourage development that respects the neighbourhood character of the area.* *To encourage a diversity of housing types and housing growth particularly in locations offering good access to services and transport.* *To allow educational, recreational, religious, community and a limited range of other non-residential uses to serve local community needs in appropriate locations*		

Land Use Zoning	Metrics	Threshold	Rationale
	• The GRZ1enables the following uses to be established without a permit: - Animal keeping (other than animal boarding) - Bed and breakfast - Dependant person's unit - Dwelling - Home occupation - Informal outdoor recreation - Medical centre - Minor utility installation - Place of worship - Railway - Residential aged care facility - Tramway • The study area GRZ1 land currently includes: - Low density standalone dwellings - Aged care facility		
Commercial 1 Zone (C1Z)	Zone Description		
	• The purpose of the C1Z is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To create vibrant mixed-use commercial centres for retail, office, business, entertainment and community uses.* *To provide for residential uses at densities complementary to the role and scale of the commercial centre.* • The C1Z enables the following uses to be established without a permit: - Accommodation - Child care centre - Cinema based entertainment facility - Education centre - Exhibition centre - Home occupation - Informal outdoor recreation - Minor utility installation - Office - Place of worship - Railway - Retail premise - Shop - Tramway • The study area C1Z land currently includes: - Banks - Dine-in and takeaway restaurants - Furniture shops - Supermarkets - General retail		
Mixed Use Zone (MUZ)	Zone Description		
	• The purpose of the MUZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.*		

Land Use Zoning	Metrics	Threshold	Rationale
	To provide for a range of residential, commercial, industrial and other uses which complement the mixed-use function of the locality. *To provide for housing at higher densities.* *To encourage development that responds to the existing or preferred neighbourhood character of the area.* *To facilitate the use, development and redevelopment of land in accordance with the objectives specified in a schedule to this zone.* • The MUZ enables the following uses to be established without a permit: - Animal Keeping (other than animal boarding) - Bed and breakfast - Dependant person's unit - Dwelling - Food and drink premises - Home occupation - Informal outdoor recreation - Medical centre - Minor utility installation - Office - Place of worship - Railway - Residential aged care facility - Shop - Tramway • The study area MUZ land currently includes: - Banks - Dine-in and takeaway restaurants - Furniture shops - Supermarkets - General retail		
Industrial 3 Zone (IN3Z)	Zone Description • The purpose of the IN3Z is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To provide for industries and associated uses in specific areas where special consideration of the nature and effects of industrial uses is required or to avoid inter-industry conflict.* *To provide a buffer between the Industrial 1 Zone or Industrial 2 Zone and local communities, which allows for industries and associated uses compatible with the nearby community.* *To allow limited retail opportunities including convenience shops, small scale supermarkets and associated shops in appropriate locations.* *To ensure that uses do not affect the safety and amenity of adjacent, more sensitive land uses.* • The IN3Z enables the following uses to be established without a permit: - Convenience shop - Crop raising - Extensive animal husbandry - Home occupation - Informal outdoor recreation - Mail centre - Minor utility installation		

Land Use Zoning	Metrics	Threshold	Rationale
	- Railway - Service Station - Shop - Supermarket - Tramway • The study area IN3Z land currently includes: - Bus depot - Storage units - Automotive services - Joiners - General retail		
Public Use Zone • Public Use Zone 2- Education (PUZ2) • Public Use Zone 7 – Other Public Use (PUZ7)	Zone Description		
	• The purpose of the PUZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To recognise public land use for public utility and community services and facilities.* *To provide for associated uses that are consistent with the intent of the public land reservation or purpose.* • The PUZ enables the following uses to be established without a permit: - Railway - Railway station - Tramway PUZ2 – enables the land to be used for education purposes without the need for a permit for use PUZ7- enables the land to be used for 'other public use' purposes within the need for a permit for use • The study area PUZ2 land currently includes: - Primary School • The study area PUZ7 land currently includes: - Justice Precinct Police Station justice Service Centre Magistrates Court		
	Groundwater Rise		
	• Inability to achieve the purpose of the applicable zone.	• Inability to support the permitted uses and enable continued use of land with established developments. • Groundwater rise to a level that reaches existing underground infrastructure such a pipes and utility lines is unacceptable	• Inability to achieve the purpose of the zone means that the area can no longer provide for that particular use and support the different elements of a community. • Material effect pathways relating to existing dwellings and structures rendering them unsafe or unliveable are addressed by geotechnical metrics.
	Flooding and Inundation		

Land Use Zoning	Metrics	Threshold	Rationale
	• Inability to achieve the purpose of the zone. • Flooding or inundation to a level that requires that flood control overlays are required in areas not previously required.	• Inability to support the permitted uses and enable continued use of land with established developments. • Flooding or inundation to a level that requires that flood control overlays are required in areas not previously required.	• Areas without pre-existing flood controls will not have dictated floor heights above ground level. Increased flood levels have the potential to significantly effect on the existing structures. • Material effect pathways relating to existing dwellings and structures rendering them unsafe or unliveable are addressed by geotechnical metrics.

9.1.2 Urban buffer between Yallourn coal mine and Morwell

Figure 9.5 identifies the study area for the urban buffer between Yallourn coal mine and Morwell.

Morwell is located approximately 4.5 kilometres east of the Yallourn coal mine. The land in this area is zoned Special Use Zone – Schedule 1 (Brown Coal), Farming Zone, Public Park and Recreation Zone, and General Residential Zone- Schedule 1 as shown in Figure 9.5.

9.1.2.1 Receptor Description

The study area is bordered to the south by the Princes Freeway as far as Latrobe Road. The eastern boundary of the site is staggered as far as Maryvale Road in the east connecting to Old Melbourne Road in the north. The northern boundary follows Old Melbourne Road west to the eastern edge of the Yallourn Open Cut Mine site.

The study area is identified below in Figure 9.6 and Figure 9.7.

Figure 9.5 : Urban buffer between Yallourn coal mine and Morwell (as of February 2016)

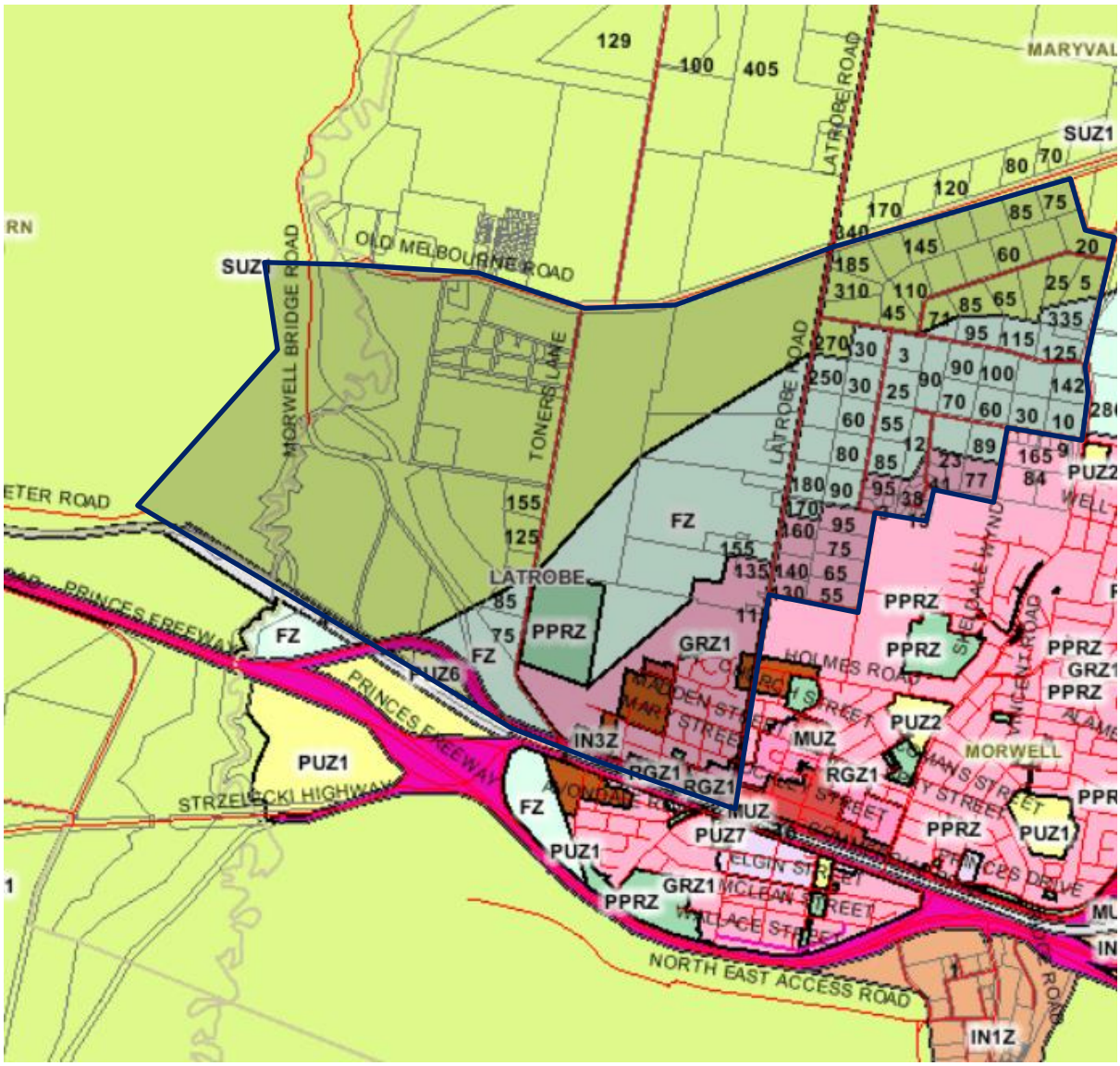


Figure 9.6 : Urban buffer betwwen Yallourn coal mine and Morwell Zoning Map

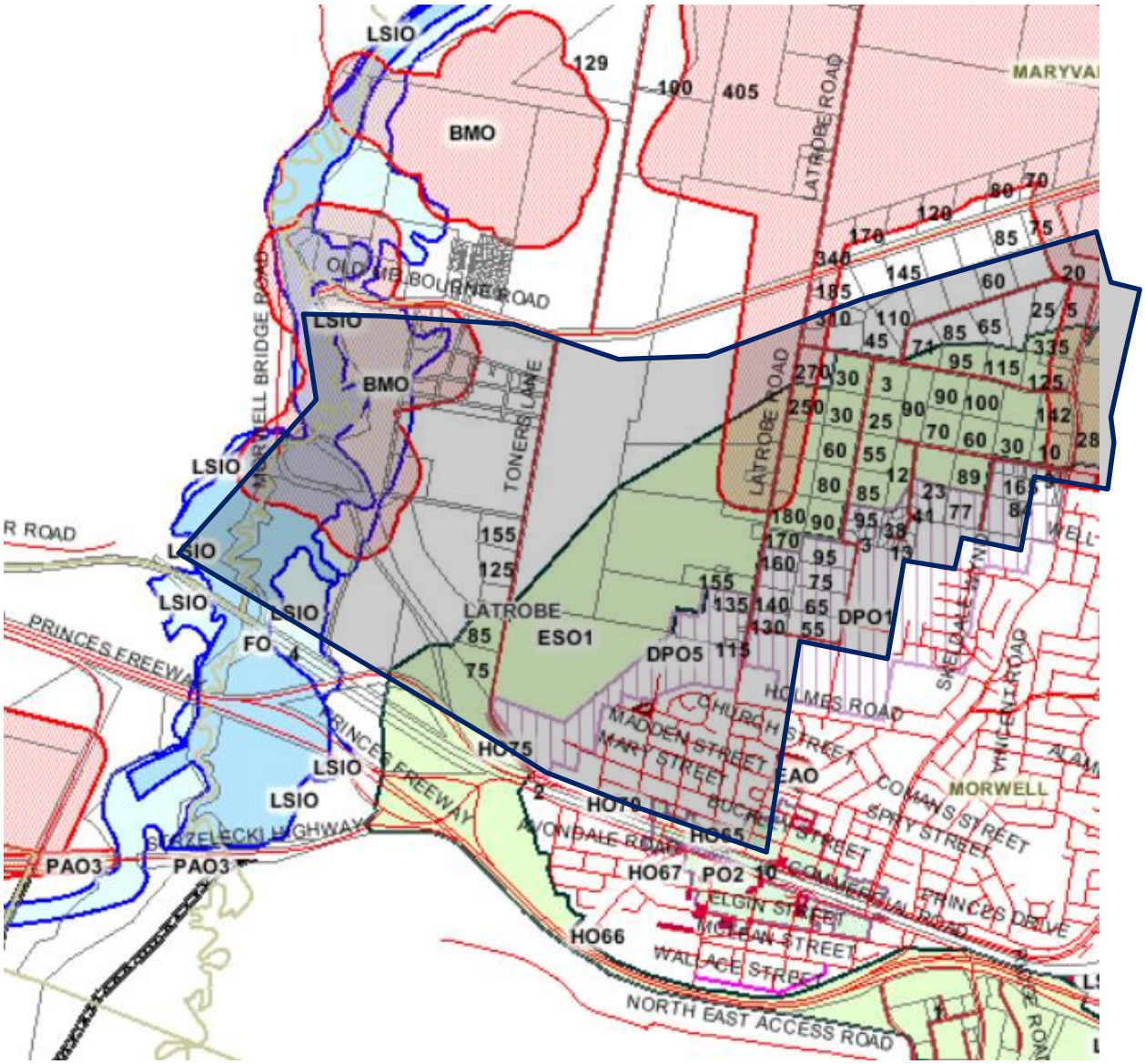


Figure 9.7 : Urban buffer betwwen Yallourn coal mine and Morwell Overlay Map

The area is subject to the following zones:

- Special Use Zone – Schedule 1 (SUZ1)
  - Brown Coal
- Public Park and Recreation (PPRZ)
- Farming Zone (FZ)
- General Residential Zone - Schedule 1 (GRZ1)
- Residential Growth Zone – Schedule 1 (RGZ1)
- Industrial 3 Zone (IN3Z)
- Mixed Use Zone (MU)
- Public Use Zone
  - Public Use Zone 6 – Local Government (PUZ6)

The area is subject to the following overlays:

- Land Subject to Inundation (LSIO)
- Bushfire Management Overlay (BMO)
- Environmental Significance Overlay – Schedule 1
  - Urban Buffer
- Floodway Overlay (FO)
- Development Plan Overlay – Schedule 5 (DPO5)
  - Residential Growth Areas
- Heritage Overlay (HO).

The area has a mix of uses. The study area is predominantly SUZ1, followed by a large area of FZ.

The south eastern corner of the study area includes a mix of uses and comprises mainly of residential dwellings.

9.1.2.2 Groundwater Usage in the urban buffer between Yallourn Coal Mine and Morwell

About 92 per cent of the water extracted for towns, industry and agriculture in Gippsland is sourced from waterways, with about 8 per cent sourced from groundwater[11].

Different land uses have different requirements for groundwater use. The residential uses in the south are described further in Section 10.1

Outside of the SUZ1, information is not currently available as to how much ground water the land uses in the study area use. It is assumed that there is a reliance on groundwater for the FZ area and a limited reliance in the south eastern corner as most of this area, particularly the residential development is connected to mains supply and therefore does not rely on ground water. Further investigation is required to understand the use of water in the study area, particularly the FZ area.

9.1.2.3 Flood Events and Inundation

Planning schemes use overlays to identify areas that are prone to flooding. There are four overlays that indicate different flood risks.

[11] Department of Sustainability and Environment (2011) Gippsland Region Sustainable Water Strategy (page 17)

The study area is subject to two overlays that relate to flooding or inundation. The LSIO and FO apply only within the SUZ1. The overlays are on the land adjacent to the coal mine pits. There are no flooding or inundation overlays within the land zoned FZ or any of the land uses in the south eastern corner of the study area.

Outside of the SUZ1 there ae no flood risks currently identified in this area. Outside of the LSIO and FO the area is outside of the 1 in 100-year flood area and therefore there are no controls relating to height of building above ground.

An explanation of the flood overlays is included below. These are the mechanisms used to protect development in flood prone areas from the effects of flooding. The Latrobe Valley has typically suffered water shortages and droughts rather than flood events and therefore it is uncommon that these overlays are present in this, or the wider area. There were unusual flood events in the period between August 2010 and April 2011 that were the result of unusual weather patterns.

There are four overlays that relate to flooding and inundation.

- **Special Building Overlays (SBO)**

  These are planning scheme controls that identify areas prone to overland flooding. The purpose of these overlays is to set appropriate conditions and floor levels to address any flood risk to developments. These overlays require a planning permit for buildings and works.

- **Land Subject to Inundation Overlays (LSIO)**

  These are planning scheme controls that apply to land affected by flooding associated with waterways and open drainage systems. Such areas are commonly known as floodplains. These overlays require a planning permit for buildings and works.

- **Floodway Overlays (FO)**

  These apply to land that's identified as carrying active flood flows associated with waterways and open drainage systems. This overlay is categorised by depths in excess of one metre.

- **Urban Floodway Zone (UFZ)**

  Unlike the overlays, the UFZ controls land use as well as development, with land use being restricted to low intensity uses such as recreation and agriculture. Development is generally not encouraged in the UFZ.

The proposed rehabilitation of the mine could have an effect on groundwater levels and flood events at the urban buffer between Yallourn and Morwell. The following metrics and thresholds provide an analysis of the existing land uses at the urban buffer between Yallourn and Morwell (also refer to Appendix E.2).

9.1.2.4 Defined Metrics, Thresholds and Rationale

Land Use Zoning	Metrics	Threshold	Rationale
Public Park and Recreation (PPRZ)	Zone Description:		
	• The purpose of the PPRZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To recognise areas for public recreation and open space.* *To protect and conserve areas of significance where appropriate.* *To provide for commercial uses where appropriate.*		
	• The PPRZ enables the following uses to be established by a public land manager without a permit: - Informal outdoor recreation - Open sports ground - Contractor's depot - Heliport		

<table>
<tr><td></td><td colspan="3">- Office
- Retail premise Store

• The study area PPRZ land currently includes:
- Toners Lane Reserve
- Helen Street Reserve
- The Morwell Cougars Baseball Club</td></tr>
<tr><td></td><td colspan="3"><u>Groundwater Rise</u></td></tr>
<tr><td></td><td>• Inability to achieve the purpose of the zone.
• If these uses are not able to function without impediment, then the zone is no longer effectively functioning as intended.</td><td>• Groundwater level changes will not trigger a threshold creating a material change</td><td>• The PPRZ zone, specifically informal recreation, does not typically require groundwater to function as intended.
• Further investigation is required to identify is groundwater is used for the watering of turfs or sports grounds.</td></tr>
<tr><td></td><td colspan="3"><u>Flooding and Inundation</u></td></tr>
<tr><td></td><td>• Inability to achieve the purpose of the zone.
• If these uses are not able to function without impediment, then the zone is no longer effectively functioning as intended.</td><td>• The PPRZ zone cannot be subject to flooding in summer as it is utilised for sporting events that require a dry ground. Inundation to the PPRZ zone more than twice in the period September to March is considered an unacceptable level.
• Requirement to place flooding or inundation overlay on land where it does not currently meet requirements</td><td>• Organised sport runs to strict weekly timetables, regular interruptions from flooding will mean that the season cannot be completed.</td></tr>
<tr><td>General Residential Zone-Schedule 1 (GRZ1)</td><td colspan="3">Zone Description</td></tr>
<tr><td></td><td colspan="3">• The purpose of the GRZ is:
To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.
To encourage development that respects the neighbourhood character of the area.
To encourage a diversity of housing types and housing growth particularly in locations offering good access to services and transport.
To allow educational, recreational, religious, community and a limited range of other non-residential uses to serve local community needs in appropriate locations

• The GRZ enables the following uses to be established without a permit:
- Animal keeping (other than animal boarding)
- Bed and breakfast
- Dependant person’s unit
- Dwelling
- Home occupation
- Informal outdoor recreation
- Medical centre
- Minor utility installation</td></tr>
</table>

	- Place of worship - Railway - Residential aged care facility - Tramway • The study area GRZ1 land currently includes: - Low density standalone dwellings - Latrobe Valley Golf Driving Range - Morwell Sunday Market - Cellars
Mixed Use Zone (MUZ)	Zone Description
	• The purpose of the MUZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To provide for a range of residential, commercial, industrial and other uses which complement the mixed-use function of the locality.* *To provide for housing at higher densities.* *To encourage development that responds to the existing or preferred neighbourhood character of the area.* *To facilitate the use, development and redevelopment of land in accordance with the objectives specified in a schedule to this zone.* • The MUZ enables the following uses to be established without a permit: - Animal Keeping (other than animal boarding) - Bed and breakfast - Dependant person's unit - Dwelling - Food and drink premises - Home occupation - Informal outdoor recreation - Medical centre - Minor utility installation - Office - Place of worship - Railway - Residential aged care facility - Shop - Tramway • The study area MUZ land currently includes: - Low density residential development
Farming Zone	Zone Description
	• The purpose of the FZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To provide for the use of land for agriculture.* *To encourage the retention of productive agricultural land.* *To ensure that non-agricultural uses, including dwellings, do not adversely affect the use of land for agriculture.* *To encourage the retention of employment and population to support rural communities.* *To encourage use and development of land based on comprehensive and sustainable land management practices and infrastructure provision.* • The FZ enables the following uses to be established without a permit:

	- Agriculture (other than Animal keeping, Apiculture, Intensive animal husbandry, racing dog training, Rice growing and Timber production) - Animal keeping - Bed and breakfast - Cattle feedlot - Dependant person's unit - Dwelling - Home occupation - Informal outdoor recreation - Minor utility installation - Primary produce sales - Racing dog training - Railway - Rural industry - Rural store - Timber production - Tramway • The study area FZ land currently includes: - Land that appears to be used for grazing
Industrial 3 Zone (IN3Z)	Zone Description
	• The purpose of the IN3Z is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To provide for industries and associated uses in specific areas where special consideration of the nature and effects of industrial uses is required or to avoid inter-industry conflict.* *To provide a buffer between the Industrial 1 Zone or Industrial 2 Zone and local communities, which allows for industries and associated uses compatible with the nearby community.* *To allow limited retail opportunities including convenience shops, small scale supermarkets and associated shops in appropriate locations.* *To ensure that uses do not affect the safety and amenity of adjacent, more sensitive land uses.* • The IN3Z enables the following uses to be established without a permit: - Convenience shop - Crop raising - Extensive animal husbandry - Home occupation - Informal outdoor recreation - Mail centre - Minor utility installation - Railway - Service Station - Shop - Supermarket - Tramway • The study area IN3Z land currently includes: - Joiners - Machining and Engineering - Transport Freight - Automotive services
	Groundwater Rise

	• Inability to achieve the purpose of the applicable zone.	• Inability to support the permitted uses and enable continued use of land with established developments. • Groundwater rise to a level that reaches existing underground infrastructure such as pipes and utility lines is unacceptable.	• Inability to achieve the purpose of the zone means that the area can no longer provide for that use and support the different elements of a community. • Material effect pathways relating to existing dwellings and structures rendering them unsafe or unliveable are addressed by geotechnical metrics.
	<u>Flooding and Inundation</u>		
	• Inability to achieve the purpose of the zone. • Flooding or inundation to a level that requires that flood control overlays are required in areas not previously required.	• Inability to support the permitted uses and enable continued use of land with established developments. • Flooding or inundation to a level that requires that flood control overlays are required in areas not previously required.	• Areas without pre-existing flood controls will not have dictated floor heights above ground level. Increased flood levels have the potential to significantly effect on the existing structures. • Material effect pathways relating to existing dwellings and structures rendering them unsafe or unliveable are addressed by geotechnical metrics.
Public Use Zone • Public Use Zone 6 – Local Government	Zone Description		
	• The purpose of the PUZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To recognise public land use for public utility and community services and facilities.* *To provide for associated uses that are consistent with the intent of the public land reservation or purpose.* • The PUZ enables the following uses to be established without a permit: - Railway - Railway station - Tramway PUZ6 – enables the land to be used for local government purposes without the need for a permit for use • The study area PUZ6 land currently includes: - Land that appears to be vacant		
	<u>Groundwater Rise</u>		
	• Inability to achieve the purpose of the applicable zone.	• The inability to develop the land for required purposes for local government use.	• The land should remain practical for development for local government purposes, as per other PUZ6 zoned land near the subject site. • Material effect pathways relating to existing dwellings and structures

			rendering them unsafe or unliveable are addressed by geotechnical metrics.
	Flooding and Inundation		
	• Inability to achieve the purpose of the zone. • Flooding or inundation to a level that requires that flood control overlays are required in areas not previously required.	• The inability to develop land for the permitted use without the need for extensive cost prohibitive mitigation. • Flooding or inundation to a level that requires that flood control overlays are required in areas not previously required.	• The land should remain practical for development for local government purposes, as per other PUZ6 zoned land near the subject site. • Material effect pathways relating to existing dwellings and structures rendering them unsafe or unliveable are addressed by geotechnical metrics.
Special Use Zone – Schedule 1 (Brown Coal)	Zone Description		
	• The purpose of the PUZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To recognise or provide for the use and development of land for specific purposes as identified in a schedule in this zone.* • The purpose of the PUZ1 is: *To provide for brown coal mining and associated uses* *To provide for electricity generation and associated uses* *To provide for interim and non-urban uses which protect brown coal resources and to discourage the use or development of land incompatible with future brown coal mining and industry* • The PUZ enables the following uses to be established without a permit: - Apiculture - Crop Raising - Dependent person's unit - Dwelling - Extensive Animal Husbandry - Extractive Industry - Home occupation - Industry - Informal outdoor recreation - Mineral exploration - Mining - Minor Utility installation - Natural systems - Railway - Road - Search for stone - Timber production - Tramway - Utility installation - Warehouse • The study area SUZ1 land currently includes: - Land uses associated with the Yallourn Coal Mine		

	Groundwater Rise and Flooding and Inundation
	The land zoned Special Use Zone – Schedule 1 (Brown Coal) is currently used for the mine and associated activities. It is anticipated that the activities within this zone will change with the rehabilitation of the mines and this will occur in consideration of the change in use. No assessment is provided for this zoning.

9.2 Dairying

Approximately 1,330 farms in Gippsland produce 1.87 billion litres of milk per year, accounting for 34% of Victoria's Milk production. Thus, Dairying is an important land use in Gippsland.

Dairy land use is an important user of water, both for rain fed pasture and through irrigation. Water availability changes have the potential to affect Dairying.

Where dairy's rely on water entitlements, the relevant metrics and thresholds are described as for other water entitlement holders. Refer to section 10.4 in this report.

Where dairy's rely on water quality, the relevant water quality metrics and thresholds are met through the environmental water quality requirements as described in section 7.2

9.3 Irrigated Agriculture

A range of irrigated agriculture is prevalent across the region relying on both groundwater and surface water as a source of water for irrigation.

Where irrigation relies on water entitlements, the relevant metrics and thresholds are described as for other water entitlement holders. Refer to sections 10.1 and 10.4 in this report.

Where irrigation relies on water quality, the relevant water quality metrics and thresholds are met through the environmental water quality requirements as described in section 7.2 and 10.1

10. Quantitative Metrics and Thresholds – Water Receptors

10.1 Aquifers and Groundwater Use

Across the catchment scale of the Latrobe Valley, two major Tertiary aquifer systems (Morwell Formation Aquifer System [MFAS] and the Traralgon Formation Aquifer System [TFAS]) underlie the LVRRS study area, and are partially separated by aquitards consisting of coal, clay and silt. A group of generally unconfined to semi confined aquifers (Pliocene to recent) represent a third, shallow regional aquifer system (herein referred to as the Shallow Aquifer System [SAS]). Figure 10.1 shows a schematic hydrogeological cross section from the Yallourn East Mine Field Mine, through Hazelwood Mine and eastward to the Loy Yang Mine, defining the major aquifers within the Latrobe Valley mining area.

At a basin scale, the hydrostratigraphy is broadly classified into three aquifer groups which identifies aquifers according to their depth and age, and this terminology is more commonly used by catchment management authorities and water regulators, namely:

- Upper Aquifer group: inclusive of the Shallow Aquifer System
- Middle Aquifer group: inclusive of the Morwell Formation Aquifer System and,
- Lower Aquifer group: inclusive of the Traralgon Formation Aquifer System.

Each aquifer group is further discretised into groundwater management units (GMUs), which are established in areas where there is a high concentration of groundwater abstraction licences – unincorporated areas (UAs) describes any area outside of a GMU for each respective aquifer group. The relevant GMUs for each aquifer group within the catchment scale of the LVRRS study area are defined below:

- Upper Aquifer Group (i.e. SAS): unincorporated area
- Middle Aquifer Group (i.e. MFAS): Rosedale GMU
- Lower Aquifer Group (i.e. TFAS): Moe GMU and Stratford GMU.

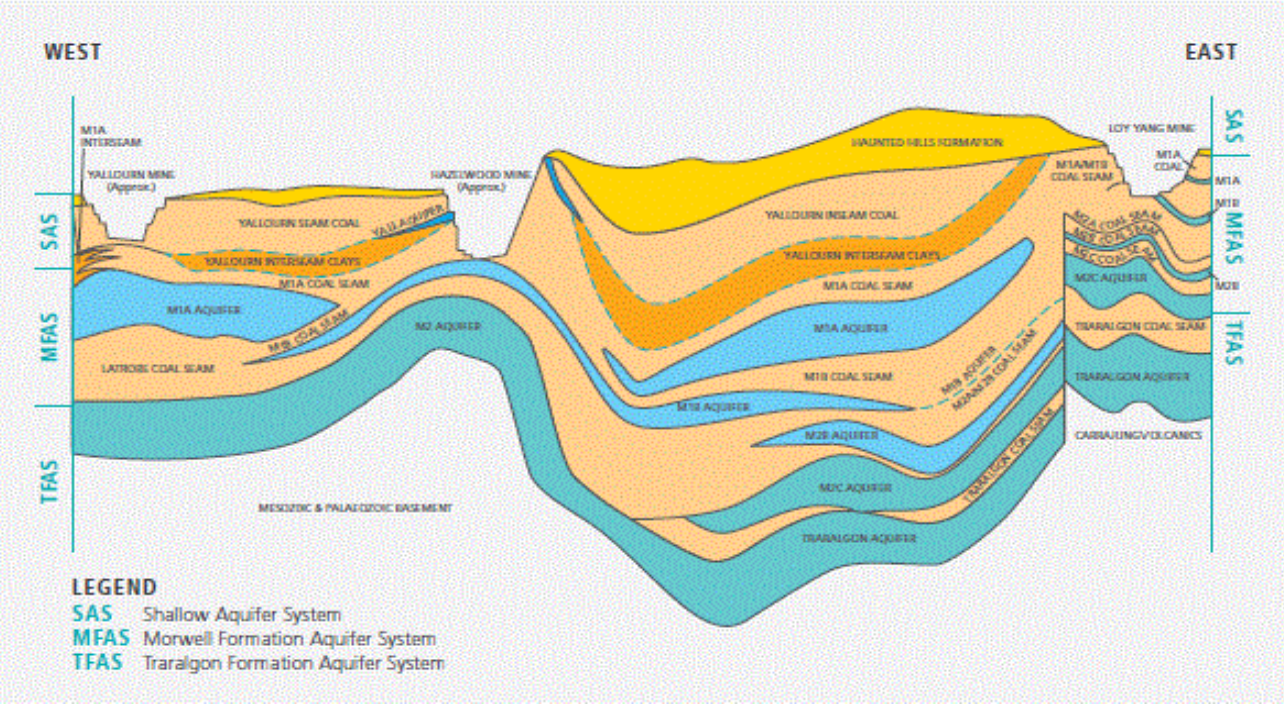


Figure 10.1: Schematic drawing representing hydrogeological features of the Latrobe Valley aquifer systems and mines

10.1.1 Shallow aquifer system

10.1.1.1 Receptor Description

The Upper Aquifer Group of the Gippsland basin occurs along the river valleys, floodplains and near the coast. They consist of coarse sand and thick gravel sediments at shallow depths. They also feature the clay aquitard of the Haunted Hills Formation, which overlies most of the sedimentary basin. Within the LVRRS catchment-scale study area, the Shallow Aquifer System occurs at or near the ground surface (Figure 10.2) and receives recharge directly from rainfall, streamflow or floods, and discharges into streams and lakes.

The SAS is generally clay-dominated and therefore low yielding from an abstraction perspective (Figure 10.3). The groundwater quality is considered brackish to fresh, and salinity is generally less than 3500 mg/L however can become more saline in areas where a near-surface water table combined with evaporation causes salt to concentrate (Figure 10.4)(SRW 2012)[12].

The depth to watertable across the region is stable and generally lies between 5 and 10 m below the surface, although many areas are at depths of less than 2 m (SRW 2012)[13]. Groundwater flow directions generally mimic topography and flow towards the coast or local and regional discharge features. Figure 10.5 presents the elevation of the watertable, showing that groundwater flows in a south-easterly direction towards the coast.

The dominant recharge mechanism is rainfall recharge and irrigation during the October to March period. Periodic flooding can cause episodic recharge in low lying areas around river systems (Jacobs 2015)[14]. There is also evidence of river recharge to the shallow groundwater system in places (SRW 2012). Discharge processes include evapotranspiration from the shallow watertable and discharge to rivers, wetlands, water bodies, and leakage to deeper aquifers (SRW 2012).

[12] Southern Rural Water (2012) Groundwater Atlas.

[14] Jacobs (2015) Onshore Natural Gas Water Science Studies – Gippsland Region Assessment of Potential Impacts on Water Resources.

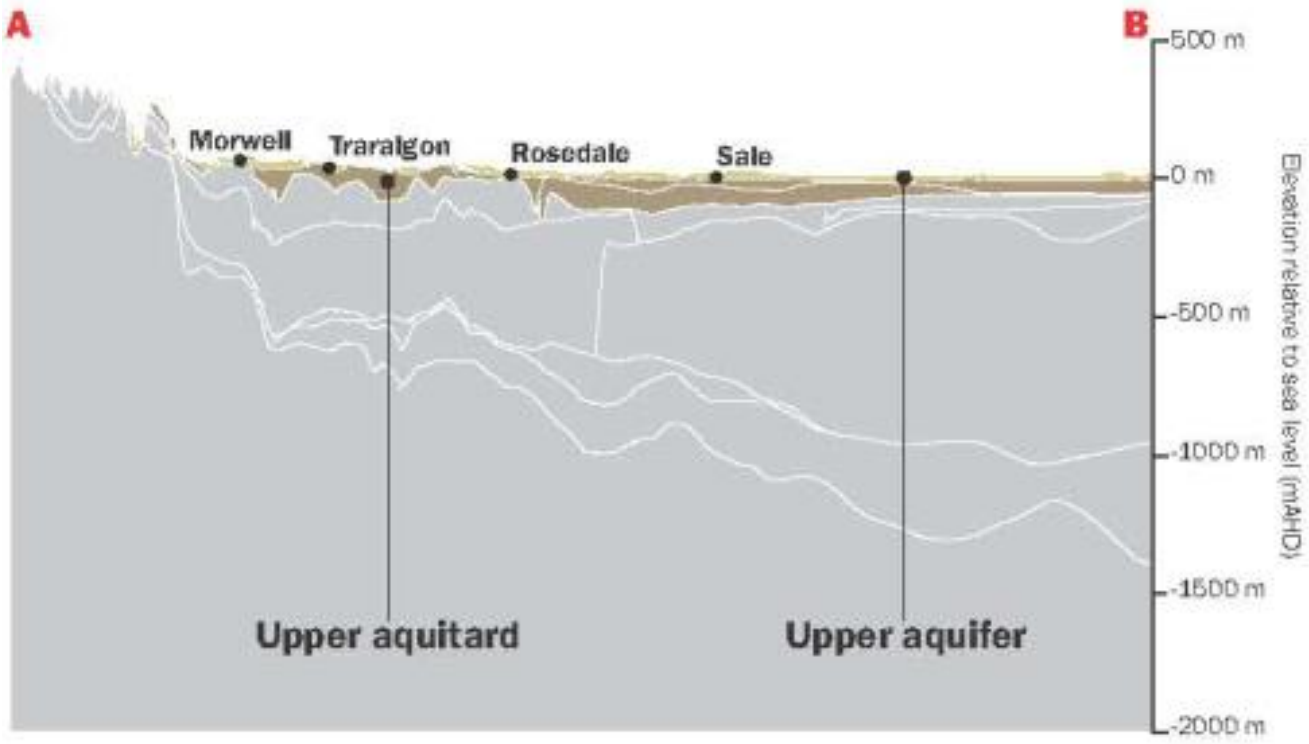


Figure 10.2 : Cross-section of the Upper Aquifer Group through the LVRRS study area (as defined by SRW 2012)

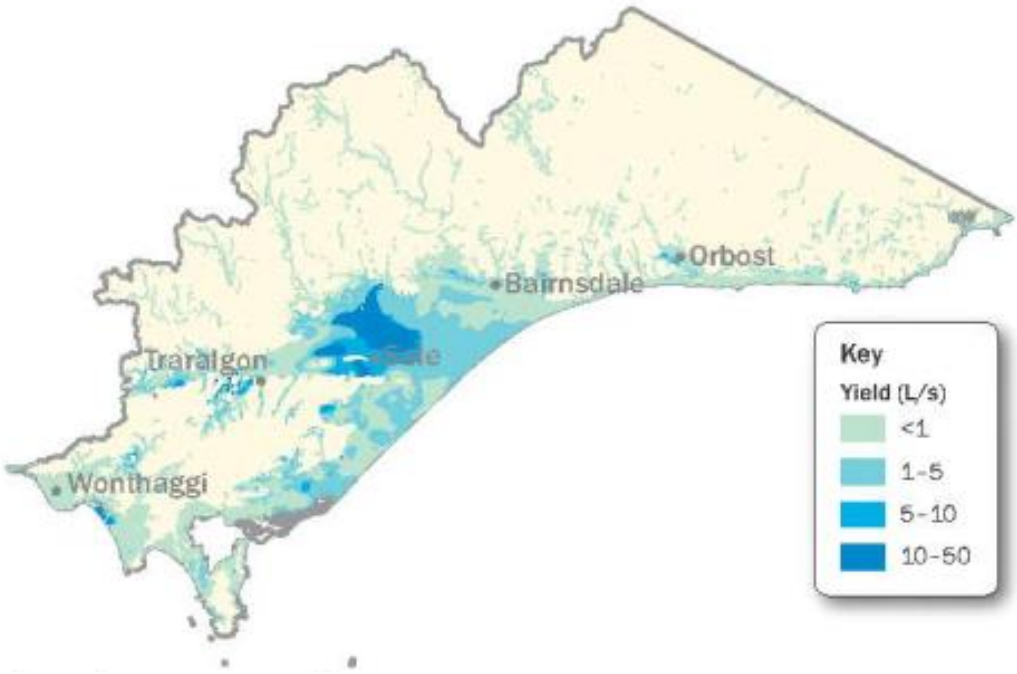


Figure 10.3 : Yield of the Upper Aquifer Group in the Gippsland Region (as defined by SRW 2012)

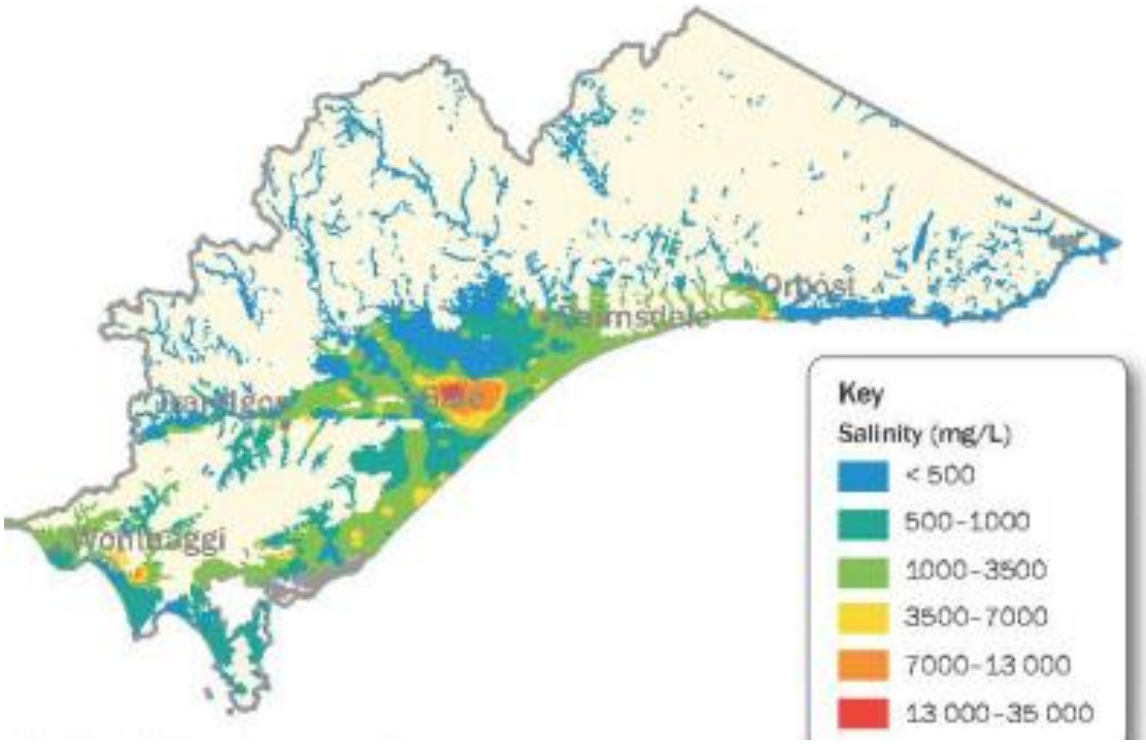


Figure 10.4 : Salinity of the Upper Aquifer Group in the Gippsland Region (as defined by SRW 2012)

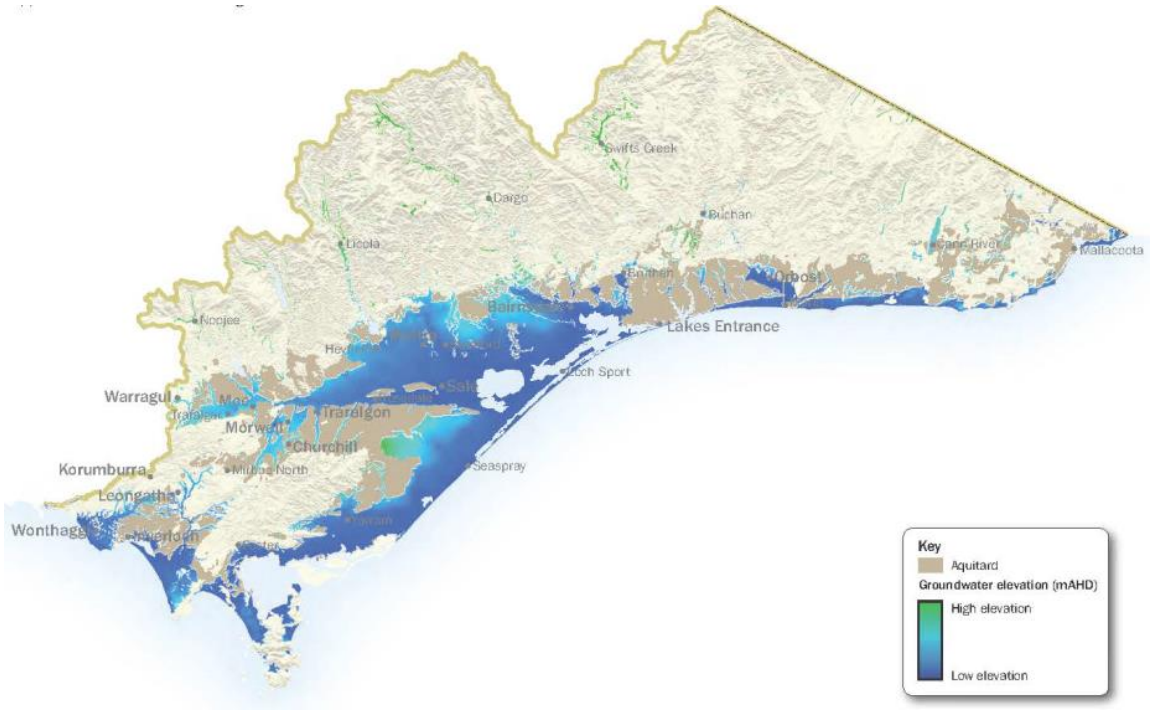


Figure 10.5 : Groundwater elevations in the Upper Aquifer Group of the Gippsland Region (as defined by SRW 2012)

10.1.1.2 Defined Metrics

Table 10.1 : Defined Metrics for the Shallow Aquifer System during filling and final mine void waterbody establishment

Value Category	Metrics
Natural Resource	• Quantity - Maintenance of depth to groundwater and/or hydraulic pressure within the historical background variation observed at a catchment and inter-mine scale. • Quality - Maintenance of groundwater quality at an inter-mine and catchment scale in accordance with SEPP (Groundwaters of Victoria) segments. • Quality - Maintenance of groundwater quality at a mine scale in accordance with the historical background variations observed in the shallow aquifer system at a catchment scale.
Social/Cultural	• Quantity - Maintenance of groundwater levels such that changes do not materially affect the social or cultural value of the receptor. • Quality – Maintenance of groundwater quality at an inter-mine and catchment scale, such that it does not become corrosive to structures or building materials.
Environment	• Quantity - Maintenance of surface water flows, such that there is no significant reduction in the groundwater contribution to seasonal baseflow of inter-dependent streams, creeks or rivers. • Quality – Maintenance of quality in receiving surface waters at an inter-mine and catchment scale in accordance with the SEPP (Waters of Victoria) segments. • Quality – Maintenance of quality in receiving surface waters at a mine scale in accordance with the historical background variations observed in the shallow aquifer system at a regional scale.
Ecosystem Dependence	• Quantity – Maintenance of groundwater levels and flow direction such that changes in inflow or reduced inputs to GDEs do not materially impair ecosystem function • Quality – Maintenance of quality in receiving groundwater dependant ecosystems, at an inter-mine and catchment scale, in accordance with the SEPP (Waters of Victoria) segments. • Quality – Maintenance of quality in receiving groundwater dependant at a mine scale in accordance with the historical background variations observed in the shallow aquifer system at a regional scale.
Economic/Water Use	• Quantity - Maintain groundwater levels and volumes such that changes do not materially and adversely affect security of supply during key extraction periods.

10.1.1.3 Defined Thresholds and Rationale

Table 10.2 : Defined Thresholds for the Shallow Aquifer System during filling and final mine void waterbody establishment (also refer to Appendix F.1)

Value Category	Threshold	Rationale
Natural Resource	• Quantity - A predicted decline of **> 15 m in the Shallow Aquifer System (SAS)**, in key regional SAS monitoring bores and at a catchment scale, after 30 years. • Quality – Predicted **exceedance of SEPP segments A1 to B**, in key regional SAS monitoring bores. • Quality – Predicted exceedance of statistically significant background data (outside the 5th and 95th percentile range) in key regional SAS monitoring bores.	• A predicted decline of > 15 m in the watertable aquifer significantly changes the function of water users and/or ecosystems. Defined by the Gippsland Region Assessment of Potential Effects on Water Resources (Jacobs 2015). • Under the SEPP guidelines, the current and potential beneficial use of the aquifer should be protected – exceedance of the segments indicates that the beneficial use of the groundwater has been reduced. • Exceedance of the statistically significant regional background data indicates that groundwater quality is being degraded at the mine scale.

Value Category	Threshold	Rationale
Social/Cultural	• Quantity - A predicted decline of **> 2 m in the watertable aquifer**, in key regional SAS monitoring bores and at catchment scale. • Quality – A predicted decline of water quality to **pH < 5**, **Hardness < 60 mg/L (as CaCO3)** and **Langlier Index < -0.5**, observed in key regional SAS monitoring bores and at a catchment scale.	• The quantity threshold is interdependent on the values associated with the environment and ecosystem dependence. A decline in groundwater levels which significantly effects on social/cultural values that is unacceptable at an inter-mine and catchment scale. • The decline in groundwater quality, outside of the defined threshold, will significantly increase the corrosion potential on buildings and saturated infrastructure. The thresholds are as defined by the trigger values for assessing the corrosiveness of water in Australian and New Zealand guidelines for fresh and marine water quality (2000) Volume 3, Primary Industries – General Use.
Environment	• Quantity - A predicted decline of **> 2 m in the shallow aquifer system**, in key regional SAS monitoring bores (52883, 80493) and at a catchment scale, and/or a predicted decline of **> 10% below the minimum average seasonal flow or the Q90 flow rate**. • Quality – Predicted exceedance of **trigger values for the protection of 90% freshwater species** in receiving surface waters at an inter-mine and catchment scale. • Quality – Predicted exceedance of statistically significant background data in receiving surface waters at a catchment scale.	• A predicted decline of > 2 m in the watertable aquifer significantly effects stream flow of connected waterway to natural or current conditions. The thresholds are as defined by the Gippsland Region Assessment of Potential Effects on Water Resources (Jacobs 2015) and the Resource Share Guidelines for Groundwater (DELWP 2015) [15]. • Exceedance of the thresholds for the protection of 90% of freshwater species indicates that the beneficial use of the receiving surface water has been reduced. These threshold values are as defined by Australian and New Zealand guidelines for fresh and marine water quality (2000) Volume 2, Aquatic Ecosystems. • Exceedance of the statistically significant regional background data indicates the quality of receiving surface water is being degraded at the mine scale.
Ecosystem Dependence	• Quantity – A predicted decline of **> 2 m in the watertable aquifer** and/or **reversal of the hydraulic gradient** observed at the ecosystem boundary, at an inter-mine and catchment scale. • Quality – Predicted exceedance of **trigger values for the protection of 90% freshwater species** (Reference in receiving groundwater dependant ecosystems, at an inter-mine and catchment scale. • Quality – Predicted exceedance of statistically significant background data in receiving groundwater dependant ecosystems, at a catchment scale.	• A predicted exceedance of the threshold values is recognised to significantly effect on the aquifer's connectivity to the dependant ecosystems. The thresholds are as defined by Ministerial Guidelines for Groundwater Licencing and the Protection of High-Value Groundwater Dependant Ecosystems (2015). • Exceedance of the trigger value for the protection of 90% of freshwater species indicates that the beneficial use of the groundwater dependant ecosystems has been reduced. These threshold values are as defined by Australian and New Zealand guidelines for fresh and marine water quality (2000) Volume 2, Aquatic Ecosystems. • Exceedance of the statistically significant regional background data indicates the quality of groundwater dependant ecosystems is being degraded at the mine scale.

[15] Department of Environment, Land and Water Protection (2015) Resource Share Guidelines for Groundwater, Victoria

Value Category	Threshold	Rationale
Economic/Water Use	• Quantity - A predicted decline in groundwater levels of **> 10% of the saturated thickness** of the shallow aquifer system in key regional SAS monitoring bores (52883, 80493) and at a catchment scale • Quantity – Any predicted increase in the usage which is **> 100% of the current PCV**.	• A predicted decline in groundwater levels is recognised to significantly reduce the accessibility of infrastructure to abstract water from the aquifer and adversely affect the security of supply. The thresholds are as defined by the Resource Share Guidelines for Groundwater (DELWP 2015)

Note: The effect from all sources is to be considered when assessing a threshold. The need for a response to mine related effects will have to be considered by the relevant regulator.

10.1.2 Morwell Formation Aquifer System

10.1.2.1 Receptor Description

Within the LVRRS catchment-scale study area the Morwell Formation Aquifer System (MFAS) is at the relevant depth to be considered the Middle Aquifer Group (Figure 10.6), receiving recharge from leakage through the overlying and surrounding sediments, and with discharge processes to the limestone aquitards and along the coast which are outside of the LVRRS project area. The Middle Aquifer Group covers a large part of the Gippsland groundwater basin from Moe to Bairnsdale. They comprise thick seams of sand aquifers separated by aquitards. The aquitards are generally clay or coal seams in the north-west of the Gippsland groundwater basin, and limestone in the east and centre of the basin.

The MFAS is dominated by thick sand, clay and coal layers, with the coal seams forming impervious aquitards; the coal seams are not continuous and are faulted, allowing connection between the sand units within each formation. The aquifer provides a valuable resource for agribusiness and industry throughout the Latrobe Valley. The groundwater quality is considered fresh with pockets of brackish quality, and salinity is generally less than 1500 mg/L (Figure 10.7)(SRW 2012). Groundwater yields are variable due to the presence of coal seam aquitards and thinning sediments; however, abstraction rates of > 50 L/s are observed between Moe and Sale (SRW 2012), inclusive of the LVRSS project area (Figure 10.8).

The depth to groundwater across the LVRRS project area is drawdown due to depressurisation of the Latrobe Valley open-cut mines and generally lies > 10 m below the surface. The natural groundwater flow directions are from the north-west, where water recharges the system, to the south-east, however in the LVRRS project area flow directions have been altered by a cone of depression extending from each of the open-cut mines Figure 10.9).

There is no significant outcrop of the middle aquifer system at the surface and subsequently no significant interaction with rivers (Jacobs 2015). Indirect interaction with rivers occurs from leakage into the middle aquifers from the upper aquifers along the major river floodplains. Nearby significant wetlands such as Dowds Morass, Sale Common, Heart Morass and Clydebank Morass may also rely on discharge from the middle aquifers due to upward groundwater pressure (SRW 2012).

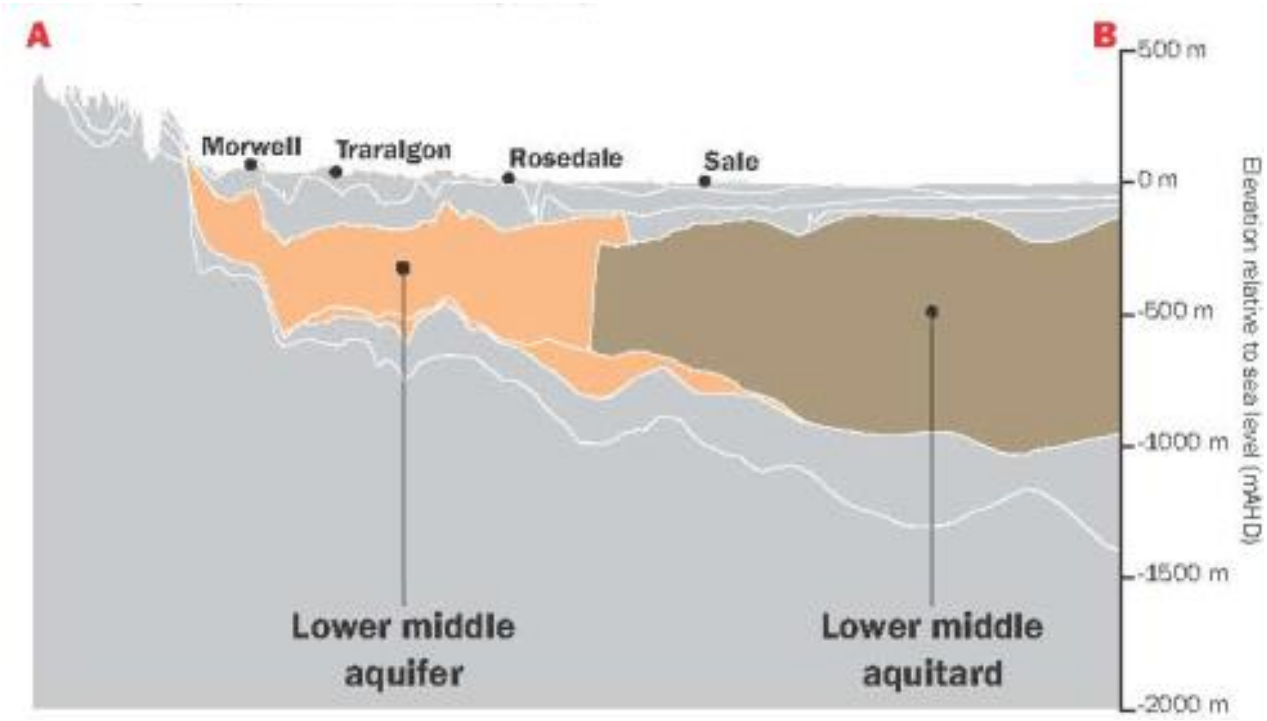


Figure 10.6 : Cross-section of the Middle Aquifer Group through the LVRRS study area (as defined by SRW 2012)

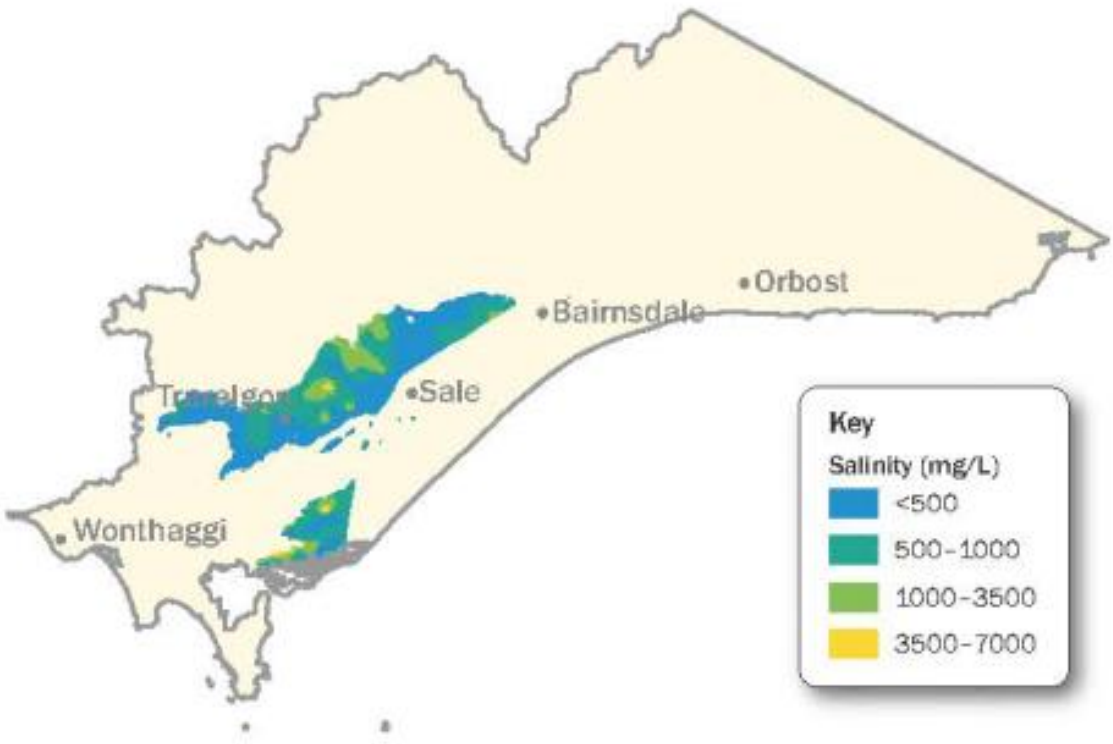


Figure 10.7 : Salinity Concentrations of the Middle Aquifer Group in the Gippsland Region (as defined by SRW 2012)

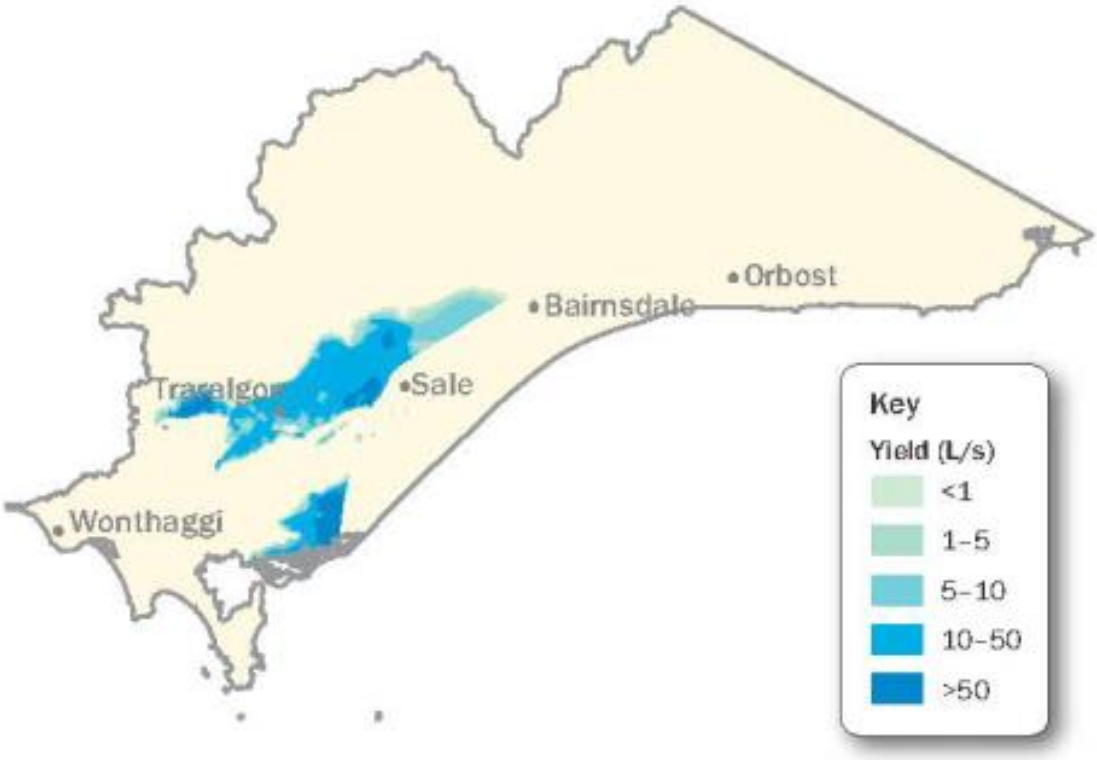


Figure 10.8 : Yield of the Middle Aquifer Group in the Gippsland Region (as defined by SRW 2012)

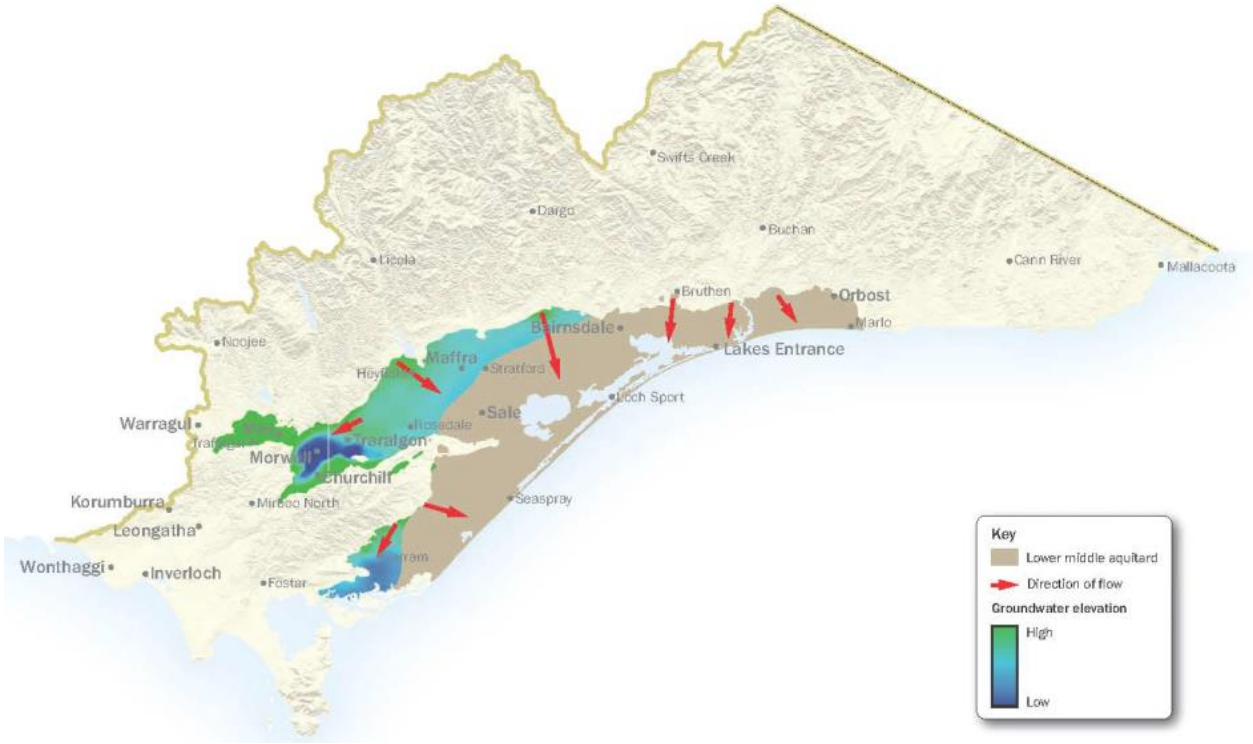


Figure 10.9 : Groundwater elevations in the Middle Aquifer Group of the Gippsland Region (as defined by SRW 2012)

10.1.2.2 Defined Metrics

Table 10.3 : Defined Metrics for the Morwell Formation Aquifer System during filling and final mine void waterbody establishment

Value Category	Metrics
Natural Resource	• Quantity - Maintenance of depth to groundwater and/or hydraulic pressure within the historical background variation recorded at a catchment and inter-mine scale. • Quality - Maintenance of groundwater quality at an inter-mine and catchment scale in accordance with SEPP (Groundwaters of Victoria) segments. • Quality - Maintenance of groundwater quality at a mine scale in accordance with the historical background variations observed in the Morwell Formation aquifer system at a catchment scale.
Economic/Water Use	• Quantity - Maintain groundwater levels and volumes such that changes do not materially and adversely affect security of supply during key extraction periods, at an inter-mine and catchment scale.

10.1.2.3 Defined Thresholds and Rationale

Table 10.4 : Defined Thresholds for the Morwell Formation Aquifer System during filling and final mine void waterbody establishment (also refer to Appendix F)

Value Category	Threshold	Rationale
Natural Resource	• Quantity - A predicted decline of **> 70 m in the Morwell Formation Aquifer System** (MFAS), in key regional MFAS monitoring bores and at a catchment scale, after 30 years. • Quality – A predicted decline of the potentiometric level does not result in the aquifer becoming unconfined. • **Exceedance of SEPP segments A1 to B**, in key regional MFAS monitoring bores and at a catchment scale. • Quality – Predicted exceedance of statistically significant background data (outside the 5th and 95th percentile range) in key regional MFAS monitoring bores.	• A predicted decline of > 70 m in the Morwell Formation aquifer significantly changes the function of water users and/or access to the natural resource. Defined by the Gippsland Region Assessment of Potential Effects on Water Resources (Jacobs 2015). • Under the SEPP guidelines, the current and potential beneficial use of the aquifer should be protected – exceedance of the segments indicates that the beneficial use of the groundwater has been reduced. • Exceedance of the statistically significant regional background data indicates that groundwater quality is being degraded at the mine scale.
Economic/Water Use	• Quantity - A predicted decline in groundwater levels of **> 10% of the saturated thickness** of the Morwell Formation Aquifer System, in key regional MFAS monitoring bores and at a catchment scale • Quantity – A predicted increase in the permissible consumptive volume which is **> 100% of the current PCV**.	• A predicted decline in groundwater levels is recognised to significantly reduce the accessibility of infrastructure to abstract water from the aquifer and adversely affect the security of supply. The thresholds are as defined by the Resource Share Guidelines for Groundwater (DELWP 2015)

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10.1.3 Traralgon Formation Aquifer System during filling and final mine void waterbody establishment

10.1.3.1 Receptor Description

Within the LVRRS catchment-scale study area the Traralgon Formation Aquifer System (TFAS) is at the relevant depth to be considered the Lower Aquifer Group (Figure 10.10), receiving recharge from leakage through the overlying and surrounding sediments, and with discharge processes occurring offshore into Bass Strait (SRW 2012). The Lower Aquifer Group underlies the entire Gippsland basin and extends offshore. They comprise thick sand sediments that rise to the surface in the west and along the basin margin but are very deep along the coast and offshore. These aquifers are overlain by the upper and middle aquifers together with thick silt, clay, coal and limestone aquitards, while underlain by basement rock.

The TFAS comprises sand and gravel aquifers, and clay, silt and coal aquitards. The aquifer system provides a valuable resource for agribusiness and industry throughout the Latrobe Valley. The groundwater quality is considered fresh, and salinity is generally less than 1000 mg/L (Figure 10.11)(SRW 2012). Groundwater yields are generally high due to the presence of thick coarse-sized sediments, and abstraction rates of up to 100 L/s are typically observed across the LVRSS project area (Figure 10.12).

Within the TFAS, the depth to groundwater across the LVRRS project area is drawdown due to depressurisation of the Latrobe Valley open-cut mines and generally lies > 50 m below the surface. The regional groundwater flow direction is from the margins of the Gippsland Basin, which are typically of higher elevations, towards the coast. In the vicinity of the LVRRS project area, groundwater flow directions have been altered by a cone of depression extending from each of the open-cut mines, which draws flow westward from as far as Rosedale (Figure 10.13).

The Lower Aquifer Group may receive recharge from rainfall and stream leakage around the margins of the Gippsland Basin where these units reach the sub-surface (SRW 2012), however in the vicinity of the LVRRS project area recharge to the TFAS is primarily from leakage of overlying sediments (Jacobs 2015).

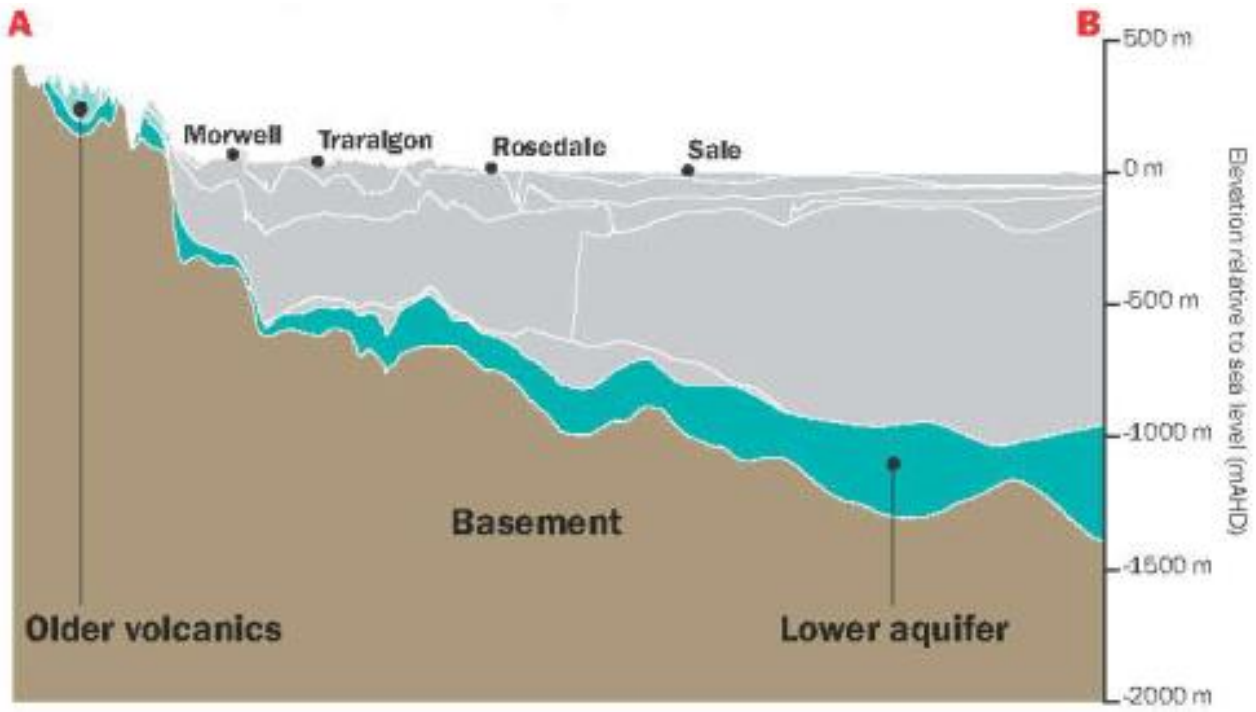

Figure 10.10 : Cross-section of the Lower Aquifer Group through the LVRRS study area (as defined by SRW 2012)

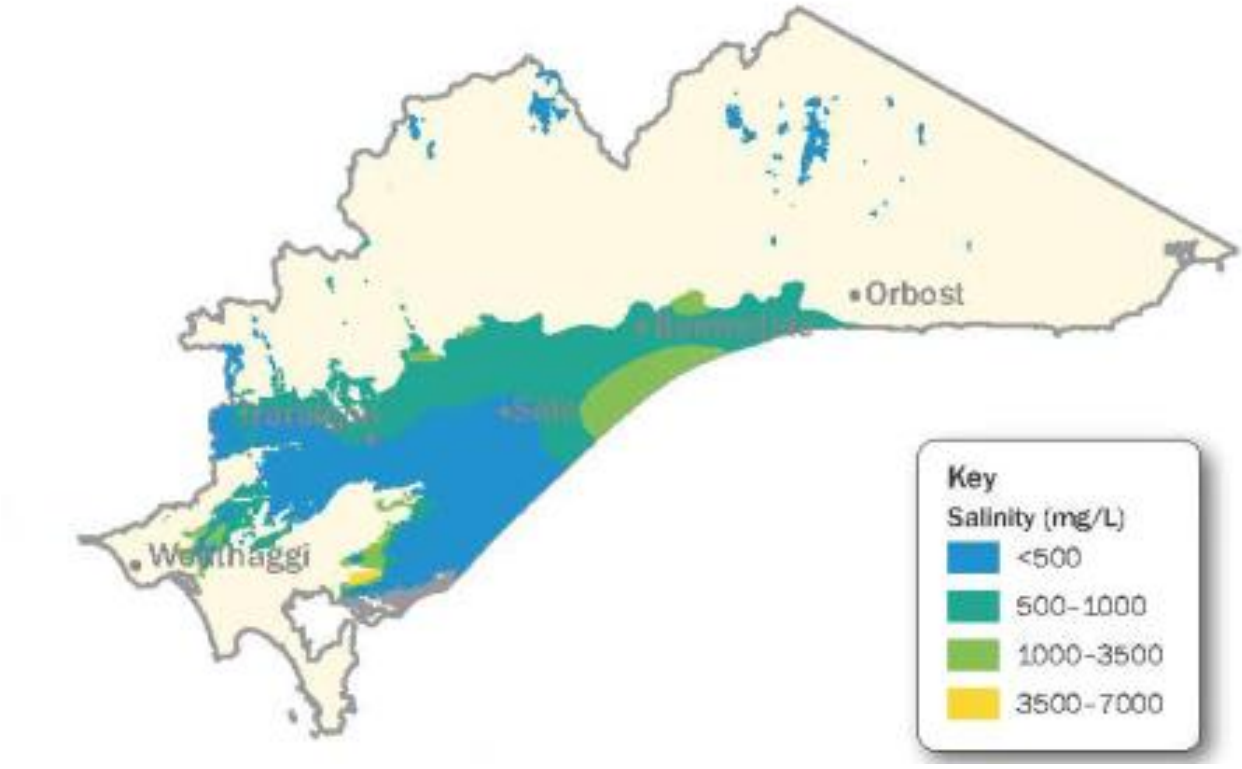

Figure 10.11 : Salinity Concentrations of the Lower Aquifer Group in the Gippsland Region (as defined by Jacobs 2015)

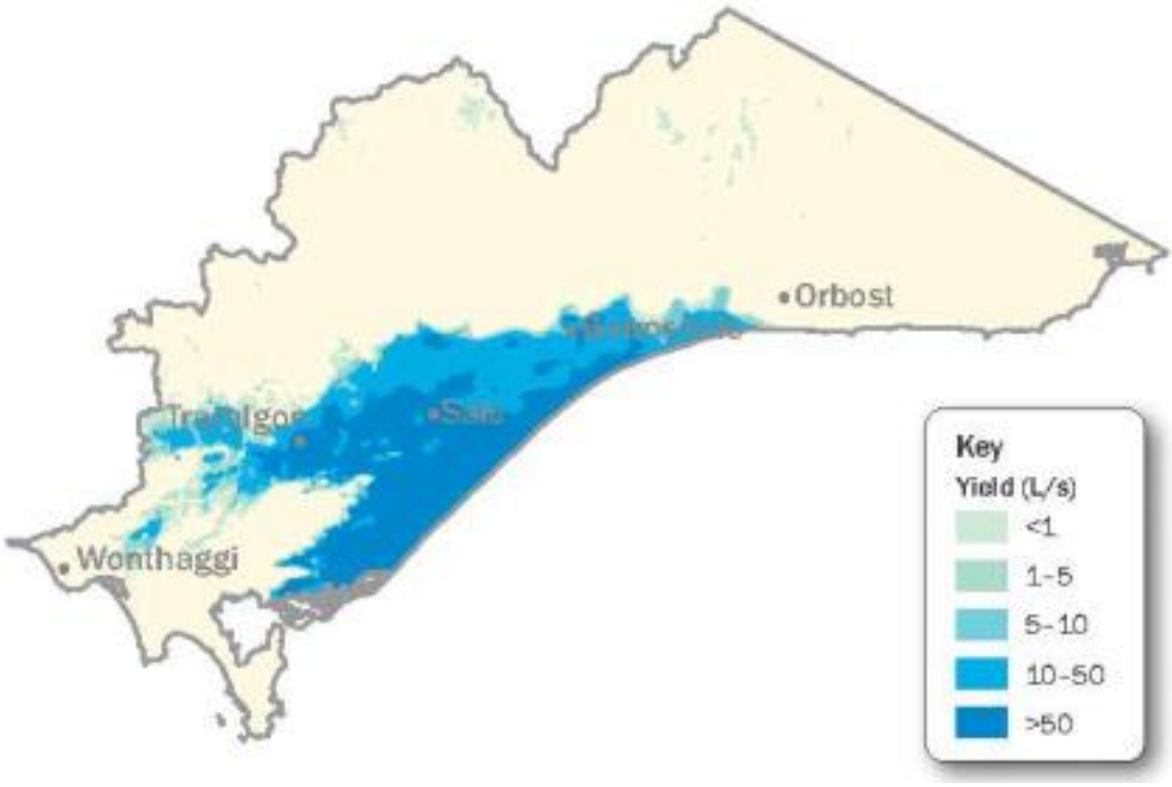

Figure 10.12 : Yield of the Lower Aquifer Group in the Gippsland Region (as defined by SRW 2012)

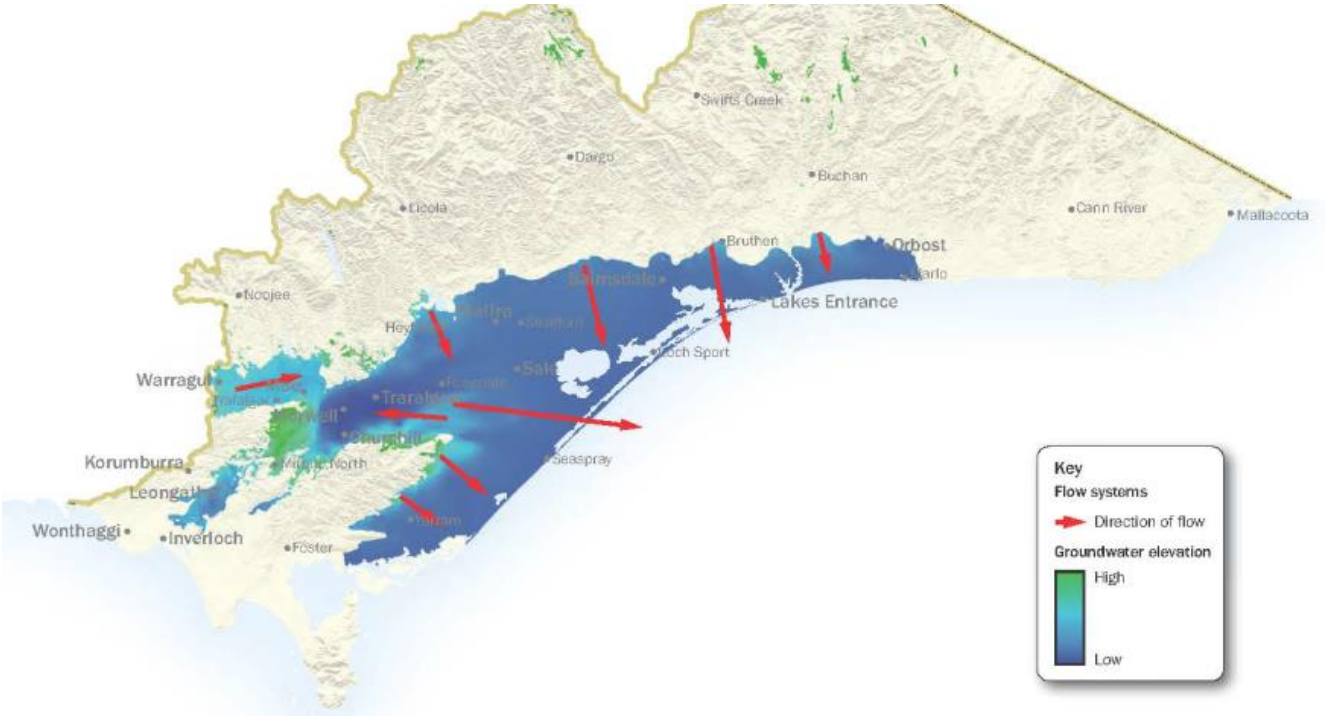

Figure 10.13 : Groundwater elevations in the Lower Aquifer Group of the Gippsland Region (as defined by Jacobs 2015)

10.1.3.2 Defined Metrics

Table 10.5 : Defined Metrics for the Traralgon Formation Aquifer System

Value Category	Metrics
Natural Resource	• Quantity - Maintenance of depth to groundwater and/or hydraulic pressure within the historical background variation recorded at a regional and inter-mine. • Quality - Maintenance of groundwater quality at an inter-mine and catchment scale in accordance with SEPP (Groundwaters of Victoria) segments. • Quality - Maintenance of groundwater quality at a mine scale in accordance with the historical background variations observed in the shallow aquifer system at a regional scale.
Economic/Water Use	• Quantity - Maintain groundwater levels and volumes such that changes do not materially and adversely affect security of supply during key extraction periods, at an inter-mine and catchment scale.

10.1.3.3 Defined Thresholds and Rationale

Table 10.6 : Defined Thresholds for the Traralgon Formation Aquifer System (also refer to Appendix F)

Value Category	Threshold	Rationale
Natural Resource	• Quantity - A predicted decline of **> 70 m in the Traralgon Formation Aquifer System** (TFAS**)**, in key regional TFAS monitoring bores and catchment scale, after 30 years. • Quality – A predicted decline of the potentiometric level does not result in the aquifer becoming unconfined. • Quality – Predicted **exceedance of SEPP segments A1 to B**, in key regional TFAS monitoring bores and at a catchment scale. • Quality – Predicted exceedance of statistically significant background data (outside the 5th and 95th percentile range) in key regional TFAS monitoring bores).	• A predicted decline of > 70 m in the Traralgon Formation aquifer significantly changes the function of water users and/or access to the natural resource. Defined by the Gippsland Region Assessment of Potential Effects on Water Resources (Jacobs 2015). • Under the SEPP guidelines, the current and potential beneficial use of the aquifer should be protected – exceedance of the segments indicates that the beneficial use of the groundwater has been reduced. • Exceedance of the statistically significant regional background data indicates that groundwater quality is being degraded at the mine scale.
Economic/Water Use	• Quantity - A predicted decline in groundwater levels of **> 10% of the saturated thickness** of the Traralgon aquifer system, in key regional TFAS monitoring bores and at a catchment scale • Quantity – A predicted increase in the permissible consumptive volume which is **> 100% of the current PCV**.	• A predicted decline in groundwater levels is recognised to significantly reduce the accessibility of infrastructure to abstract water from the aquifer and adversely affect the security of supply. The thresholds are as defined by the Resource Share Guidelines for Groundwater (DELWP 2015)

10.1.4 Moe Groundwater Management Area

The Moe Groundwater Management Area (GMA) is located within the Moe Groundwater Catchment, where the boundary meets the Central Gippsland Catchment, and falls within the LVRRS project area. The plan is lodged with the Central Plan Office, reference number LEGL./04-146.

A Permissible Consumptive Volume (PCV) of 8,200 ML/yr currently applies to the Moe GMA. The PCV is a cap on the amount of groundwater allocated in this management unit. The PCV applies to all areas of the Moe GMA for all formations below 25 m from the surface.

There are 97 groundwater licences in the Moe GMA that authorise a total of 3,992.9 ML. Over 70% of groundwater licensed in the Moe GMA is for irrigation purposes, however groundwater is also used in dairies for cooling and wash-down purposes.

10.1.5 Rosedale Groundwater Management Areas - Zone 1 and 2

The Rosedale GMA is located within the Central Gippsland Catchment and is comprised of three zones, with Zones 1 and 2 falling within the LVRRS project area. The plan is lodged with the Central Plan Office, reference number LEGL./04-157.

A PCV of 22,372 ML/yr currently applies to the Rosedale GMA. The PCV includes the two subzones within the LVRRS project area:

- Zone 1 – All formations from 50 metres to 150 meters below the surface and,
- Zone 2 – All formations from 25 metres to 350 metres below the surface.

There are 60 groundwater licences in the Rosedale GMA that authorise a total of 22,313 ML. Approximately 57% of groundwater licensed in the Rosedale GMA is for irrigation purposes, however groundwater is also used by power generators in the Latrobe Valley.

10.1.6 Stratford Groundwater Management Areas - Zone 1 and 2.

Stratford GMA is located within the Central Gippsland Catchment and is comprised of two zones, both of which fall within the LVRRS project area. The Stratford GMA plan is lodged with the Central Plan Office, reference number LEGL./04-158.

A PCV of 27,645 ML/yr currently applies to the Stratford GMA. The PCV includes the two subzones:

- Zone 1 – All formations below 150 metres from the surface and,
- Zone 2 – All formations below 350 metres from the surface.

There are 7 groundwater licences in the Stratford GMA that authorise a total of 27,645 ML. Approximately 3% of groundwater licensed in the Stratford GMA is for irrigation purposes, with a large component of groundwater is used by power generators in the Latrobe Valley.

10.1.6.1 Defined Metrics and Thresholds

The Moe, Rosedale and Stratford Groundwater Management Areas outline jurisdictional boundaries for aquifers that underlie the entire LVRRS project area. The metrics and thresholds for determination of effects on the underlying Shallow, Morwell Formation and Traralgon Formation aquifer systems is detailed in Section 10.1.1, 10.1.2 and 10.1.3 respectively. These sections outlined the metrics for the economic utilisation of these aquifers and therefore no further metrics and thresholds will be defined for the Moe, Rosedale and/or Stratford GMAs (refer also to Appendix F).

10.1.6.2 Current Status and Possible Trajectory

The current status of the groundwater within the Moe, Rosedale and Stratford Groundwater Management are described for the Shallow, Morwell Formation and Traralgon Formation aquifer systems in Section 10.1.1, 10.1.2 and 10.1.3 respectively.

10.2 Artificial lakes and Reservoirs

10.2.1 Buckley's Hill Reservoir

The Buckley's Hill Reservoir provides treated water to the Morwell and Churchill communities as well as raw water to the power industry. The raw water source for the Buckley's Hill Reservoir is the Moondarra Reservoir on the Tyers River for which Gippsland Water holds a Bulk Entitlement of 62,000 ML/y on average. Water is piped from Moondarra Reservoir to the Buckley's Hill storage.

The original Buckley's Hill storage was built in the early 1960s and embankment works, and other maintenance were performed most recently in 2015 and 2017 to ensure ongoing compliance with modern design standards and to extend the life of the facility. For example, to ensure the future integrity of the structure, extra material was added to the northern walls of the reservoir which has been subject to some minor movements over many years.

10.2.2 Lake Narracan

Lake Narracan is popular for water skiing, boating and other recreational activities. Southern Rural Water manages the water releases from Blue Rock Reservoir to Lake Narracan for the local power stations. Occasionally they release water from Blue Rock Reservoir to Lake Narracan as part of an ongoing agreement with the Latrobe Council and Ski Club. The Latrobe City Council is responsible for the waterway, recreation and surrounding land.

The lake is an essential part of providing water for cooling the power stations generators in the Latrobe Valley. The lake was first constructed in between 1959 and 1961 and has the capacity of 8,600 megalitres (ML).

In 2002 major works were undertaken to bring the lake dam wall up to modern day standards, including anchoring the dam wall to the foundation bedrock and strengthening the four gates.

10.2.3 Blue Rock Reservoir

Blue Rock Reservoir began construction in 1979 and was complete in 1984. It has a capacity of 208,000 megalitres (ML). Following construction of the reservoir, the safe yield of the Latrobe River system upstream of the Morwell River Junction was increased to 325,000 megalitres per annum. The embankment of the reservoir dam is constructed from earth and rock fill material.

The Latrobe Valley electricity generating companies are able to extract 150,000 megalitres per annum of yield from Blue Rock Reservoir, for use as cooling water in existing power stations and for future power generation expansion. Gippsland Water, which is the urban water corporation for the Latrobe Valley, is able to draw 14,000 megalitres annually from Blue Rock Reservoir to supplement Moondarra Reservoir. Gippsland Water also pumps water from the Tanjil River to the township of Moe.

Water drawn from the reservoir is available to maintain minimum flows in the Latrobe River during periods of naturally low flows.

10.2.4 Moondarra Reservoir

The Moondarra Reservoir supplies industry and towns in and around the Latrobe Valley. Blue Rock Reservoir is used to supplement Moondarra Reservoir in dry periods, to supply Moe during periods when water availability in Narracan Creek is insufficient or water quality is untreatable, and as the sole source of supply for Willow Grove.

The usable storage capacity of Moondarra Reservoir is 29,853 ML The relatively small capacity of Moondarra Reservoir, compared to other storages around the state, means that this system depends on reliable inflows. In drier years, water pumped from Gippsland Water's share of Blue Rock Reservoir is used to supplement natural inflow to Moondarra Reservoir.

10.2.4.1 Defined Metrics and Thresholds

The Moondarra and Blue Rock Reservoirs are both capable of providing a potable water supply (filtered and disinfected). Therefore, the appropriate metrics for these systems are the SEPP (Waters) and NHMRC[16] WQOs (for drinking water quality).

As the Moondarra Reservoir (which feeds storage at Buckley's Hill) and the Blue Rock Reservoir are impounded headwaters of the Tyers River and Tanjil River respectively, the SEPP WQOs for Segment B of Schedule F5 can be used as a threshold to measure water quality changes that could affect these water storages. Similarly, as these storages have been used for drinking water purposes, the NHMRC Australian Drinking Water Guidelines are strictly applicable to any water stored in them.

Water quality in the reservoirs is of course affected by a myriad of factors, most of which will be unrelated to the project, have water quality changes associated with additional water take is likely to be the effect pathway. A comparison of water quality in all the upstream reaches and reservoir, against SEPP and NHMRC WQOs respectively, is therefore identified as the most useful threshold (refer to Appendices F.5 and F.6).

10.2.4.2 Current and Projected Status

The Blue Rock, Moondarra, Narracan and Buckley's Hill water storages have recorded wide range of storage levels over the years of use and targets for storage supply and thresholds are set by the managers, in water management plans, including urban water strategies.

Due to land use and public access restrictions in the catchments surrounding the upland reservoirs, water quality is maintained at near drinking water standard, however algal blooms experienced during periods of drought and bushfires within catchment areas present the greatest threat to maintaining water quality. There is strong recreational usage of Blue Rock Reservoir and Lake Narracan. Recreational fishing and boating are popular on these water bodies too.

Climate change poses a significant challenge to the future management of all reservoirs and these are not immune. The combination of increased temperature, reduced rainfall, increased incidence of drought, floods, and bushfires, could result in water quality and water availability changes.

With the effects of climate change, combined with changing demand patterns and the future inclusion of cultural values of water it is likely that the metrics and thresholds for these receptors will change with time. It is recommended that these above metrics and thresholds be used as a starting point and specific targets in keeping with contemporary values are developed at the time of any future assessment.

10.2.5 Rehabilitated Mine Void Waterbodies

After the cessation of mining and rehabilitation of Loy Yang, Yallourn and Hazelwood, three void waterbodies may remain. The Definition of Regional Rehabilitation Scenarios (Jacobs, 2019b) provides the preliminary details of water level, connectivity, access/use and fill timings for each void waterbody. Ultimately the configuration of each void waterbody and its intended use (i.e. recreational, fishing, etc.) will define the water quality metrics and thresholds which need to be maintained.

10.2.5.1 Defined Metrics and Thresholds

It is anticipated that the rehabilitated mine void waterbodies will have metrics and thresholds defined similar to the quantitative assessment completed for Thomson Dam and Buckley's Hill above. Hence, the initial metric for

[16] National Health and Medical Research Council (2011) The Australian Drinking Water Guidelines. National Water Quality Management System Paper 6. Commonwealth of Australia, Canberra, October 2017.

the rehabilitated mine void waterbodies should be primarily related to a decrease in void waterbody water quality resulting in an increased salinity and a change of the desired SEPP segment. It is expected that further metrics and thresholds will be defined once analysis has been completed (refer also Appendix F.7).

10.2.5.2 Current and Projected Status

The current status of the rehabilitated mine void waterbodies cannot be determined as they are yet to be established. The projected status of the void waterbodies will be modelled from a water quality and quantity perspective as part of the mine operators development of Declared Mine Rehabilitation Plans,

10.3 Drains

10.3.1 Morwell Main Drain

10.3.1.1 Receptor Description

The Morwell Main Drain (Morwell River Drain) is a 4.9 km open channel which runs for a substantial distance alongside the Princes Freeway, located southwest of the Morwell township, and was originally constructed in 1949 by the State Electricity Commission of Victoria as a component of the Hazelwood open cut mine. The Morwell main drain is primarily responsible for conveying stormwater westwards between Princes Freeway and the Hazelwood mine and discharging into the Morwell River.

Upon privatisation of the Hazelwood mine in 1994, the Morwell Main Drain has remained a private drain, however approximately 70–90% of the water that now runs through it enters from connected drains owned and managed by the Latrobe City Council and VicRoads.

10.3.1.2 Defined Metrics and Thresholds

Diversion of the Morwell River and use of the drain as a receptacle for surface water run-off, directed from urban and industrial areas, ultimately discharges via the Morwell Main Drain into the Latrobe River immediately north of the Yallourn mine operations. Therefore, the metrics and thresholds for determination of effects on the Morwell River, as detailed in Section 7.1.3, are deemed most appropriate and no further metrics or thresholds will be defined (refer also Appendix F.8).

10.3.1.3 Current Status

The Morwell main drain was repaired and upgraded in 2011 after heavy rainfall created a sinkhole in the areas surrounding the drain.

10.4 Water Rights and Entitlement Holders

10.4.1 Water Entitlement Holders (as listed in the Victorian Water Register)

10.4.1.1 Receptor Description

Water entitlements consider surface water and groundwater resources for both consumptive and environmental purposes at all phases of the water cycle.

The Victorian Minister for Water issues entitlements under the *Water Act 1989*, which includes:

- Bulk entitlements
- Environmental entitlements
- Water shares and,
- Water licences.

Furthermore, the *Water Act 1989* allows individuals to take water for domestic and stock purposes from a range of surface water and groundwater sources without a licence. These domestic and stock rights are defined under

section 8(1) and section 8(4)(c) of the *Water Act 1989* and are not formally issued. They include farm dams for domestic and stock purposes.

10.4.1.2 Defined Metrics and Thresholds

Abstraction and use of surface waters and groundwater across the Latrobe Valley is for the most part regulated by Southern Rural Water. Therefore, the metrics and thresholds for determination of effects on the surface water and groundwater systems, as detailed respectively in Section 7.2 and Section 10.1, are deemed appropriate and no further metrics or thresholds will be defined (refer also Appendix F). It may be that with further assessment of the impacts of mine void waterbodies that material effects are identified that would require assessment. In this case, the status of the receptor group may change, and different quantitative thresholds may need to be defined. At the time of preparing this report, water deliveries to possible mine void waterbodies were planned to be provided in accordance with the water entitlement framework. As the framework includes dealing with possible changes in entitlements and rights of others, then there it is considered that void waterbody development can be managed within the current entitlement framework and additional thresholds are not required. Thus, the required test for a new user or entitlement would apply. These issues are complex and subject to licencing and Ministerial directions.

In keeping with the water framework requirements mentioned here, an appropriate metric for entitlement is: The volume and time of water access. The relevant metric for this is: no chance to current conditions, access or security as a result of water use for mine void water bodies.

10.4.1.3 Current and Projected Status

The current and projected status of water entitlement holders are described for the Morwell and Latrobe Rivers respectively in Section 7.2.1, 7.2.2, and Lake Wellington and Lake Victoria in Section 7.2.7.

10.5 Environmental Water Reserve

10.5.1 Flows in rivers that are for environmental purposes

10.5.1.1 Receptor Description

Above cap flows comprises the majority of the Environmental Water Reserve and is the water left over after limits on diversions have been reached and unregulated flows which cannot be kept in storage.[17] It is set aside by law to protect environmental values and is needed to improve the condition of river estuary and fringing wetlands in the Gippsland Lake System. For the Latrobe River, the system is fully capped. This receptor includes passing flows, environmental entitlements and above cap flows.

10.5.1.2 Defined Metrics and Thresholds

Environmental water flow patterns provide a suitable metric for assessment of how well the current and future flow scenarios comply with flow recommendations. Even where current flows do not meet recommended flows, a comparison of the differences in compliance are still an appropriate assessment approach. The combination of water quality and flow thresholds provides a meaningful assessment of effects on the river and the ecological values it supports.

The appropriate thresholds for the Latrobe River are therefore the SEPP and ANZECC WQOs from Schedule F5, Segment E, and the environmental flow recommendations for the Latrobe River as set out in the Latrobe River flow study. The relevant Latrobe River reaches, and the relevant compliance points are:

- Reach 3 – Latrobe River (Lake Narracan to Scarnes Bridge; Gauge Number 226401)
- Reach 4 – Latrobe River (Scarnes Bridge to Rosedale; Gauge Number 226228)
- Reach 5 – Latrobe River (Rosedale to Thomson River; Gauge Number 226227)
- Reach 6 – Latrobe River (Thomson River to Lake Wellington; Gauge Number 226802).
- Reach 8 – Tanjil River
- Reach 9 – Tyers River
- Reach 10 – Morwell River
- Reach 11 – Traralgon Creek

The appropriate metrics for water quality (SEPP/ANZECC) and flow recommendations from the Latrobe River flow study) do not vary with the mine/inter-mine/catchment scales set out for considerations in this project. However, the specific thresholds vary between river reaches, as flow recommendations and in some cases WQOs are established for the specific environmental objectives of each river reach and these vary. In many cases, the broad environmental objectives are consistent between reaches, but some variation exists due to the characteristics of the river in each reach and the associated environmental values. The flow recommendations for relevant reaches of the Latrobe River are shown in Table 5.4, Table 5.5 and Table 5.6.

10.5.1.3 Current and Projected Status

The current and projected status of above-cap flows are described for the Morwell, Latrobe Rivers respectively in Section 7.2.1, 7.2.2, and Lake Wellington and Lake Victoria in Section 7.2.7.

[17] Gippsland Region Sustainable Water Strategy, 2011.

11. Description and Metrics of Recognised Receptors – Qualitative Assessment

11.1 Aboriginal and Historical Cultural Heritage

Table 11.1 – Aboriginal and Heritage Receptors to be qualitatively assessed

Sub-Category	Receptor	Description and Metrics
Aboriginal cultural heritage	Tangible • Aboriginal Places are recorded in all three mine licence areas. Intangible • Aboriginal cultural significant attached to water places and form • Water flow and availability patterns that support specific social activities	**Tangible Values** The effects from rehabilitation scenarios on tangible values (aboriginal places within the mine licence areas) would only be affected by one mine void waterbody, and therefore managed by each mine's cultural heritage management plan. As such this receptor is not considered for qualitative assessment. Metrics defined for other aboriginal cultural heritage receptors are deemed applicable. **Intangible Values** The intangible Aboriginal cultural values of the Latrobe Valley have yet to be defined. It is also possible that species of non-threatened flora or fauna may be of cultural significance to GLaWAC. Further assessment will provide more clarity on the potential effect pathways associated with these water-dependent cultural values. Based on the legislative review, the key metric for all Aboriginal cultural heritage is avoidance of harm and protection of cultural values. Therefore, the intangible and tangible Aboriginal cultural values, considered for qualitative assessment within the Latrobe Valley, is to remain in their current condition because of the project.
Historical cultural heritage	• 152 individual historical heritage places of local significance • 14 heritage precincts • 6 Victorian Heritage Register places of state significance • 38 places of potential significance to be further investigated • The Great Morwell Brown Coal Mine • Yallourn North Open Cut • Yallourn Open Cut • Yallourn North Extension • Morwell Open Cut • Loy Yang Open Cut • La Mode Factory • Morwell Power Station • Australian Paper Mill (APM Staff House 2, APM Staff Housing group, APM Staff House 3, APM Staff House 1)	The proposed rehabilitation scenarios effect on historical heritage places/precincts as individual places/precincts would only be affected by one void waterbody, and therefore managed by each mine's cultural heritage management plan. As such these receptors are not considered for qualitative assessment.

Sub-Category	Receptor	Description and Metrics
	• Yinnar Butter Factory (former) • St Marks Anglican Church • Horseshoe Vale Homestead • Hoyles Residence (former) • Cairnbrook Farm Complex • Morwell National Park (original) • Eastern Railway Line • Traralgon Courthouse and Post Office • Gormandale Cooperative Creamery and Butter Building (former) • Burn Brae • Traralgon Park Homestead • Traralgon Hotel • Star Hotel (former) • Lilitree • Arva	

11.2 Environment

Table 11.2 – Environment Receptors – To be qualitatively assessed

Sub-Category	Receptors	Description and Metrics
Rivers, waterways and natural lakes[18]	• Rintoul's Creek (feed to Latrobe River)	Rintoul's Creek forms a confluence with the Latrobe River at Glengarry West, due east of the Tyers Rd bridge. **Potential water-related metrics** • Altered flow rates – decreased water availability/entitlement • Decrease in water quality – increased salinity resulting in change of SEPP segment
Terrestrial habitats	• Native vegetation in West Gippsland • Four threatened ecological communities in the Gippsland Basin • Gippsland Red Gum Community	Since non-Aboriginal settlement most of the native vegetation within the LVRRS study area has been cleared primarily for agriculture purposes. Within the Latrobe City shire, less than 23% native vegetation cover remains and less than 5% of plains grassy woodland. As a result, few BioSites receptors remain on the floor of the Latrobe Valley other than the local natural water ways For threatened flora and fauna species, the likelihood of pathway for threatened species is generally low. Several the threatened tree species are known to exist around the mining areas, and whilst some may be remnant it is
Listed species	• 10 plant species (e.g. matted flax lilly, Strzelecki Gum) • 88 listed bird species • 6 mammals • 3 reptiles (turtles)	

[18] 1. During stakeholder workshops the Macalister and Thomson Rivers were identified as potential receptors for mine rehabilitation if additional water would need to be released from dams on these rivers to offset the impacts on the Gippsland Lakes caused by increased diversions from the Latrobe River for mine rehabilitation. As these options were not proposed for mine rehabilitation, they were not considered further.

Sub-Category	Receptors	Description and Metrics
		more than likely these have been planted by mine operators. Other threatened species are less likely to occur given the more limited habitat on which they depend i.e. Marine-base flora/fauna. A summary of the ecological communities and species listed under the EPBC Act and FFG Act within the Gippsland Basin bioregion is presented below[19]. **Threatened ecological communities within the Gippsland Basin bioregion:** • Gippsland Red Gum, Grassy Woodland and Associated Native Grassland • Littoral Rainforest and Coastal Vine Thicket of Eastern Australia • Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains • White Yellow-Box, Box, Blakely's Red Gum, Grass Woodland and Derived Native Grassland **Threatened flora listed within the Gippsland Basin bioregion:** • Aniseed Boronia • Dwarf Kerrawang • Leafless Tongue Orchid • Leafy Greenhood • Maroon Leak-orchid • Matted Flax-Lilly • River Swamp Wallaby-grass • Strzelecki Gum • Swamp Everlasting • Swamp Greenhood **Threatened fauna listed within the Gippsland Basin bioregion:** • Australian Fur Seal • Blue Whale • Grey-headed flying fox • Humpback Whale • Long-footed Potaroo • Southern Right Whale • Green Turtle • Leatherback Turtle • Loggerhead Turtle **Potential water-related metrics**

[19] Doody TM, Pritchard J, Carey H, Galinec V and Walker K (2015) Description of the water-dependent asset register for the Gippsland Basin bioregion. Product 1.3 from the Gippsland Basin Bioregional Assessment. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia.

Sub-Category	Receptors	Description and Metrics
		As these listed species and terrestrial habitats are reliant on discharging waterways, the potential water-related metrics relate to: • Altered flow rates – reduction in environmental flows • Decrease in water quality – increased salinity resulting in change of SEPP segment
Water dependent habitats	• Groundwater Dependent Ecosystems	The Gippsland Lakes and Hinterland area is a Landscape Priority Area under the West Gippsland Regional Catchment Strategy. A total of 24 wetlands are recognised within the Gippsland Basin bioregion and are listed nationally under a directory of important wetlands in Australia. Notably, the Latrobe Valley drains to the Gippsland Lakes and Corner Inlet Ramsar wetlands. The area includes the lower reaches of the Latrobe River. A total of 30 groundwater dependent assets are noted within the Gippsland Basin bioregion, however no specific ground water dependent ecosystems are defined within the LVRRS study area. **Potential water-related metrics** As the water-dependent wetlands are primarily fed by discharge via the Latrobe River, the potential water-related metrics relate to: • Altered flow rates – reduction in environmental flows (refer Appendix C.8) • Decrease in water quality – increased salinity resulting in change of SEPP segment
Wetlands	• 24 water dependent wetlands in the Gippsland Basin (excluding Lake Victoria and Lake Wellington)	

11.3 Infrastructure

Table 11.3 – Infrastructure Receptors – To be qualitatively assessed

Sub-Category	Receptors	Description
Airports	• Latrobe Regional Airport	Except for bridges on roads in the inter-mine area, no clear pathway or material effect has been identified for the infrastructure receptor sub-categories described below, and therefore water-related metrics will not be defined. **Bridges within the inter-mine area** Several road bridges traverse creek and river crossings at an inter-mine scale across the LVRRS study area. These bridges are primarily maintained by local council; however, several may fall within the lease of mine-operators. The engineered design clearance of each bridge is based on the maximum modelled flood level. During rehabilitation scenarios, whereby additional flow is directed to waterways during the void waterbody filling process, water levels in these water ways is expected to be higher than historic observations. **Potential water-related metrics** As the effect on bridges is dependent on the waterway which it traverses, water-related metrics relate to altered flow rates (increased flood frequency) and water level heights in these receiving creeks and rivers.
Alternate energy sources	• Future biofuels facility for the processing of agricultural or timber residuals located in the mine scale or inter-mine scale • Future waste to energy facility located in the mine scale or inter-mine scale	
Bridges	• All bridges on roads in the inter-mine area. This excludes culverts.	
Coal fired power generation	• Yallourn Power Station • Loy Yang Power Station	
Industry and manufacturing	• Future logistics and manufacturing (undertaken in existing industrial use zones in Traralgon and Morwell)	
Telecommunications	• Telecommunications Infrastructure (Base Stations) across the Latrobe basin • Network cables	

11.4 Land

Table 11.4 – Land Receptors – To be qualitatively assessed

Sub-Category	Receptors	Description
Coal reserve	• Driffield East, Churchill, Churchill North, Loy Yang East, Coalville (black coal), Corridor, Driffield, Maryvale East, Fernbank, Flynn, Gormandale, Latrobe River, Morwell Township, Rosedale, Tyres, Traralgon Creek, Yinnar • Defined by the Strategic Coal Reserve and associated planning overlay(s)	Despite the current and propose cessation of mining activities at Hazelwood and Loy Yang/Yallourn respectively, several coal reserves will remain in-situ and are not precluded from future development. The discontinuation of groundwater dewatering, for mining purposes across the LVRRS study area, will result in recovery (to some extent) of the hydrogeological environment. Future development will need to deal with water access and availability in line with current regulation and on this basis water-related metrics will not be defined.
Protected public land	• Tyers Park • Woorabinda Education Area • Traralgon South Flora and Fauna Reserve • Coalville G219 Bushland Reserve	Land receptors categorised as Protected Public Land and Townships/Settlements are present across the LVRRS study area at a catchment-scale, and due to these significant distances from rehabilitated mine void

	• Sayers Trig Bushland Reserve • Jeeraland North Education Area • Gormandale Flora Reserve • Narracan State Forest • Moondarra State Park • National Parks in West Gippsland Catchment • Current Tenements – Extractives • Current Tenements – Retention Licences • Current Tenements – Mining Licences	waterbodies, these receptors are designated for qualitative effect assessment. Water-related effects from mine void waterbodies in areas of protected public land and the townships of Traralgon, Morwell, Yallourn North, Moe, Churchill and Newborough are unlikely. Any water-related effects would be because of changes in the local hydrological system, experienced during void waterbody filling (i.e. higher water levels in adjacent waterways, reduced drainage capacity of fields). **Potential water-related metrics** As the rivers and creeks adjacent these land receptors provide the pathway for water-related effects, the metrics for these receptors should be applied at the closest reach, defined by: • Altered flow rates – increased flood frequency • Decrease in water quality – increased salinity
Townships/ settlements	• Traralgon, Morwell, Yallourn North, Moe, Churchill, Newborough inclusive of zones: o Central Business District/Activity Centre o Existing urban areas, future urban use o Existing industrial areas, future industrial, future bulky goods o Proposed public Open Space, Existing Open Space, Amenity Lifestyle Precinct	
Recreation	• 92 recreation areas related to water in Latrobe Basin • Fishing and hunting • Future fishing	Recreation land receptors are materially linked to the LVRRS rehabilitation due to the likelihood that water is drawn from the Latrobe River and adjacent waterways for direct application in these areas. However, as the pathway for these receptors to be affected by water-related effects is indirect, they have been designated for qualitative effect assessment. The water-related effects on these receptors is likely to be because of an inability/reduction in the ability to utilise drawn water from adjacent water ways, due to redirected flows to the mine void waterbodies during filling. This reduction in flow may have further implications on a decrease in water quality. **Potential water-related metrics** Whilst the rivers and creeks drawn on by these land receptors are quantitatively assessed in Section 7, the metrics for these receptors should be applied at the closest reach to the surface water abstraction point, defined by: • Altered flow rates – decreased water availability/entitlement • Decrease in water quality – increased salinity resulting in change of SEPP segment

Intensive agriculture	• Future intensive agricultural activities (such as broiler farms or piggeries) • Intensive Agriculture • Potential future intensive agriculture such as non-soil-based vegetable herb growing (in greenhouses) located in close proximity mine void waterbodies • Potential future processing of vegetables located in close proximity to mine void waterbodies	The following land receptors are present across the LVRRS study area at both a catchment and inter-mine scale, however due to their locational uncertainty, they are designated for qualitative effect assessment: • Intensive agriculture (as defined) • Cropping • Grazing • Forestry plantations • Multiple Public Use • Primary production and support infrastructure • Specialist Facilities • Waste management This grouping of receptors is primarily dependent on rainfall variability and intensity. As a pathway for water-related effect is unlikely, metrics will not be defined for these receptors except for Cropping, Grazing and Forestry plantations. **Potential water-related metrics** As groundwater levels rise and return to a post-mining static equilibrium, previously unsaturated salts in the unsaturated zone may be remobilized and increase the salinity of local groundwater. As such, the following metrics for Cropping, Grazing and Forestry plantation receptors should be applied to local groundwater monitoring bores near each receptor: • Altered groundwater level – groundwater rise • Decrease in water quality – increased salinity
Cropping	• Cropping	
Grazing	• Grazing	
Forestry plantations	• Timber production and plantations	
Multiple public use	• Future tourism (arts and culture) and recreation (e.g. bikes paths) at Yallourn • Future tourism (arts and culture) and recreation (bike paths) at Hazelwood • Future tourism (arts and culture) and recreation (bike paths) at Loy Yang	
Primary production and support infrastructure	• Future non-soil-based vegetable herb growing (in greenhouses) located near proposed void waterbody (lightweight structure) • Future processing of vegetables in the mine scale or inter-mine scale	
Specialist facilities	• Potential future education and training facilities (relating to land rehabilitation, mining, environmental science and clean energy technologies) located near the potential mine void waterbodies	
Waste management	• Future waste process • Future organics recycling and composting facility located in the mine scale or inter-mine scale • Landfills	

11.5 Water

Table 11.5 – Water Receptors to be qualitatively assessed

Sub-Category	Receptors	Description and Metrics
Dams, artificial lakes and reservoirs	• Loy Yang High Water Level Storage • Hazelwood Pondage • Yallourn North Extension Open Cut pit lake	The artificial lakes, dams and reservoirs listed as receptors in this sub-category have directly or indirectly provided a water supply to the Latrobe Valley power stations or supported operations at some point in time. The Hazelwood Pondage and Loy Yang High Water Level Storage are privately owned. The receptors provide an opportunity for recreational fishing. **Hazelwood Pondage and Loy Yang High Water Level Storage** These receptors are located at a mine scale and unlikely to be specifically affect by cumulative rehabilitation of the mine void waterbodies. The management of these receptors will be specific to each mine operator, and therefore metrics will not be defined. **Potential water-related metrics** A qualitative assessment in Section 7, details the metrics and thresholds for rivers on which these artificial water storages are located. Hence, the following metrics for these receptors should be applied at each water body: • Decrease in water quality – increased salinity resulting in change of SEPP segment
Wastewater infrastructure	• Moe and Morwell Waste Water Treatment Plant • Gippsland Water Factory – water treatment	No clear pathway or material effect has been identified for the wastewater infrastructure receptors, and therefore water-related metrics will not be defined. The geotechnical metrics relating to wastewater infrastructure receptors is discussed in the LVRRS geotechnical-related metrics and thresholds report (Jacobs, 2020).

Sub-Category	Receptors	Description and Metrics
Water delivery infrastructure	• Irrigation Infrastructure – Publicly and Privately Owned • Gippsland Water Factory – recycled water production • Groundwater monitoring bore network • Potable Infrastructure (pipes and tanks etc.) – Public and Privately owned • Town water bores	Except for the existing groundwater monitoring bore network and town water bores, no clear pathway or material effect has been identified for the water delivery infrastructure receptors, and therefore water-related metrics will not be defined. The geotechnical metrics and thresholds relating to water delivery infrastructure receptors is discussed in Jacobs (2020b). **Groundwater monitoring bores and Town water bores** The effects on monitoring and production bores across the Latrobe Valley is discussed in the quantitative assessment of each aquifer, presented in Section 10.1. The metrics and applicable monitoring points are defined therein.
Drains	• Drains associated with railway line and embankment	No clear pathway or material effect has been identified for drains other than the Morwell Main Drain (discussed further in Section 10.3), and therefore water-related metrics will not be defined. The geotechnical metrics and thresholds relating to drains is discussed in Jacobs (2020b).
Fisheries	• Gippsland Lakes Fishery	Effect pathway relates to changes to water quality and flows sediment transport. As the river and creeks feed into the fisheries, the water water-related metrics are shared, including: • Altered flow rates – decreased water availability/entitlement • Decrease in water quality – increased salinity resulting in change of SEPP segment The geotechnical metrics and thresholds relating Fisheries is discussed in Jacobs (2020b).

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Appendix A. Workshop Notes

A.1 LVRRS Coordination and Oversight Workshop

The LVRRS Coordination and Oversight Workshop was held on the 22nd of August 2017 at the Century Inn Traralgon.

A.1.1 Attendees

List of Attendees is given in the below table,

Table A.1: List of Attendees at the Coordination and Oversight Workshop (Latrobe Valley Mine Rehabilitation Advisory Committee (LVMRAC))

Attendees		
• Anthony Feigl - DEDJTR • Mark Pratt - DEDJTR • Peter Carmichael – DEDJTR • Brett Milsom – DEDJTR • Brett Davis - DELWP • Ann Kirwan – DELWP	• Andrew Tingay – Jacobs • Greg Hoxley – Jacobs • Carolyn Cameron – Jacobs • Ferne Burchard – Jacobs • Sharon Gibson – Latrobe City Councillor • Michael Timpano – Latrobe Valley Authority	• Rae Mackay - LVMRAC • Roland Davies - LVMRAC • Grace Mitchell - LVMRAC • James Faithful - LVMRAC • Jane Burton - LVMRAC • Nicole Griffin - LVMRAC • Phil Stone - LVMRAC • Susan Lloyd - LVMRAC • Lance Wallace - LVMRAC

A.1.2 Key Outcomes

- Discussed and updated receptor inventory (water, environment and infrastructure & land)
- Valuation Criteria
  - In the final reports have some more examples of the valuation criteria under each heading, and criteria should be all at the same definition level
  - Look at grouping some of the list of valuation criteria
- Confirmed the addition of publicly listed documents as source of valuation, including:
  - Regional agribusiness plans
  - Work plans or commitments of mines re conservation areas
  - SEPP for Gippsland Lakes
  - Victoria has recently released a paper about increased timber production
- Discussed how LVRSS will assess effect on receptors.
- Discussed and confirmed whether a quantitative or qualitative assessment should be used for each valued receptor, including:
  - coal reserves – LVRRS will qualitatively assess the biophysical effects on coal reserves
  - aquifers – are valued, materially linked to scenario and effects to aquifers to be quantified
  - roads – effects assessment will need to consider likelihood and extent of regional subsidence, likelihood of differential movement and flooding consequence

- townships
  - Urban area between Yallourn and Hazelwood – clear ground movement material link
  - Beyond – material link is unclear (e.g. ground movement caused by a tremor caused by filling of mine void waterbody).
- Productive Land uses
  - Material link relates to water rights and extraction limits
  - Material link needs to be considered in the context of water entitlement framework
  - If effect needs to be assessed quantitatively, metrics will be extraction amount of water
- Discussed Scenario Design

A.2 LVRRS Water and Environmental Receptor Custodian Workshop

The LVRRS Water and Environmental Receptor Custodian Workshop was held on the 23rd of August 2017 at the Traralgon Business Centre.

A.2.1 Attendees

List of Attendees is given in the below table

Table A.2: List of Attendees at the Water and Environmental Receptor Custodian Workshop

Attendees		
• Anthony Feigl - DEDJTR • Mark Pratt - DEDJTR • Peter Carmichael – DEDJTR • Brett Davis – DELWP • Tolly Das - DELWP • Natasha Sertori – DELWP • Ann Kirwan – DELWP • Andrew Rhodes – DELWP	• Andrew Tingay – Jacobs • Greg Hoxley – Jacobs • David Kelly – Jacobs • Carolyn Cameron – Jacobs • Ferne Burchard – Jacobs	• Terry Flynn – Southern Rural Water • David Stork – West Gippsland CMA • Adrian Clements – West Gippsland CMA • Nazrul Islam – Gippsland Water • Paul Leahy – EPA • Patrick Ndere – EPA

A.2.2 Key Outcomes

- Discussed and updated receptor inventory (water, environment and land)
- Confirmed the addition of publicly listed documents as source of valuation, including:
  - RAMSAR Management Plan
  - West Gippsland Waterway Strategy
  - Water for Victoria
  - Urban Water Strategy for Gippsland Water
  - Planning and Environment 1987
  - GLaWAC Regional Water Management Plan
- Review the following documents as source of metrics:
  - Water Science Study

- SEPP's:
- Cultural value for water - SEPP for Gippsland Lakes update
- West Gippsland Waterway Strategy:
- Waterways in the Latrobe Valley are protected allowing people to swim in them. The policy goal to achieve river health could already be near edge which is important for metrics and thresholds

- Discussed Receptor Valuation, including the Latrobe River, Hazelwood Pondage, Traralgon Creek
- Discussed whether a quantitative or qualitative assessment should be used for each valued receptor

1) Water
   - Sub-category – Aquifers
     - Clear linkage – Effect to be quantitatively assessed
   - Sub-category – Dams and Reservoirs:
     - Materiality test relates to upstream supply pathway. Highly unlikely to be changes to water quality in Blue Rock and Lake Narracan because of potentially less water
     - Receptor - Thomson Dam part of Latrobe River System leading to Gippsland Lakes. Thomson Dam would only be materially linked if there was an extreme regional rehabilitation scenario that required mine void waterbodies to take vastly more water than available under the system cap. *Effect to be qualitatively assessed* unless there is scenario that envisages water take from upstream that is outside of the allocation framework
     - Receptor - Lake Narracan – *Effect to be qualitatively assessed* unless there is scenario that envisages water take from upstream that is outside of the allocation framework
       - Power station operators not currently using total entitlement
       - Pathway is upstream and may be materially linked from a water supply perspective if a scenario envisages water take outside of existing allocation framework. Pathway is not hydrologically linked
       - Social and economic assessment – Lake Narracan should be qualitatively assessed if a scenario envisages using full allocation, resulting in water levels falling and this may affect real estate values
       - Ground movement unlikely
     - Receptor - Blue Rock Reservoir – *Effect to be qualitatively assessed* unless there is scenario that envisages water take from upstream that is outside of the allocation framework. Further away from Lake Narracan and so pathway is unlikely.
     - Receptor - Moondarra Reservoir – *Effect to be qualitatively assessed* unless there is a scenario that envisages Gippsland Water needing to significantly increase water take because of the mine void waterbodies
     - Receptor - Hazelwood Pondage – *Effect to be qualitatively assessed* unless there is a scenario that envisages the water from Hazelwood Pondage being needed to fill the mine void waterbodies.
     - Receptor - Loy Yang High Water Level Storage – *Effect to be qualitatively assessed* for the Regional Water Studies and may need to be quantitatively assessed by Regional Geotechnical Studies. From a land-use planning perspective the asset should be assessed as potential to become a stranded asset. While Loy Yang is executing their Mine Closure Plan water in the storage will be required for firefighting purposes

- Receptor - Water Rights Holders – *Effect to be qualitatively assessed* unless there is a scenario that envisages going outside of existing water allocation. Effect on Water Rights Holders could be included in social and economic land use assessment

2) Environment

- Sub-categories – Wetlands, Listed Species and Habitats (Aquatic ecosystems etc.):
  - Receptor - Gippsland Lakes – *Effect to be quantitatively assessed.* Metrics could include:
    - Social, economic and biophysical - Fisheries
    - Gippsland Dolphin use SEPP for metrics
    - Cultural watering
    - Quantitative assessment must factor in climate change from a water availability and consider (qualitatively) other indirect effects such as coastal incursion
- Sub-category – Rivers and Waterways:
  - Receptor - Traralgon Creek – Effect to be quantitatively assessed. Creek itself is more a pathway rather than receptor. Ephemeral if not for Loy Yang
  - Metrics for waterways are likely to focus on Geomorphic health
- Sub-categories – Listed Species and Habitats (Land, Water/Terrestrial, Aquatic Ecosystems)
  - There are different aspects of habitat and must focus on species and habitats with a material linkage to water. These are riparian. Effect assessment should consider how water changes to ecosystems with water may alter invasive species
  - Receptor - Mammals - Effect to be qualitatively assessed. No material linkage.
  - Receptor - Growling Grass Frog - *Effect to be quantitatively assessed subject to appropriate metrics* (e.g. geomorphic health). Material linkage to water availability and potentially water quality
  - Receptor - Turtles - *Effect to be quantitatively assessed subject to appropriate metrics (*e.g. geomorphic health). Material linkage to water availability and potentially water quality

3) Land

- Sub-category - Recreational areas
  - Receptor - fishing and hunting – *Effect to be qualitatively assessed.* Will be a key focus of the social and economic assessment for land-use
- Sub-Category - Dairying – *Effect to be qualitatively assessed.* No clear material linkage.
- Sub-Category Intensive agriculture – Further research and analysis required to determine if effect should be qualitatively or quantitatively assessed. Material link depends on changes in groundwater and surface water quality. If water becomes more saline may affect land use. Scenarios may also have a beneficial effect due to long term groundwater recovery
- Sub-category - Irrigation infrastructure. Effect to be quantitatively assessed for Regional Geotechnical Study and *qualitatively assessed from Regional Water Study from the perspective* of potential operational effect if key infrastructure becomes a water source in a scenario (e.g. Gippsland Water Factory)
  - Receptor - Buckley's Hill – *Effect to be quantitatively assessed for ground movement.* Dam wall is moving, and consequence may be that it needs to relocate

- Discussed Scenario Design
- Discussed Data framework

A.3 LVRRS Infrastructure Receptor Custodian Workshop

The LVRRS Infrastructure Receptor Custodian Workshop was held on the 30th of August 2017 at Traralgon

A.3.1 Attendees

List of Attendees is given in the below table

Table A.3: List of Attendees at the Infrastructure Receptor Custodian Workshop

Attendees		
• Anthony Feigl - DEDJTR • Mark Pratt - DEDJTR • Peter Carmichael – DEDJTR • Brett Davis - DELWP • Ann Kirwan – DELWP	• Andrew Tingay – Jacobs • Greg Hoxley – Jacobs • David Kelly – Jacobs • Meredith Goss – Jacobs • Ferne Burchard – Jacob	• Michael Morgan – VicTrack • Phil Stone – Latrobe City Council • Denis Andrews – AusNet • Representative TBC – V/Line •

A.3.2 Key Outcomes

- Discussed basis of value for each receptor
  - Regional network development plan for rail (Transport Integration Act)
- Discussed whether a quantitative or qualitative assessment should be used for each valued receptor

1) Rail
   - Slow movement or upheaval would have minimal effect and therefore low risk for railway. However, there are unknowns in terms of friction piles. Need to consider bore holes
   - VLine have completed boreholes in areas of mines to assess issues around potential differential movement and other geotechnical risks.
   - Concern about corrosion and shallow ground water
   - Concern about bridge foundations and especially piles
   - Consider induced seismicity
2) Gas
   - From a pipeline perspective, require further details such as changing ground conditions. Main issue is subsidence
   - Corrosion a concern from changes in groundwater levels / chemistry
   - Note that Australian Standard for pipeline risk assessment is the key threshold and metric document. Need to include this in assessments.

- Discussed Data framework

A.4 LVRRS Land and Heritage Receptor Custodian Workshop

The LVRRS Land and Heritage Receptor Custodian Workshop was held on the 31st of August 2017 at Traralgon

A.4.1 Attendees

List of Attendees is given in the below table

Table A.4: List of Attendees at the Land and Heritage Receptor Custodian Workshop

Attendees		
• Anthony Feigl - DEDJTR • Mark Pratt - DEDJTR • Peter Carmichael – DEDJTR • Brett Davis - DELWP • Ann Kirwan – DELWP	• Andrew Tingay – Jacobs • Greg Hoxley – Jacobs • David Kelly – Jacobs • Meredith Goss – Jacobs • Ferne Burchard – Jacobs	• Jody Riordon – Latrobe City Council • Damien Kennedy – VPA • Kate Morton – Aboriginal Victoria • Andy Gillham – Parks Victoria • Alan Freitag – DELWP • Stephen Chapple – DELWP

A.4.2 Key Outcomes

- Discussed and updated receptor inventory (heritage, environment, infrastructure and land)
- Confirmed the addition of publicly listed documents as source of valuation, including:
  - Wellington Planning Scheme
  - Biodiversity 2037 Strategy
  - Victorian Coal Statement
  - Latrobe City Study Heritage Study
  - Morwell West Development Plan
  - Parks and reserves strategy (Latrobe City and Parks Victoria)
- Discussed and confirmed whether a quantitative or qualitative assessment should be used for each valued land receptor
  - Sub-category – Towns
    - Assessment to look at differential movement. Clear linkage – *Effect to be quantitatively assessed*
  - Sub-category – Aboriginal
    - Materiality test also needs to look at native title rights.
  - Sub-category – Protected Public Land
    - Quantitatively assess downstream effects on RAMSAR sites.
    - For State Forests effect is unlikely. *Effect to be qualitatively assessed*
  - Sub-category – Future land uses at intra-mine scale
    - *Effect to be qualitatively assessed*. Future land uses at an intra-mine scale are likely to be removed from receptor list and dealt with through regional rehabilitation scenarios
  - Sub-category – Historic
    - Assessment conducted if receptors are potentially materially affected. Should have a distance limit. *Effect to be qualitatively assessed*
- Discussed Scenario Design
- Discussed Data framework

A.5 LVRRS Mining Operators Workshop

The LVRRS Mining Operators Workshop was held on the 1st of September 2017 at Traralgon.

A.5.1 Attendees

List of Attendees is given in the below table.

Table A.5: List of Attendees at the Mining Operators Workshop

Attendees		
• Anthony Feigl - DEDJTR • Mark Pratt - DEDJTR • Peter Carmichael – DEDJTR • Brett Davis - DELWP • Ann Kirwan – DELWP	• Andrew Tingay – Jacobs • Greg Hoxley – Jacobs • David Kelly – Jacobs • Carolyn Cameron – Jacobs • Meredith Goss – Jacobs • Ferne Burchard – Jacobs	• Paul Barrand – AGL • Lance Wallace – Energy Australia • James Faithful – Engie

A.5.2 Key Outcomes

- Discussed and updated receptors
- Effects on operating coal mines to be *quantitatively assessed*
- Discussed Scenario Design
- Discussed Data framework

A.6 LVRRS VicRoads Meeting Notes

The LVRRS VicRoads Meeting was held on the 1st of September 2017 at the Traralgon Government Offices.

A.6.1 Attendees

List of Attendees is given in the below table.

Table A.6: List of Attendees at the VicRoads Meeting

Attendees		
• Anthony Feigl – DEDJTR • Mark Pratt – DEDJTR • Peter Carmichael – DEDJTR	• Greg Hoxley – Jacobs • Andrew Tingay – Jacobs • Meredith Goss – Jacobs • Ferne Burchard – Jacobs	• Michael Mattingley – VicRoads

A.6.2 Key Outcomes

- Discussed and updated receptors
- Discussed and confirmed whether a quantitative or qualitative assessment should be used for each valued land receptor
    - Roads

- Progressive/gradual land level changes not a significant risk to roads, risk is significant differential movements or block failures. In terms of groundwater rebound, will only be an issue if differential movements occur over short distances. Nothing to suggest significant differential movements to date.
- Suggestion to consider potential effects on all arterial roads, in particular:
  - Proposed Traralgon Bypass
  - Highland Hwy
  - Traralgon Creek Rd

- Bridges
  - Look into how bridges will respond to rebound. Most bridges in Morwell are designed to move. VicRoads soon to upgrade 6 bridges and some require changes to foundations e.g. to pile foundation

- Discussed Data framework

A.7 LVRRS Latrobe City Council Meeting Notes

The LVRRS Latrobe City Council Meeting was held on the 1st of September 2017 at the Morwell Council Offices.

A.7.1 Attendees

List of Attendees is given in the below table.

Table A.7: List of Attendees at the Latrobe City Council Meeting

Attendees		
• Anthony Feigl – DEDJTR • Mark Pratt – DEDJTR • Peter Carmichael – DEDJTR	• Greg Hoxley – Jacobs • Andrew Tingay – Jacobs • Meredith Goss – Jacobs • Ferne Burchard – Jacobs	• Phil Stone – Latrobe City Council • Gail Gatt – Latrobe City Council

A.7.2 Key Outcomes

- Discussed and updated receptors
  - Hazelwood Pondage (what its future may be in any form)
  - Traralgon Creek
  - Traralgon Bypass
  - Land around Latrobe Rd and south of Morwell
  - Brodribb Road
  - Morwell Main Drain

Appendix B. Quantitative Thresholds (Aboriginal and non-Aboriginal Cultural Heritage Receptors)

B.1 Tangible Values

The key metric for all Aboriginal cultural heritage is avoidance of harm and protection of cultural values. Therefore, the thresholds for tangible Aboriginal cultural values within the Latrobe Valley is that they remain in their current condition during implementation of the rehabilitation strategy and thereafter.

B.2 Intangible Values

The key metric for all Aboriginal cultural heritage is avoidance of harm and protection of cultural values. Therefore, the thresholds for intangible Aboriginal cultural values within the Latrobe Valley is that they remain in their current condition during implementation of the rehabilitation strategy and thereafter.

Appendix C. Quantitative Thresholds (Environment Receptors)

C.1 Morwell River (Yallourn to the East)

Table 12.8 : Summary flow recommendations – Reach Ten - Morwell River

Flows recommendation				Rationale
Period	**Magnitude**	**Frequency**	**Duration**	
Dec-May	Low flow >60 ML/d (or natural)	Continuous	Continuous	Average depth of pools >0.4m for provision of habitat for Blackfish, inundation of bed for macroinvertebrate habitat
Dec-May	Low flow freshes >260 ML/d	2 per season	3 days	Inundation of in-stream bars to maintain channel form and provide watering of aquatic vegetation communities, riffle thalweg >0.4m for movement of River Blackfish, minimum reach velocity >0.3m/s for bed disturbance
June-Nov	High flow >260 ML/d or natural	Continuous	Continuous	Inundation of instream bars to maintain channel form and prevent vegetation encroachment, >0.3m over thalweg between pools for migration of small bodied diadromous species
June-Nov	High flow freshes >1380 ML/day	4 per season	4 days	Bench inundation to maintain channel form and provide watering of bench vegetation, pool velocity >1m/s for scour hole formation and maintenance
June-Nov	Overbank flow >3456 ML/day	1 per year	2 days	Channel maintenance and watering of floodplain and wetland vegetation.

Table 12.9 : SEPP (Waters) - Schedule 3 - Central Foothills and Coastal Plains Segment - Environmental Quality Indicators and Objectives.

Indicators (units)		Central Foothills and Coastal Plains
Total phosphorous (µg/L)	75th Percentile	≤55
Total nitrogen (µg/L)	75th Percentile	≤1100
Dissolved Oxygen (% saturation)	25th Percentile	≥75
	Maximum	130
Turbidity (NTU)	75th Percentile	≤25

Indicators (units)		Central Foothills and Coastal Plains
Electrical Conductivity (µS/cm@ 25°C)	75th Percentile	≤250
pH	25th Percentile	≥6.7
	75th Percentile	≤7.7
Toxicants Water	% protection	95
Toxicants Sediment		Low

C.2 Latrobe River (Yallourn to the north and lower reaches)

Table 12.10 : Summary flow recommendations – Latrobe River Reach 3 (Lake Narracan to Scarnes Bridge). Compliance point – Latrobe River at Scarnes Bridge

Flows recommendation				Rationale
Period	Magnitude	Frequency	Duration	
Dec-May	Low flow > 560 ML/d (or natural)	Continuous	Continuous	Inundation of bed for provision of Macroinvertebrate habitat, average depth of pools >0.4m for provision of habitat for Grayling and Blackfish
Dec-May	Low flow freshes >1380 ML/d	3 per period	6 days	Inundation of in-stream bars to maintain channel form and provide watering of vegetation, riffle thalweg >0.4m for movement of River Blackfish, minimum reach velocity >0.3m/s for bed disturbance
June-Nov	High flow >1380 ML/d or natural	Continuous	Continuous	Inundation of in-stream bars to maintain channel form and prevent Vegetation encroachment, >0.4m over thalweg between pools for migration of Grayling
June-Nov	High flow freshes >7780 ML/day	2 per season	3 days	Bench inundation to maintain channel form and provide watering of bench vegetation, pool velocity >1m/s for scour hole formation and maintenance
June-Nov	Overbank flow >17300 ML/day	1 every 2 years	2 days' average duration with variation between 1 and 3 days	Channel maintenance and watering of floodplain and wetland vegetation

Table 12.11 : Summary flow recommendations – Latrobe River Reach 4 (Scarnes Bridge to Rosedale). Compliance Point: Latrobe River at Rosedale (anabranch) and (main stream)

Flows recommendation				Rationale
Period	Magnitude	Frequency	Duration	
Dec-May	Low flow >520 ML/d (or natural)	Continuous	Continuous	Inundation of bed for provision of macroinvertebrate habitat, average depth of pools >1.0 m for provision of habitat for Bass
Dec-May	Low flow freshes >1470 ML/d	3 per season	7 days	Inundation of in-stream bars to maintain channel form and provide watering of aquatic vegetation, riffle thalweg >0.5m for movement of Bass, minimum reach velocity >0.3m/s for bed disturbance
June-Nov	High flow >1470 ML/d or natural	Continuous	Continuous	Inundation of in-stream bars to maintain channel form and prevent vegetation encroachment, riffle thalweg >0.5m for migration of Bass
June-Nov	High flow freshes >6900 ML/day	3 per season	5 days	Maintain channel form through bed disturbance and scour hole formation
June-Nov	Overbank flow >12960 ML/day	1 per season	2 days	Channel maintenance and watering of floodplain and wetland vegetation
June-Nov	Wetland watering flow >8640 ML/d	2 per season	3 days	Wetland inundation

Table 12.12 : Summary flow recommendations – Reach 5 - Latrobe River (Rosedale to Thomson River)

Flows recommendation				Rationale
Period	Magnitude	Frequency	Duration	
Dec-May	Low flow > 690 ML/d (or natural)	Continuous	Continuous	Inundation of bed for provision of habitat to macroinvertebrates, average depth of pools >1.0 m for provision of habitat for Bass
Dec-May	Low flow freshes >1296 ML/d	3 per season	7 days	Inundation of in-stream bars to maintain channel form and provide watering of aquatic vegetation, riffle thalweg >0.5m for movement of Bass, minimum reach velocity >0.3m/s for bed disturbance
June-Nov	High flow >1470 ML/d or natural*	Continuous	Continuous	Inundation of in-stream bars to maintain channel form and prevent vegetation encroachment (based on upstream reach), riffle thalweg >0.5m for migration of Bass

Flows recommendation				Rationale
Period	Magnitude	Frequency	Duration	
June-Nov	High flow freshes > 6900 ML/day	3 per season	5 days	Maintain channel form through bed disturbance and scour hole formation
June-Nov	Overbank flow > 12960 ML/day	1 per season	2 days	Channel maintenance and watering of floodplain and wetland vegetation
Sep-Nov	Wetland watering flow >8640 ML/day	2 per season	3 days	Wetland inundation

Table 12.13 : SEPP (Waters) - Schedule 3 - Central Foothills and Coastal Plains Segment - Environmental Quality Indicators and Objectives.

Indicators (units)		Central Foothills and Coastal Plains
Total phosphorous (µg/L)	75th Percentile	≤55
Total nitrogen (µg/L)	75th Percentile	≤1100
Dissolved Oxygen (% saturation)	25th Percentile	≥75
	Maximum	130
Turbidity (NTU)	75th Percentile	≤25
Electrical Conductivity (µS/cm@ 25°C)	75th Percentile	≤250
pH	25th Percentile	≥6.7
	75th Percentile	≤7.7
Toxicants Water	% protection	95
Toxicants Sediment		Low

C.3 Traralgon Creek (near Loy Yang)

Table 12.14 : Summary flow recommendations – Reach 11 – Traralgon Creek. Compliance Point – Traralgon Creek at Traralgon (Princes Highway)

Flows recommendation				Rationale
Period	**Magnitude**	**Frequency**	**Duration**	
Dec-May	Low flow > 35 ML/d (or natural)	Continuous	Continuous	Inundation of bed for provision of macroinvertebrate habitat, average depth of pools >0.4m for provision of habitat for Blackfish
Dec-May	Low flow freshes >210 ML/d	1 per season	3 days	Inundation of in-stream bars to maintain channel form and provide watering of aquatic vegetation, riffle thalweg >0.4m for movement of River Blackfish, minimum reach velocity >0.3m/s for bed disturbance
June-Nov	High flow > 130 ML/d or natural	Continuous	Continuous	Inundation of in-stream bars to maintain channel form and prevent vegetation encroachment
June-Nov	High flow freshes > 520 ML/day	3 per season	3 days	Bench inundation to maintain channel form and provide watering of bench vegetation, pool velocity >1 m/s for scour hole formation and maintenance
June-Nov	Overbank flow > 1555 ML/day	1 per 2 years	2 days	Channel maintenance and watering of floodplain and wetland vegetation

Table 12.15 : SEPP (Waters) - Schedule 3 - Central Foothills and Coastal Plains Segment - Environmental Quality Indicators and Objectives.

Indicators (units)		Central Foothills and Coastal Plains
Total phosphorous (µg/L)	75th Percentile	≤55
Total nitrogen (µg/L)	75th Percentile	≤1100
Dissolved Oxygen (% saturation)	25th Percentile	≥75
	Maximum	130
Turbidity (NTU)	75th Percentile	≤25
Electrical Conductivity (µS/cm@ 25°C)	75th Percentile	≤250
pH	25th Percentile	≥6.7

Indicators (units)		Central Foothills and Coastal Plains
	75th Percentile	≤7.7
Toxicants Water	% protection	95
Toxicants Sediment		Low

C.4 Flynn's Creek (near Loy Yang), Sheepwash Creek (near Loy Yang), Merriman's, Billy's Creek, Bennet's Creek

Table 12.16 : SEPP (Waters) - Schedule 3 - Central Foothills and Coastal Plains Segment - Environmental Quality Indicators and Objectives.

Indicators (units)		Central Foothills and Coastal Plains
Total phosphorous (µg/L)	75th Percentile	≤55
Total nitrogen (µg/L)	75th Percentile	≤1100
Dissolved Oxygen (% saturation)	25th Percentile	≥75
	Maximum	130
Turbidity (NTU)	75th Percentile	≤25
Electrical Conductivity (µS/cm@ 25°C)	75th Percentile	≤250
pH	25th Percentile	≥6.7
	75th Percentile	≤7.7
Toxicants Water	% protection	95
Toxicants Sediment		Low

Table 12.17 : Eco-hydrologic metrics that could be used as appropriate measures of effect in waterways without flow recommendations

Hydrologic metric	Definition
Magnitude of flow events - average flow conditions	
Low flow discharge (75th %ile)	Percentiles from flow duration curve
Low flow discharge (90th %ile)	

Hydrologic metric	Definition
Low flow discharge (95th %ile)	
Low flow discharge (99th %ile)	
Low flow index 1	The lowest and second lowest monthly flows in a year
Low flow index 2	7-day minimum flow / water year mean daily flow, calculated each year then averaged
Magnitude of flow events - high flow conditions	
High flow discharge (1st %ile)	Percentiles from flow duration curve
High flow discharge (5th %ile)	
High flow discharge (10th %ile)	
High flow discharge (25th %ile)	
Specific mean annual maximum runoff	Mean annual maximum flow divided by catchment area
High flow volume (>1xMDF)	Mean of the high flow volume (calculated as the area between the hydrograph and the upper threshold defined as 1, 3, and 7 times MDF, respectively) divided by MDF
High flow volume (>3xMDF)	
High flow volume (>7xMDF)	
Frequency of flow events - low flow conditions	
Low flow spell count (<75th %ile)	Mean number of annual occurrences during which the magnitude of flow remains below a lower threshold defined by the percentile (from the flow duration curve)
Low flow spell count (<90th %ile)	
Low flow spell count (<99th %ile)	
High pulse count	
CV of low flow spell count (<75th %ile)	Coefficient of variation in number of annual occurrences during which the magnitude of flow remains below a lower threshold defined by the percentile (from the flow duration curve)
CV of low flow spell count (<90th %ile)	
CV of low flow spell count (<99th %ile)	
Frequency of flow events - high flow conditions	
High flow spell count (>25th %ile)	Mean number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by the percentile (from the flow duration curve)
High flow spell count (>10th %ile)	
High flow spell count (>1st %ile)	
CV of high flow spell count (>25th %ile)	

Hydrologic metric	Definition
CV of high flow spell count (>10th %ile)	Coefficient of variation in number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by the percentile (from the flow duration curve)
CV of high flow spell count (>1st %ile)	
High flow spell count (>3xMDF)	Mean number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by multiple of MDF
High flow spell count (>7xMDF)	
Zero flow index Mean duration of zero flow periods	The proportion of time that the stream is dry (or nearly so) Zero flow days in full record divided by zero flow periods in full record

C.5 Thomson River

Table 12.18 : SEPP (Waters) - Schedule 3 – Uplands A Segment - Environmental Quality Indicators and Objectives Forest and Forestry areas (upstream of the wall of Cowwarr Weir)

Indicators (units)		Uplands A
Total phosphorous (µg/L)	75th Percentile	≤35
Total nitrogen (µg/L)	75th Percentile	≤900
Dissolved Oxygen (% saturation)	25th Percentile	≥80
	Maximum	130
Turbidity (NTU)	75th Percentile	≤15
Electrical Conductivity (µS/cm@ 25°C)	75th Percentile	≤100
pH	25th Percentile	≥6.4
	75th Percentile	≤7.6
Toxicants Water	% protection	95
Toxicants Sediment		Low

Table 12.19 : SEPP (Waters) - Schedule 3 - Central Foothills and Coastal Plains Segment - Environmental Quality Indicators and Objectives (downstream of the wall of Cowwarr Weir to its junction with the Latrobe River)

Indicators (units)		Central Foothills and Coastal Plains
Total phosphorous (µg/L)	75th Percentile	≤55
Total nitrogen (µg/L)	75th Percentile	≤1100
Dissolved Oxygen (% saturation)	25th Percentile	≥75
	Maximum	130
Turbidity (NTU)	75th Percentile	≤25
Electrical Conductivity (µS/cm@ 25°C)	75th Percentile	≤250
pH	25th Percentile	≥6.7
	75th Percentile	≤7.7
Toxicants Water	% protection	95
Toxicants Sediment		Low

Table 12.20 : Eco-hydrologic metrics that could be used as appropriate measures of effect in waterways without flow recommendations

Hydrologic metric	Definition
Magnitude of flow events - average flow conditions	
Low flow discharge (75th %ile)	Percentiles from flow duration curve
Low flow discharge (90th %ile)	
Low flow discharge (95th %ile)	
Low flow discharge (99th %ile)	
Low flow index 1	The lowest and second lowest monthly flows in a year
Low flow index 2	7-day minimum flow / water year mean daily flow, calculated each year then averaged
Magnitude of flow events - high flow conditions	
High flow discharge (1st %ile)	Percentiles from flow duration curve
High flow discharge (5th %ile)	

Hydrologic metric	Definition
High flow discharge (10th %ile)	
High flow discharge (25th %ile)	
Specific mean annual maximum runoff	Mean annual maximum flow divided by catchment area
High flow volume (>1xMDF)	Mean of the high flow volume (calculated as the area between the hydrograph and the upper threshold defined as 1, 3, and 7 times MDF, respectively) divided by MDF
High flow volume (>3xMDF)	
High flow volume (>7xMDF)	
Frequency of flow events - low flow conditions	
Low flow spell count (<75th %ile)	Mean number of annual occurrences during which the magnitude of flow remains below a lower threshold defined by the percentile (from the flow duration curve)
Low flow spell count (<90th %ile)	
Low flow spell count (<99th %ile)	
High pulse count	
CV of low flow spell count (<75th %ile)	Coefficient of variation in number of annual occurrences during which the magnitude of flow remains below a lower threshold defined by the percentile (from the flow duration curve)
CV of low flow spell count (<90th %ile)	
CV of low flow spell count (<99th %ile)	
Frequency of flow events - high flow conditions	
High flow spell count (>25th %ile)	Mean number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by the percentile (from the flow duration curve)
High flow spell count (>10th %ile)	
High flow spell count (>1st %ile)	
CV of high flow spell count (>25th %ile)	Coefficient of variation in number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by the percentile (from the flow duration curve)
CV of high flow spell count (>10th %ile)	
CV of high flow spell count (>1st %ile)	
High flow spell count (>3xMDF)	Mean number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by multiple of MDF
High flow spell count (>7xMDF)	
Zero flow index Mean duration of zero flow periods	The proportion of time that the stream is dry (or nearly so) Zero flow days in full record divided by zero flow periods in full record

C.6 Lake Wellington

Table 12.21 : Eco-hydrologic metrics that could be used as appropriate measures of effect in waterways without flow recommendations

Hydrologic metric	Definition
Magnitude of flow events - average flow conditions	
Low flow discharge (75th %ile)	Percentiles from flow duration curve
Low flow discharge (90th %ile)	
Low flow discharge (95th %ile)	
Low flow discharge (99th %ile)	
Low flow index 1	The lowest and second lowest monthly flows in a year
Low flow index 2	7-day minimum flow / water year mean daily flow, calculated each year then averaged
Magnitude of flow events - high flow conditions	
High flow discharge (1st %ile)	Percentiles from flow duration curve
High flow discharge (5th %ile)	
High flow discharge (10th %ile)	
High flow discharge (25th %ile)	
Specific mean annual maximum runoff	Mean annual maximum flow divided by catchment area
High flow volume (>1xMDF)	Mean of the high flow volume (calculated as the area between the hydrograph and the upper threshold defined as 1, 3, and 7 times MDF, respectively) divided by MDF
High flow volume (>3xMDF)	
High flow volume (>7xMDF)	
Frequency of flow events - low flow conditions	
Low flow spell count (<75th %ile)	Mean number of annual occurrences during which the magnitude of flow remains below a lower threshold defined by the percentile (from the flow duration curve)
Low flow spell count (<90th %ile)	
Low flow spell count (<99th %ile)	
High pulse count	
CV of low flow spell count (<75th %ile)	Coefficient of variation in number of annual occurrences during which the magnitude of flow remains below a lower threshold defined by the percentile (from the flow duration curve)
CV of low flow spell count (<90th %ile)	
CV of low flow spell count (<99th %ile)	

Hydrologic metric	Definition
Frequency of flow events - high flow conditions	
High flow spell count (>25th %ile)	Mean number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by the percentile (from the flow duration curve)
High flow spell count (>10th %ile)	
High flow spell count (>1st %ile)	
CV of high flow spell count (>25th %ile)	Coefficient of variation in number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by the percentile (from the flow duration curve)
CV of high flow spell count (>10th %ile)	
CV of high flow spell count (>1st %ile)	
High flow spell count (>3xMDF)	Mean number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by multiple of MDF
High flow spell count (>7xMDF)	
Zero flow index Mean duration of zero flow periods	The proportion of time that the stream is dry (or nearly so) Zero flow days in full record divided by zero flow periods in full record

Figure 12-1 : SEPP (Waters) - Schedule 3 - Gippsland Lakes Segment - Environmental Quality Indicators and Objectives.

Indicators (units)		Lake Wellington
		Surface
Total phosphorous (µg/L)	75th Percentile	120
Total nitrogen (µg/L)	75th Percentile	1,000
Dissolved Oxygen (% saturation) Chl-a (µg/L)	25th Percentile-Max	95-130
	75th Percentile	25
Dissolved Inorganic Phosphorus (µg/L)	75th Percentile	15
Dissolved Inorganic Nitrogen (µg/L)	75th Percentile	15
TSS (mg/L) Salinity (PSU)	75th Percentile	30
	25th Percentile	NA
	75th Percentile	15
Light Attenuation (m-l)	75th Percentile	2.5
pH	25th-75th Percentile	7.5-8.5

Indicators (units)		Lake Wellington
Toxicants Water	% protection	95
Toxicants Sediment		Low

C.7 Lake Victoria

Table 12.22 : Eco-hydrologic metrics that could be used as appropriate measures of effect in waterways without flow recommendations

Hydrologic metric	Definition
Magnitude of flow events - average flow conditions	
Low flow discharge (75th %ile)	Percentiles from flow duration curve
Low flow discharge (90th %ile)	
Low flow discharge (95th %ile)	
Low flow discharge (99th %ile)	
Low flow index 1	The lowest and second lowest monthly flows in a year
Low flow index 2	7-day minimum flow / water year mean daily flow, calculated each year then averaged
Magnitude of flow events - high flow conditions	
High flow discharge (1st %ile)	Percentiles from flow duration curve
High flow discharge (5th %ile)	
High flow discharge (10th %ile)	
High flow discharge (25th %ile)	
Specific mean annual maximum runoff	Mean annual maximum flow divided by catchment area
High flow volume (>1xMDF)	Mean of the high flow volume (calculated as the area between the hydrograph and the upper threshold defined as 1, 3, and 7 times MDF, respectively) divided by MDF
High flow volume (>3xMDF)	
High flow volume (>7xMDF)	
Frequency of flow events - low flow conditions	
Low flow spell count (<75th %ile)	
Low flow spell count (<90th %ile)	

Hydrologic metric	Definition
Low flow spell count (<99th %ile)	Mean number of annual occurrences during which the magnitude of flow remains below a lower threshold defined by the percentile (from the flow duration curve)
High pulse count	
CV of low flow spell count (<75th %ile)	Coefficient of variation in number of annual occurrences during which the magnitude of flow remains below a lower threshold defined by the percentile (from the flow duration curve)
CV of low flow spell count (<90th %ile)	
CV of low flow spell count (<99th %ile)	
Frequency of flow events - high flow conditions	
High flow spell count (>25th %ile)	Mean number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by the percentile (from the flow duration curve)
High flow spell count (>10th %ile)	
High flow spell count (>1st %ile)	
CV of high flow spell count (>25th %ile)	Coefficient of variation in number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by the percentile (from the flow duration curve)
CV of high flow spell count (>10th %ile)	
CV of high flow spell count (>1st %ile)	
High flow spell count (>3xMDF)	Mean number of annual occurrences during which the magnitude of flow remains above a higher threshold defined by multiple of MDF
High flow spell count (>7xMDF)	
Zero flow index Mean duration of zero flow periods	The proportion of time that the stream is dry (or nearly so) Zero flow days in full record divided by zero flow periods in full record

Figure 12-2 : SEPP (Waters) - Schedule 3 - Gippsland Lakes Segment - Environmental Quality Indicators and Objectives.

Indicators (units)		Lake Victoria	
		Surface	Bottom
Total phosphorous (µg/L)	75th Percentile	120	110
Total nitrogen (µg/L)	75th Percentile	1,000	600
Dissolved Oxygen (% saturation) Chl-a (µg/L)	25th Percentile-Max	95-130	50-130
	75th Percentile	25	15
Dissolved Inorganic Phosphorus (µg/L)	75th Percentile	15	50

Indicators (units)		Lake Victoria	
Dissolved Inorganic Nitrogen (µg/L)	75th Percentile	15	50
TSS (mg/L) Salinity (PSU)	75th Percentile	30	10
	25th Percentile	NA	21
	75th Percentile	15	28
Light Attenuation (m-l)	75th Percentile	2.5	N/A
pH	25th-75th Percentile	7.5-8.5	N/A
Toxicants Water	% protection	95	97
Toxicants Sediment		Low	Low

C.8 Water Dependant Habitats

Table 12.23 : Summary flow recommendations – Reach 5 - Latrobe River (Rosedale to Thomson River)

Flows recommendation				Rationale
Period	Magnitude	Frequency	Duration	
Dec-May	Low flow > 690 ML/d (or natural)	Continuous	Continuous	Inundation of bed for provision of habitat to macroinvertebrates, average depth of pools >1.0 m for provision of habitat for Bass
Dec-May	Low flow freshes >1296 ML/d	3 per season	7 days	Inundation of in-stream bars to maintain channel form and provide watering of aquatic vegetation, riffle thalweg >0.5m for movement of Bass, minimum reach velocity >0.3m/s for bed disturbance
June-Nov	High flow >1470 ML/d or natural*	Continuous	Continuous	Inundation of in-stream bars to maintain channel form and prevent vegetation encroachment (based on upstream reach), riffle thalweg >0.5m for migration of Bass
June-Nov	High flow freshes > 6900 ML/day	3 per season	5 days	Maintain channel form through bed disturbance and scour hole formation
June-Nov	Overbank flow > 12960 ML/day	1 per season	2 days	Channel maintenance and watering of floodplain and wetland vegetation
Sep-Nov	Wetland watering flow >8640 ML/day	2 per season	3 days	Wetland inundation

Figure 12-3 : SEPP (Waters) - Schedule 3 – Wetlands Segment - Environmental Quality Indicators and Objectives.

Environmental Quality Indicators									
		pH range	Dissolved oxygen (% saturation)	Electrical conductivity (µScm-1)	Turbidity (NTU)	Total Nitrogen (µg/L)	Total Phosphorous (µg/L)	Toxicants Water	Toxicants sediment
Wetland type	Sub-type	Min-Max	Min-Max	75th percentile	75th percentile	75th percentile	75th percentile	% protection	
Riverine	Flow-through	6.5-8.5	80-120	1,500	5	500	30	95	Low
	Terminal	6.5-8.5	80-120	N/A	15	1,500	100		
	Floodplain	6.5-8.5	80-120	N/A	15	1,500	100		
Coastal Dune	Eastern	6-7.5	80-120	1,500	5	500	30	95	Low
	Western	6.5-8.5	80-120	1,500	5	500	30		
Deep inland	Fresh	6.5-8.5	80-120	1,500	5	500	30	95	Low
	Saline	6.5-8.5	80-120	N/A	5	500	30		
Shallow inland	With an outflow	6.5-8.5	80-120	N/A	15	1,500	100	95	Low
	Closed	N/A	N/A	N/A	N/A	N/A	N/A		

C.9 Wetlands

Table 12.24 : Summary flow recommendations – Reach 5 - Latrobe River (Rosedale to Thomson River)

Flows recommendation				Rationale
Period	Magnitude	Frequency	Duration	
Dec-May	Low flow > 690 ML/d (or natural)	Continuous	Continuous	Inundation of bed for provision of habitat to macroinvertebrates, average depth of pools >1.0 m for provision of habitat for Bass
Dec-May	Low flow freshes >1296 ML/d	3 per season	7 days	Inundation of in-stream bars to maintain channel form and provide watering of aquatic vegetation, riffle thalweg >0.5m for movement of Bass, minimum reach velocity >0.3m/s for bed disturbance
June-Nov	High flow >1470 ML/d or natural*	Continuous	Continuous	Inundation of in-stream bars to maintain channel form and prevent vegetation encroachment (based on upstream reach), riffle thalweg >0.5m for migration of Bass
June-Nov	High flow freshes > 6900 ML/day	3 per season	5 days	Maintain channel form through bed disturbance and scour hole formation
June-Nov	Overbank flow > 12960 ML/day	1 per season	2 days	Channel maintenance and watering of floodplain and wetland vegetation
Sep-Nov	Wetland watering flow >8640 ML/day	2 per season	3 days	Wetland inundation

Figure 12-4: SEPP (Waters) - Schedule 3 – Wetlands Segment - Environmental Quality Indicators and Objectives.

Environmental Quality Indicators									
		pH range	Dissolved oxygen (% saturation)	Electrical conductivity (µScm-1)	Turbidity (NTU)	Total Nitrogen (µg/L)	Total Phosphorous (µg/L)	Toxicants Water	Toxicants sediment
Wetland type	Sub-type	Min-Max	Min-Max	75th percentile	75th percentile	75th percentile	75th percentile	% protection	
Riverine	Flow-through	6.5-8.5	80-120	1,500	5	500	30	95	Low
	Terminal	6.5-8.5	80-120	N/A	15	1,500	100		
	Floodplain	6.5-8.5	80-120	N/A	15	1,500	100		
Coastal Dune	Eastern	6-7.5	80-120	1,500	5	500	30	95	Low
	Western	6.5-8.5	80-120	1,500	5	500	30		
Deep inland	Fresh	6.5-8.5	80-120	1,500	5	500	30	95	Low
	Saline	6.5-8.5	80-120	N/A	5	500	30		
Shallow inland	With an outflow	6.5-8.5	80-120	N/A	15	1,500	100	95	Low
	Closed	N/A	N/A	N/A	N/A	N/A	N/A		

Appendix D. Quantitative Thresholds (Infrastructure Receptors)

No clear pathway or material effect has been identified for the infrastructure receptor sub-categories, and therefore water-related metrics and thresholds are not defined.

Appendix E. Quantitative Thresholds (Land Receptors)

E.1 Southern Urban Boundary of Morwell

Land Use Zoning	Metrics	Threshold	Rationale
Public Park and Recreation (PPRZ)	Zone Description: • The purpose of the PPRZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To recognise areas for public recreation and open space.* *To protect and conserve areas of significance where appropriate.* *To provide for commercial uses where appropriate.* • The PPRZ enables the following uses to be established by a public land manager without a permit: - Informal outdoor recreation - Open sports ground - Contractor's depot - Heliport - Office - Retail premise Store • The study area PPRZ land currently includes: - Morwell Recreation Reserve - Morwell Cricket Club - Keegan Street Reserve - Morwell Town Common - Morwell Centenary Rose Garden - Eric Lubcke Yarra Gum Conservation Reserve - Linear Park		
	Groundwater Rise		
	• Inability to achieve the purpose of the zone. • If these uses are not able to function without impediment, then the zone is no longer effectively functioning as intended.	• Minor groundwater level changes will not trigger a threshold creating a material change	• The PPRZ zone, specifically informal recreation, does not typically require groundwater to function as intended. • Further investigation is required to identify if groundwater is used for the watering of turfs or sports grounds
	Flooding and Inundation		
	• Inability to achieve the purpose of the zone. • If these uses are not able to function without impediment, then the zone is no longer effectively functioning as intended.	• The PPRZ zone cannot be subject to flooding in summer as it is utilised for sporting events that require a dry ground. Inundation to the PPRZ zone more than twice in the period September to	• Organised sport runs to strict weekly timetables, regular interruptions from flooding will mean that the season cannot be completed.

Land Use Zoning	Metrics	Threshold	Rationale
		March is considered an unacceptable level. • Requirement to place flooding or inundation overlay on land where it does not currently meet requirements	
General Residential Zone (GRZ1)	Zone Description		
	• The purpose of the GRZ1 is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To encourage development that respects the neighbourhood character of the area.* *To encourage a diversity of housing types and housing growth particularly in locations offering good access to services and transport.* *To allow educational, recreational, religious, community and a limited range of other non-residential uses to serve local community needs in appropriate locations* • The GRZ1enables the following uses to be established without a permit: - Animal keeping (other than animal boarding) - Bed and breakfast - Dependant person's unit - Dwelling - Home occupation - Informal outdoor recreation - Medical centre - Minor utility installation - Place of worship - Railway - Residential aged care facility - Tramway • The study area GRZ1 land currently includes: - Low density standalone dwellings - Aged care facility		
Commercial 1 Zone (C1Z)	Zone Description		
	• The purpose of the C1Z is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To create vibrant mixed-use commercial centres for retail, office, business, entertainment and community uses.* *To provide for residential uses at densities complementary to the role and scale of the commercial centre.* • The C1Z enables the following uses to be established without a permit: - Accommodation - Child care centre - Cinema based entertainment facility - Education centre - Exhibition centre - Home occupation - Informal outdoor recreation - Minor utility installation		

Land Use Zoning	Metrics	Threshold	Rationale
	- Office - Place of worship - Railway - Retail premise - Shop - Tramway • The study area C1Z land currently includes: - Banks - Dine-in and takeaway restaurants - Furniture shops - Supermarkets - General retail		
Mixed Use Zone (MUZ)	Zone Description		
	• The purpose of the MUZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To provide for a range of residential, commercial, industrial and other uses which complement the mixed-use function of the locality.* *To provide for housing at higher densities.* *To encourage development that responds to the existing or preferred neighbourhood character of the area.* *To facilitate the use, development and redevelopment of land in accordance with the objectives specified in a schedule to this zone.* • The MUZ enables the following uses to be established without a permit: - Animal Keeping (other than animal boarding) - Bed and breakfast - Dependant person's unit - Dwelling - Food and drink premises - Home occupation - Informal outdoor recreation - Medical centre - Minor utility installation - Office - Place of worship - Railway - Residential aged care facility - Shop - Tramway • The study area MUZ land currently includes: - Banks - Dine-in and takeaway restaurants - Furniture shops - Supermarkets - General retail		
Industrial 3 Zone (IN3Z)	Zone Description		
	• The purpose of the IN3Z is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.*		

Land Use Zoning	Metrics	Threshold	Rationale
	To provide for industries and associated uses in specific areas where special consideration of the nature and effects of industrial uses is required or to avoid inter-industry conflict. *To provide a buffer between the Industrial 1 Zone or Industrial 2 Zone and local communities, which allows for industries and associated uses compatible with the nearby community.* *To allow limited retail opportunities including convenience shops, small scale supermarkets and associated shops in appropriate locations.* *To ensure that uses do not affect the safety and amenity of adjacent, more sensitive land uses.* • The IN3Z enables the following uses to be established without a permit: - Convenience shop - Crop raising - Extensive animal husbandry - Home occupation - Informal outdoor recreation - Mail centre - Minor utility installation - Railway - Service Station - Shop - Supermarket - Tramway • The study area IN3Z land currently includes: - Bus depot - Storage units - Automotive services - Joiners - General retail		
Public Use Zone • Public Use Zone 2- Education (PUZ2) • Public Use Zone 7 – Other Public Use (PUZ7)	Zone Description • The purpose of the PUZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To recognise public land use for public utility and community services and facilities.* *To provide for associated uses that are consistent with the intent of the public land reservation or purpose.* • The PUZ enables the following uses to be established without a permit: - Railway - Railway station - Tramway PUZ2 – enables the land to be used for education purposes without the need for a permit for use PUZ7- enables the land to be used for 'other public use' purposes within the need for a permit for use • The study area PUZ2 land currently includes: - Primary School • The study area PUZ7 land currently includes: - Justice Precinct Police Station justice Service Centre		

Land Use Zoning	Metrics	Threshold	Rationale
	Magistrates Court		
	Groundwater Rise		
	• Inability to achieve the purpose of the applicable zone.	• Inability to support the permitted uses and enable continued use of land with established developments. • Groundwater rise to a level that reaches existing underground infrastructure such a pipes and utility lines is unacceptable	• Inability to achieve the purpose of the zone means that the area can no longer provide for that particular use and support the different elements of a community. • Material effect pathways relating to existing dwellings and structures rendering them unsafe or unliveable are addressed by geotechnical metrics.
	Flooding and Inundation		
	• Inability to achieve the purpose of the zone. • Flooding or inundation to a level that requires that flood control overlays are required in areas not previously required.	• Inability to support the permitted uses and enable continued use of land with established developments. • Flooding or inundation to a level that requires that flood control overlays are required in areas not previously required.	• Areas without pre-existing flood controls will not have dictated floor heights above ground level. Increased flood levels have the potential to significantly effect on the existing structures. • Material effect pathways relating to existing dwellings and structures rendering them unsafe or unliveable are addressed by geotechnical metrics.

E.2 Urban Buffer between Yallourn Coal mine and Morwell

Land Use Zoning	Metrics	Threshold	Rationale
Public Park and Recreation (PPRZ)	Zone Description:		
	• The purpose of the PPRZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To recognise areas for public recreation and open space.* *To protect and conserve areas of significance where appropriate.* *To provide for commercial uses where appropriate.* • The PPRZ enables the following uses to be established by a public land manager without a permit: - Informal outdoor recreation - Open sports ground - Contractor's depot - Heliport - Office - Retail premise Store • The study area PPRZ land currently includes: - Toners Lane Reserve - Helen Street Reserve - The Morwell Cougars Baseball Club		
	Groundwater Rise		
	• Inability to achieve the purpose of the zone. • If these uses are not able to function without impediment, then the zone is no longer effectively functioning as intended.	• Groundwater level changes will not trigger a threshold creating a material change	• The PPRZ zone, specifically informal recreation, does not typically require groundwater to function as intended. • Further investigation is required to identify is groundwater is used for the watering of turfs or sports grounds.
	Flooding and Inundation		
	• Inability to achieve the purpose of the zone. • If these uses are not able to function without impediment, then the zone is no longer effectively functioning as intended.	• The PPRZ zone cannot be subject to flooding in summer as it is utilised for sporting events that require a dry ground. Inundation to the PPRZ zone more than twice in the period September to March is considered an unacceptable level. • Requirement to place flooding or inundation overlay on land where it does not currently meet requirements	• Organised sport runs to strict weekly timetables, regular interruptions from flooding will mean that the season cannot be completed.

General Residential Zone-Schedule 1 (GRZ1)	Zone Description • The purpose of the GRZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To encourage development that respects the neighbourhood character of the area.* *To encourage a diversity of housing types and housing growth particularly in locations offering good access to services and transport.* *To allow educational, recreational, religious, community and a limited range of other non-residential uses to serve local community needs in appropriate locations* • The GRZ enables the following uses to be established without a permit: - Animal keeping (other than animal boarding) - Bed and breakfast - Dependant person's unit - Dwelling - Home occupation - Informal outdoor recreation - Medical centre - Minor utility installation - Place of worship - Railway - Residential aged care facility - Tramway • The study area GRZ1 land currently includes: - Low density standalone dwellings - Latrobe Valley Golf Driving Range - Morwell Sunday Market - Cellars
Mixed Use Zone (MUZ)	Zone Description • The purpose of the MUZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To provide for a range of residential, commercial, industrial and other uses which complement the mixed-use function of the locality.* *To provide for housing at higher densities.* *To encourage development that responds to the existing or preferred neighbourhood character of the area.* *To facilitate the use, development and redevelopment of land in accordance with the objectives specified in a schedule to this zone.* • The MUZ enables the following uses to be established without a permit: - Animal Keeping (other than animal boarding) - Bed and breakfast - Dependant person's unit - Dwelling - Food and drink premises - Home occupation - Informal outdoor recreation - Medical centre - Minor utility installation - Office - Place of worship - Railway - Residential aged care facility - Shop

	- Tramway • The study area MUZ land currently includes: - Low density residential development
Farming Zone	Zone Description
	• The purpose of the FZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To provide for the use of land for agriculture.* *To encourage the retention of productive agricultural land.* *To ensure that non-agricultural uses, including dwellings, do not adversely affect the use of land for agriculture.* *To encourage the retention of employment and population to support rural communities.* *To encourage use and development of land based on comprehensive and sustainable land management practices and infrastructure provision.* • The FZ enables the following uses to be established without a permit: - Agriculture (other than Animal keeping, Apiculture, Intensive animal husbandry, racing dog training, Rice growing and Timber production) - Animal keeping - Bed and breakfast - Cattle feedlot - Dependant person's unit - Dwelling - Home occupation - Informal outdoor recreation - Minor utility installation - Primary produce sales - Racing dog training - Railway - Rural industry - Rural store - Timber production - Tramway • The study area FZ land currently includes: - Land that appears to be used for grazing
Industrial 3 Zone (IN3Z)	Zone Description
	• The purpose of the IN3Z is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To provide for industries and associated uses in specific areas where special consideration of the nature and effects of industrial uses is required or to avoid inter-industry conflict.* *To provide a buffer between the Industrial 1 Zone or Industrial 2 Zone and local communities, which allows for industries and associated uses compatible with the nearby community.* *To allow limited retail opportunities including convenience shops, small scale supermarkets and associated shops in appropriate locations.* *To ensure that uses do not affect the safety and amenity of adjacent, more sensitive land uses.* • The IN3Z enables the following uses to be established without a permit: - Convenience shop - Crop raising

<table>
<tr><td></td><td colspan="3">- Extensive animal husbandry
- Home occupation
- Informal outdoor recreation
- Mail centre
- Minor utility installation
- Railway
- Service Station
- Shop
- Supermarket
- Tramway

• The study area IN3Z land currently includes:
- Joiners
- Machining and Engineering
- Transport Freight
- Automotive services</td></tr>
<tr><td></td><td colspan="3"><u>Groundwater Rise</u></td></tr>
<tr><td></td><td>• Inability to achieve the purpose of the applicable zone.</td><td>• Inability to support the permitted uses and enable continued use of land with established developments.
• Groundwater rise to a level that reaches existing underground infrastructure such as pipes and utility lines is unacceptable.</td><td>• Inability to achieve the purpose of the zone means that the area can no longer provide for that use and support the different elements of a community.
• Material effect pathways relating to existing dwellings and structures rendering them unsafe or unliveable are addressed by geotechnical metrics.</td></tr>
<tr><td></td><td colspan="3">Flooding and Inundation</td></tr>
<tr><td></td><td>• Inability to achieve the purpose of the zone.
• Flooding or inundation to a level that requires that flood control overlays are required in areas not previously required.</td><td>• Inability to support the permitted uses and enable continued use of land with established developments.
• Flooding or inundation to a level that requires that flood control overlays are required in areas not previously required.</td><td>• Areas without pre-existing flood controls will not have dictated floor heights above ground level. Increased flood levels have the potential to significantly effect on the existing structures.
• Material effect pathways relating to existing dwellings and structures rendering them unsafe or unliveable are addressed by geotechnical metrics.</td></tr>
<tr><td>Public Use Zone
• Public Use Zone 6 – Local Government</td><td colspan="3">Zone Description</td></tr>
<tr><td></td><td colspan="3">• The purpose of the PUZ is:
To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.
To recognise public land use for public utility and community services and facilities.
To provide for associated uses that are consistent with the intent of the public land reservation or purpose.

• The PUZ enables the following uses to be established without a permit:
- Railway</td></tr>
</table>

	- Railway station - Tramway PUZ6 – enables the land to be used for local government purposes without the need for a permit for use • The study area PUZ6 land currently includes: - Land that appears to be vacant		
	Groundwater Rise		
	• Inability to achieve the purpose of the applicable zone.	• The inability to develop the land for required purposes for local government use.	• The land should remain practical for development for local government purposes, as per other PUZ6 zoned land near the subject site. • Material effect pathways relating to existing dwellings and structures rendering them unsafe or unliveable are addressed by geotechnical metrics.
	Flooding and Inundation		
	• Inability to achieve the purpose of the zone. • Flooding or inundation to a level that requires that flood control overlays are required in areas not previously required.	• The inability to develop land for the permitted use without the need for extensive cost prohibitive mitigation. • Flooding or inundation to a level that requires that flood control overlays are required in areas not previously required.	• The land should remain practical for development for local government purposes, as per other PUZ6 zoned land near the subject site. • Material effect pathways relating to existing dwellings and structures rendering them unsafe or unliveable are addressed by geotechnical metrics.
Special Use Zone – Schedule 1 (Brown Coal)	Zone Description		
	• The purpose of the PUZ is: *To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.* *To recognise or provide for the use and development of land for specific purposes as identified in a schedule in this zone.* • The purpose of the PUZ1 is: *To provide for brown coal mining and associated uses* *To provide for electricity generation and associated uses* *To provide for interim and non-urban uses which protect brown coal resources and to discourage the use or development of land incompatible with future brown coal mining and industry* • The PUZ enables the following uses to be established without a permit: - Apiculture - Crop Raising - Dependent person's unit - Dwelling - Extensive Animal Husbandry - Extractive Industry		

	- Home occupation - Industry - Informal outdoor recreation - Mineral exploration - Mining - Minor Utility installation - Natural systems - Railway - Road - Search for stone - Timber production - Tramway - Utility installation - Warehouse • The study area SUZ1 land currently includes: - Land uses associated with the Yallourn Coal Mine
	<u>Groundwater Rise and Flooding and Inundation</u>
	The land zoned Special Use Zone – Schedule 1 (Brown Coal) is currently used for the mine and associated activities. It is anticipated that the activities within this zone will change with the rehabilitation of the mines and this will occur in consideration of the change in use. No assessment is provided for this zoning.

Appendix F. Quantitative Thresholds (Water Receptors)

F.1 Shallow Aquifer System

Table 12.25 : Defined Thresholds for the Shallow Aquifer System

Value Category	Threshold	Rationale
Natural Resource	• Quantity - A predicted decline of **> 15 m in the Shallow Aquifer System**, in key regional SAS monitoring bores and at a catchment scale, after 30 years. • Quality – Predicted **exceedance of SEPP segments A1 to B**, in key regional SAS monitoring bores. • Quality – Predicted exceedance of statistically significant baseline data (outside the 5th and 95th percentile range) in key regional SAS monitoring bores.	• A predicted decline of > 15 m in the watertable aquifer significantly changes the function of water users and/or ecosystems. Defined by the Gippsland Region Assessment of Potential Effects on Water Resources (Jacobs 2015). • Under the SEPP guidelines, the current and potential beneficial use of the aquifer should be protected – exceedance of the segments indicates that the beneficial use of the groundwater has been reduced. • Exceedance of the statistically significant baseline data indicates that groundwater quality is being degraded at the mine scale.
Social/Cultural	• Quantity - A predicted decline of **> 2 m in the watertable aquifer**, in key regional SAS monitoring bores and at catchment scale. • Quality – A predicted decline of water quality to **pH < 5**, **Hardness < 60 mg/L (as CaCO3)** and **Langlier Index < -0.5**, observed in key regional SAS monitoring bores and at a catchment scale.	• The quantity threshold is interdependent on the values associated with the environment and ecosystem dependence. A decline in groundwater levels which significantly effects on social/cultural values that is unacceptable at an inter-mine and catchment scale. • The decline in groundwater quality, outside of the defined threshold, will significantly increase the corrosion potential on buildings and saturated infrastructure. The thresholds are as defined by the trigger values for assessing the corrosiveness of water in Australian and New Zealand guidelines for fresh and marine water quality (2000) Volume 3, Primary Industries – General Use.
Environment	• Quantity - A predicted decline of **> 2 m in the shallow aquifer system**, in key regional SAS monitoring bores and at a catchment scale, and/or a predicted decline of **> 10% below the minimum average seasonal flow or the Q90 flow rate**. • Quality – Predicted exceedance of **trigger values for the protection of 90% freshwater species** in receiving surface waters at an inter-mine and catchment scale. • Quality – Predicted exceedance of statistically significant baseline data in receiving surface waters at a mine scale.	• A predicted decline of > 2 m in the watertable aquifer significantly effects stream flow of connected waterway to natural or current conditions. The thresholds are as defined by the Gippsland Region Assessment of Potential Effects on Water Resources (Jacobs 2015) and the Resource Share Guidelines for Groundwater (DELWP 2015). • Exceedance of the thresholds for the protection of 90% of freshwater species indicates that the beneficial use of the receiving surface water has been reduced. These threshold values are as defined by Australian and New Zealand guidelines for fresh and marine water quality (2000) Volume 2, Aquatic Ecosystems. • Exceedance of the statistically significant baseline data indicates that the quality of receiving surface water is being degraded at the mine scale.

Value Category	Threshold	Rationale
Ecosystem Dependence	• Quantity - A predicted decline of **> 2 m in the watertable aquifer** and/or **reversal of the hydraulic gradient** observed at the ecosystem boundary, at an inter-mine and catchment scale. • Quality – Predicted exceedance of **trigger values for the protection of 90% freshwater species** (Reference in receiving groundwater dependant ecosystems, at an inter-mine and catchment scale. • Quality – Predicted exceedance of statistically significant baseline data in receiving groundwater dependant ecosystems, at a mine scale.	• A predicted exceedance of the threshold values is recognised to significantly effect on the aquifer's connectivity to the dependant ecosystems. The thresholds are as defined by Ministerial Guidelines for Groundwater Licencing and the Protection of High-Value Groundwater Dependant Ecosystems (2015). • Exceedance of the trigger value for the protection of 90% of freshwater species indicates that the beneficial use of the groundwater dependant ecosystems has been reduced. These threshold values are as defined by Australian and New Zealand guidelines for fresh and marine water quality (2000) Volume 2, Aquatic Ecosystems. • Exceedance of the statistically significant baseline data indicates that the quality of groundwater dependant ecosystems is being degraded at the mine scale.
Economic/Water Use	• Quantity - A predicted decline in groundwater levels of **> 10% of the saturated thickness** of the shallow aquifer system in key regional SAS monitoring bores and at a catchment scale • Quantity – A predicted increase in the permissible consumptive volume which is **> 100% of the current PCV**.	• A predicted decline in groundwater levels is recognised to significantly reduce the accessibility of infrastructure to abstract water from the aquifer and adversely affect the security of supply. The thresholds are as defined by the Resource Share Guidelines for Groundwater (DELWP 2015)

F.2 Morwell Formation Aquifer System

Table 12.26 : Defined Thresholds for the Morwell Formation Aquifer System

Value Category	Threshold	Rationale
Natural Resource	• Quantity - A predicted decline of **> 70 m in the middle aquifer system**, in key regional MFAS monitoring bores and at a catchment scale, after 30 years. • Quality – A predicted decline of the potentiometric level does not result in the aquifer becoming unconfined. • **exceedance of SEPP segments A1 to B**, in key regional MFAS monitoring bores and at a catchment scale. • Quality – Predicted exceedance of statistically significant baseline data (outside the 5th and 95th percentile range) in key regional MFAS monitoring bores.	• A predicted decline of > 70 m in the Morwell Formation aquifer significantly changes the function of water users and/or access to the natural resource. Defined by the Gippsland Region Assessment of Potential Effects on Water Resources (Jacobs 2015). • Under the SEPP guidelines, the current and potential beneficial use of the aquifer should be protected – exceedance of the segments indicates that the beneficial use of the groundwater has been reduced. • Exceedance of the statistically significant baseline data indicates that groundwater quality is being degraded at the mine scale.
Economic/Water Use	• Quantity - A predicted decline in groundwater levels of **> 10% of the saturated thickness** of the Morwell Formation Aquifer System, in key regional MFAS monitoring bores and at a catchment scale • Quantity – A predicted decline in the permissible consumptive volume which is **> 100% of the current PCV**.	• A predicted decline in groundwater levels is recognised to significantly reduce the accessibility of infrastructure to abstract water from the aquifer and adversely affect the security of supply. The thresholds are as defined by the Resource Share Guidelines for Groundwater (DELWP 2015)

F.3 Traralgon Formation Aquifer System

Table 12.27 : Defined Thresholds for the Traralgon Formation Aquifer System

Value Category	Threshold	Rationale
Natural Resource	• Quantity - A predicted decline of **> 70 m in the Traralgon Formation Aquifer System**, in key regional TFAS monitoring bores and catchment scale, after 30 years. • Quality – A predicted decline of the potentiometric level does not result in the aquifer becoming unconfined. • Quality – Predicted **exceedance of SEPP segments A1 to B**, in key regional TFAS monitoring bores and at a catchment scale. • Quality – Predicted exceedance of statistically significant baseline data (outside the 5th and 95th percentile range) in key regional TFAS monitoring bores.	• A predicted decline of > 70 m in the Traralgon Formation aquifer significantly changes the function of water users and/or access to the natural resource. Defined by the Gippsland Region Assessment of Potential Effects on Water Resources (Jacobs 2015). • Under the SEPP guidelines, the current and potential beneficial use of the aquifer should be protected – exceedance of the segments indicates that the beneficial use of the groundwater has been reduced. • Exceedance of the statistically significant baseline data indicates that groundwater quality is being degraded at the mine scale.
Economic/Water Use	• Quantity - A predicted decline in groundwater levels of **> 10% of the saturated thickness** of the Traralgon aquifer system, in key regional TFAS monitoring bores and at a catchment scale • Quantity – A predicted decline in the permissible consumptive volume which is **> 100% of the current PCV**.	• A predicted decline in groundwater levels is recognised to significantly reduce the accessibility of infrastructure to abstract water from the aquifer and adversely affect the security of supply. The thresholds are as defined by the Resource Share Guidelines for Groundwater (DELWP 2015)

F.4 Groundwater Management Areas

See Aquifer System thresholds defined in Appendix F.1, Appendix 0 and Appendix 0

F.5 Buckley's Hill Reservoir

Table 12.28 : SEPP WQOs

Indicators (units)		Segment B (*predominantly forests and forestry activities*)
pH (pH units)	Acceptable range	5.5 – 8.0
Dissolved Oxygen (mg/L and % saturation)	Min. concentration	>8.0
	Min. saturation	>85%
Toxicants (formula)	Maximum	<T*
Salinity (mg/L)	an. 90th percentile	<200
	Maximum	<300

Indicators (units)		Segment B (*predominantly forests and forestry activities*)
Suspended solids (mg/L)	an. 50th percentile	<5
	an. 90th percentile	<10
Turbidity (NTU)	an. 50th percentile	<5
	an. 90th percentile	<10
Colour (Pt.Co units)	an. 50th percentile	N/A
	an. 90th percentile	N/A
Total phosphorous (mg/L)	an. 50th percentile	<0.015
	an. 90th percentile	<0.030
Total nitrogen (mg/L)	an. 50th percentile	<0.60
	an. 90th percentile	<1.00
E. coli (org/100mL)	42-day geometric mean	N/A
Temperature: variation from N (deg. Celsius)	an. 90th percentile	<0.3
	maximum	<0.5
	rate of change	<1.0 in 30 minutes
pH (pH units)	variation from N	<0.5
Salinity	% increase	<5%
Colour	% increase	N/A

F.6 Thomson Dam

Table 12.29 : SEPP WQOs

Indicators (units)		Segment B (*predominantly forests and forestry activities*)
pH (pH units)	Acceptable range	5.5 – 8.0
Dissolved Oxygen (mg/L and % saturation)	Min. concentration	>8.0
	Min. saturation	>85%
Toxicants (formula)	Maximum	<T*
Salinity (mg/L)	an. 90th percentile	<200
	Maximum	<300
Suspended solids (mg/L)	an. 50th percentile	<5
	an. 90th percentile	<10
Turbidity (NTU)	an. 50th percentile	<5
	an. 90th percentile	<10
Colour (Pt.Co units)	an. 50th percentile	N/A
	an. 90th percentile	N/A

Indicators (units)		Segment B (*predominantly forests and forestry activities*)
Total phosphorous (mg/L)	an. 50th percentile	<0.015
	an. 90th percentile	<0.030
Total nitrogen (mg/L)	an. 50th percentile	<0.60
	an. 90th percentile	<1.00
E. coli (org/100mL)	42-day geometric mean	N/A
Temperature: variation from N (deg. Celsius)	an. 90th percentile	<0.3
	maximum	<0.5
	rate of change	<1.0 in 30 minutes
pH (pH units)	variation from N	<0.5
Salinity	% increase	<5%
Colour	% increase	N/A

F.7 Rehabilitated Mine Void Water Bodies

The configuration of each mine void waterbody and its intended use (i.e. recreational, fishing, etc.) will define the water quality metrics and thresholds which need to be maintained, and these will need to be determined after the completion of detailed modelling to support the mine operators' Declared Mine Rehabilitation Plans.

F.8 Morwell Main Drain

Table 12.30 : SEPP WQOs

Indicators (units)		Segment E (predominantly the industrial area of the Latrobe Valley)
pH (pH units)	Acceptable range	6.0 – 8.5
Dissolved Oxygen (mg/L and % saturation)	Min. concentration	>5.0
	Min. saturation	>55%
Toxicants (formula)	Maximum	<T*
Salinity (mg/L)	an. 90th percentile	<500 (except Latrobe River upstream of Glengarry Rd when <350 shall apply)
	Maximum	<700 (except Latrobe River upstream of Glengarry Rd when <400 shall apply)
Suspended solids (mg/L)	an. 50th percentile	<50 (except Latrobe River upstream of Glengarry Rd when <35 shall apply)
	an. 90th percentile	<90 (except Latrobe River upstream of Glengarry Rd when <70 shall apply)
Turbidity (NTU)	an. 50th percentile	<25
	an. 90th percentile	<50
Colour (Pt.Co units)	an. 50th percentile	<60
	an. 90th percentile	<100

Indicators (units)		Segment E (predominantly the industrial area of the Latrobe Valley)
Total phosphorous (mg/L)	an. 50th percentile	<0.060
	an. 90th percentile	<0.100
Total nitrogen (mg/L)	an. 50th percentile	<0.90
	an. 90th percentile	<1.60
E. coli (org/100mL)	42-day geometric mean	<200
Temperature: variation from N (deg. Celsius)	an. 90th percentile	<1.5 except industries existing as at 1 January 1996 and discharging to Traralgon Ck where <3.0 shall apply Dec to March; and industries existing as at 1 January 1996 and discharging to Morwell River where <3.0 shall apply Dec to March
	maximum	<2.0 except industries existing as at 1 January 1996 and discharging to Traralgon Ck where <3.5 shall apply Dec to March; and industries existing as at 1 January 1996 and discharging to Morwell River where <4.0 shall apply Dec to March and <6.0 shall apply April to Nov
	rate of change	<1.0 in 30 minutes except industries existing as at 1 January 1996 and discharging to Traralgon Ck where <2.0 in 30 minutes shall apply; and industries existing as at 1 January 1996 and discharging to Morwell River where <2.0 in 30 minutes shall apply
pH (pH units)	variation from N	<1.0
Salinity	% increase	<10%
Colour	% increase	<20%

F.9 Water Entitlement Holders (as listed in the Victorian Water Register)

See River and Waterway thresholds defined in Appendix C.1, and Appendix C.5, and Aquifer System thresholds defined in Appendix F.1.