Tullaroop Integrated Catchment Management Plan

Background Paper

Geoff Park and Anna Roberts (Natural Decisions) Caitlin Dunolly-Lee (Dja Dja Wurrung Aboriginal Clans Corporation)

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Acknowledgement of Country

The North Central Catchment Management Authority acknowledges Traditional Owners within the region, their rich culture and spiritual connection to Country. We also acknowledge the contribution and interest of Aboriginal and Torres Strait Islander people and organisations in land and natural resource management, and pay respects to Elders past, present and emerging.

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Guidance for reading this document

This Background Paper is a comprehensive and lengthy document. It has been developed to support the development of the ICMP and in particular as pre-reading for participants in the two INFFER workshops that will be held to gather information and knowledge that informs the assessment of ICMP options.

As a guide we suggest that you focus on the Discussion Boxes at the start of key sections throughout the document. These include some questions and prompts to inform your contribution to the workshops.

We would be happy for you to read it all but don't expect you to!

Introduction

The Tullaroop catchment has been identified as a key area where better collaboration between Central Highlands Water (CHW), North Central Catchment Management Authority (CMA), Hepburn Shire, Central Goldfields Shire, City of Ballarat, Goulburn Murray Water (GMW) and other stakeholders and the community could improve integrated catchment management outcomes. The catchment, including Tullaroop Reservoir and its feeder waterways, is also of major cultural significance to the Traditional Owners the Jaara people, represented by Dja Dja Wurrung Clans Aboriginal Corporation.

Water reform and predicted future climate change is likely to place an increasing demand on water resources in the north central region as a whole including the Tullaroop catchment. This will pose significant challenges in balancing the environmental, economic, cultural and social requirements for water, and require an explicit assessment of trade-offs associated with achieving shared catchment goals.

There is significant complexity around the issues in the catchment, the roles and responsibilities of the different stakeholder organisations involved and therefore a need to bring all parties together to determine what can feasibly be achieved in the Tullaroop catchment.

Integrated Catchment Management (ICM) has been variously defined and understood (Natural Decisions, 2018). The application of the term ICM in this project is ...

The coordinated management of land, water and biodiversity resources based on catchment areas. It incorporates environmental, economic and social considerations. This approach seeks to ensure the long-term viability of natural resource systems and human needs across current and future generations. Integrated catchment management requires a partnership between Catchment Management Authorities (CMAs), regional communities and other management partners (DELWP, 2016).

The approach to the development of the Tullaroop Integrated Catchment Management Plan (ICMP) is guided by a set of principles as outlined in Appendix A.

The need for the development of an ICMP was explored by the North Central CMA in 2019 (RMCG, 2019) through a series of workshops that brought together representatives from catchment authorities, water corporations, government agencies, Landcare and other interested community groups. These stakeholders explored the need to develop an ICMP for the Tullaroop catchment,

identified focus areas, considered potential barriers and discussed the long-term vision for the catchment.

Purpose

This Background Paper has been developed to synthesise key information relevant to improving the management and condition of land and water resources in the Tullaroop catchment.

The paper provides an overview of:

- The Tullaroop catchment and key threats and issues faced.
- Significant environmental assets in the catchment, condition and trends
- Preliminary thinking on scope and SMART¹ objectives
- Current projects and initiatives
- Key knowledge gaps
- ICMP development process using INFFER²

The North Central CMA and CHW are keen to bring stakeholders together to explore opportunities for collaboration through the identification of shared goals and a preliminary assessment of the feasibility of options that improve environmental outcomes for the catchment and downstream assets. Providing an integrated approach to catchment management within declared water supply protection catchments will be important to maintain the long term health of the their natural resources.

The paper also outlines the approach to the INFFER assessment with a focus on information required for a preliminary assessment of actions required to improve the condition of significant assets, in particular river health, water quality and security of water resources.

Dja Dja Wurrung perspectives and aspirations

Jaara people have lived on our traditional lands and cared for our County over many thousands of years. For us, Country is more than just a landscape, it is more than what is visible to the eye - it is a living entity that holds the stories of creation and histories.

Rivers such as the Loddon and its tributaries, including the Tullaroop Creek as well as associated swamps and wetlands – these are significant parts of our Country that link us to our past and will provide for our future.

Goal 5 of the 'Dhelkunya Dja Country Plan' states that: Our rivers and waterways are healthy and meet the needs of our people and land.

Traditional Aboriginal culture revolved around relationships to the land and water – relationships that hold deep physical, social, environmental, spiritual and cultural significance. Today, the land and its waterways remain central to our cultural identity and aspirations for community and economic development. Our rivers are the veins of Country, and provide food and medicine, and places to camp, hunt, fish, swim and hold ceremonies. They are places that are central to our creation stories, and many of our cultural heritage sites are associated with waterways – burial sites, birthing sites

¹ Specific, Measurable, Attainable, Realistic and Time-bound (see https://www.inffer.com.au/using-inffer/setting-smart-goals/)

² INFFER (Investment Framework for Environmental Resources) - <u>www.inffer.com.au</u>

and middens. Our waterways are places that we connect with our ancestors and pass traditional knowledge on to our children and grandchildren.

To achieve our goal, we aim to:

- Ensure all of our waterways are healthy, with the right water in the right place at the right time to meet the needs of the environment, Jaara people and the broader community
- Have a recognised and legitimate role in water governance, with genuine consultation in policy development and a part in decision-making about our waterways
- Secure adequate and equitable water rights that meet our social, cultural, spiritual, economic and environmental needs
- Share our creation stories to teach people of how water works in the landscape

Recognition and Settlement agreement

The Victorian Government and the Dja Dja Wurrung Clans Aboriginal Corporation (DDWCAC) (on behalf of the Dja Dja Wurrung Traditional Owner group) have entered into a 'Recognition and Settlement Agreement' which formally recognises the Dja Dja Wurrung people as the Traditional Owners for part of Central Victoria.

The Dja Dja Wurrung Recognition Settlement Agreement (RSA) includes 'Natural Resource Management Participation Strategies', under which the State of Victoria has committed to provide the Dja Dja Wurrung people (through DDWCAC) with the opportunity to 'actively participate in the development and review of natural resource management policies and strategic plans, and regional management and action plans' within the Agreement area, in order to further Dja Dja Wurrung people's rights and interests in water.

Schedule 16 – Natural Resources Management Participation Strategies of the Dja Dja Wurrung Settlement Agreement includes partnership arrangements between Dja Dja Wurrung and North Central CMA, which commits both parties to further developing a mutually beneficial relationship that will allow the organisations to work proactively together to build capacity, capability and sustainability. The Memorandum of Understanding (MoU) aims to define and further the relationship between the two organisations to deliver on North Central CMA commitments regarding the Dja Dja Wurrung RSA and to deliver outcomes that go beyond compliance with the RSA. The RSA also includes a draft authorisation order, which authorises the take and use of water from a waterway or bore to meet any personal, domestic or non-commercial communal needs of Dja Dja Wurrung people³.

Cultural Heritage

Within the Cultural Landscape there are memories and stories of past visits and management of Country pre-colonisation. All waterways are culturally sensitive areas that trigger the Aboriginal Heritage Act 2006. Causing harm to Aboriginal heritage is a criminal offence under this Act, as is undertaking an act likely to harm Aboriginal heritage.

³ This order authorises the taking and use of water from a waterway or bore only where the Dja Dja Wurrung member has access to a waterway or bore in the circumstances set out in section 8(1) of the Victorian Water Act.

For the purposes of the Aboriginal Heritage Act 2006, all riparian land in Victoria is designated as an 'area of cultural sensitivity. Additionally, all land within 200 metres of named waterways is prescribed as being an 'area of cultural sensitivity' under the Aboriginal Heritage Regulations 2007.

Through RSA negotiations Dja Dja Wurrung have also secured freehold title to a property between Tullaroop Reservoir and Carisbrook, a culturally significant place to the Jaara people.

Throughout the Tullaroop catchment numerous sites have been recorded in the AAV system such as artefact scatters, scarred trees, grinding grooves and stone arrangements/ceremonial places. These are particularly prevalent along the Tullaroop Creek, Tullaroop Reservoir and the township of Carisbrook. There is also evidence of raised earthen rings, shell middens and fish traps being found in the catchment.

Strategic context

The Tullaroop ICMP is being developed within the context of a number of strategic initiatives at regional, state and Murray-Darling Basin wide scale.

Appendix B describes the roles and responsibilities of the key agencies and stakeholders with an interest in the ICMP.

As well as being subject to the Murray Darling Basin Plan, some of the more important strategies are:

- Northern Region Sustainable Water Strategy (SWS) 2009 and Central Region Sustainable Water Strategy (SWS) 2006 - Sustainable water strategies are statutory processes for statewide water resource planning in Victoria. They are used to manage threats to the supply and quality of water resources to protect environmental, economic, cultural and recreational values. Sustainable water strategies are developed to:
 - Help entitlement holders manage their own risks
 - Identify potential ways to improve waterway health.

DELWP is currently undertaking the new Central region SWS.

- 2. North Central Regional Catchment Strategy The North Central CMA is leading the renewal of the Regional Catchment Strategy (RCS) for 2021-27. The RCS is the overarching strategy for land, water and biodiversity management in the region. It is an important planning document that defines a long-term vision, identifies priority directions and places to direct investment. The North Central Waterway Strategy 2014-22 is a sub strategy of the North Central RCS and outlines waterway priorities and actions for the region.
- 3. Central Highlands Water Urban Water Strategy 2017 A 50-year water outlook for our communities in the Central Highlands region contains information to:
 - Provide context to the water and wastewater services CHW provide and the communities they serve
 - Summarise factors influencing CHW's future service delivery (including population growth, climate change, regulatory requirements, policy directions and customer needs)
 - Assess water supply and demand scenarios for the next 50 years

- Assess wastewater capacity and needs over a 20-30 year outlook
- Identify where action will (or may) be required in the short term (within 5 years) or long term (within 50 years) to meet current and future customer and community needs
- Clearly communicate the strategic actions CHW commit to implementing, and estimated timeframes in which they will be delivered
- 4. Declared Water Supply Catchment Areas, as gazetted under the *Catchment and Land Protection Act 1994*⁴
 - Creswick, Tullaroop and McCallums creeks
- 5. Groundwater Management Areas (GMAs)
 - Loddon Highlands Water Supply Protection Area (WSPA)⁵, which covers contains five groundwater management zones (Blampied, Newlyn, Ascot, Talbot, Waubra)⁶. The Moolort borefields are also just within the Upper Loddon WSPA (and outside the surface water catchment) rather than in the Mid Loddon GMA (the Moolort zone being one of three zones in the Mid Loddon GMA)⁷.
- <u>Dhelkunya Dja Dja Dja Wurrung Country Plan 2014-2034</u> is about re-affirming the aspirations and describing the future of our people, the Traditional Owners of Dja Dja Wurrung Country. It recognises the importance of cultural heritage – significant places and landscapes, stories and language, customs and practices and our responsibilities for looking after Country.

Catchment Overview

The Tullaroop catchment is within the Loddon Basin within the Murray-Darling Basin⁸. An overview of the catchment has been provided by RMCG (2019). The catchment (71,818 ha in total) is the area inclusive and upstream of Tullaroop Reservoir (including Tullaroop, Birch's and Creswick creeks).

Birch's, Creswick and Tullaroop creeks are the major waterways above Tullaroop Reservoir. Beyond economic and urban water supplies, the creeks sustain the interconnected natural and built environment around it. The catchment's waterways and land also support local biodiversity values and recreation. For example, fishing tourism has grown significantly in the catchment (RMCG 2019). A dated but useful detailed overview of the history, geography, soils and land use of the Tullaroop catchment is available⁹. A map of the catchment including recorded works undertaken by the North Central CMA and Landcare is shown in Figure 1.

⁴ http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/dwsc_areas

⁵ https://www.g-mwater.com.au/water-resources/ground-water/management/loddonhighlandswspa

⁶ https://www.g-mwater.com.au/downloads/gmw/Hydrographs/2020/20201117_LODDON_HIGHLANDS_WSPA.pdf

⁷ https://www.g-mwater.com.au/downloads/gmw/Hydrographs/2020/20201117_MID-LODDON_GMA.pdf

⁸ https://www.mdba.gov.au/water-management/catchments/loddon-avoca

http://vro.agriculture.vic.gov.au/dpi/vro/nthcenregn.nsf/0d08cd6930912d1e4a2567d2002579cb/ceb584de29bd139eca25752800055d62/ \$FILE/Tullaroop.pdf

Key threats and issues

Consider the key threats and issues documented in Table 1:

- Have we got the threat levels right? If not, where do you have a different view and why?
- In terms of potential actions have the important ones been captured? What's missing?
- Are there any errors of fact or omission in Table 1?

The catchment faces a range of threats, some of which can be managed and others which are more difficult. An important part of the INFFER analysis and the ICMP development is to make decisions about the threats that will be addressed and those which will not.

Table 1 provides a summary of the major threats and their underlying causes, the impacts of these threats on catchment assets and potential actions that may be required to reduce the impact of these threats. This table was developed through review of available documents and discussions with staff from CHW, GMW and North Central CMA and can be modified if needed. A preliminary assessment of the current magnitude of the threat as well as a prediction of what would happen to this threat over a 20-year timeframe without intervention – that is without implementing the ICMP. Additional supporting information on threats can be found in Appendix C.



Figure 1: Map of the Tullaroop catchment including catchment works undertaken by the North Central CMA and Landcare in recent years.

Table 1: Summary	of key	v threats and	estimated	magnitude of	f threat in	the Tullaroon	catchment.
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Threats to values	Underlying cause/s	Potential impacts on assets and values	Level of threat ¹⁰ – VH, H,M,L	Potential actions
Loss of connection to culture	Population growth, urban encroachment Land use changes	Loss of stories, cultural heritage not protected (including sacred sites and relics), loss of connection to Country	Current – H Future - VH	 Dja Dja Wurrung to be engaged in the ICMP at a collaborative level, which supports self-determination of the Dja Dja Wurrung people in line with their Recognition and Settlement Agreement with the State of Victoria. Dja Dja Wurrung to be supported to complete Cultural Heritage Assessments, Aboriginal Waterway Assessments and other cultural mapping within the ICMP area. This will help to better inform Cultural values in the catchment as well as support the preservation and long term conservation of Cultural material such as Cultural Heritage and Traditional food & fibre sources present in the catchment.
Reduced availability of drinking water, water for agriculture and ecosystems	Climate change and variability	Drinking water: Increased costs to consumers and increasing constraints (e.g. water restrictions) <u>Water for agriculture:</u> Loss of agricultural production and increased costs <u>Water for ecosystems:</u> Continued degradation to ecosystems and species resulting from altered and/or reduced natural flows Areas under most pressure are in the south of the catchment (Coghills Creek, Ascot, Newlyn, Kingston,	Current - H Future - VH	Underlying causes need to be addressed at global scale. The only short-term practical options are to access additional water supplies or make better use of available water (e.g. reduced frequency of algal blooms). Water security issues are summarised further in Appendix C. Further restrictions on water use which will be unpopular with urban residents and irrigators. Additional purchase of entitlements for drinking water which will impact on agriculture. Catchment actions should be focused on maintain/improving catchment integrity and function. Continue to Implement the Loddon Highlands Water Supply Protection Area Groundwater Management Plan.

¹⁰ Without intervention by 2040. VH Very high; H High; M Medium; L Low; VL Very low.

Threats to values	Underlying cause/s	Potential impacts on assets and values	Level of threat ¹⁰ – VH, H,M,L	Potential actions
		Springmount, Tourello)		
Agricultural intensification	Movement of intensive industries (e.g. broiler farms) to the region	Increased pressure on water resources (quantity and quality) Further ecosystem degradation due to subdivision Erosion of agriculture's 'social licence'	Current – H Future - VH	Planning mechanisms (e.g. use Declared Special Water Supply Catchment where these exist under the CALP Act and/or Environmental Significance Overlays) to reduce cumulative impacts. The Moolort borefields appear not to be under a Declared Special Water Supply catchment (within the Mid Loddon Groundwater Management Area not the Loddon Highlands Water Supply Protection Area).
Pollutants (nutrients, sediments, chemicals) run-off from urban and peri-urban land	Population growth and urban development	Decline in condition and function of waterways Blue-green algal blooms on reservoirs and creeks	Current - M Future - H	Best practice waste water management (e.g. septics) and Water Sensitive Urban Design. Maintaining ground cover and minimizing nutrient losses through best management practices (grazing).
Pollutants (nutrients, sediments, chemicals) run-off from farming land	Fertiliser application and poor groundcover from land management practices	Risk of groundwater contamination Increased treatment costs for potable water supplies	Current - M Future - H	 Stock exclusion from waterways through fencing and riparian protection. Maintaining ground cover and minimizing nutrient losses through best management practices (grazing). Updated Hepburn Shire stormwater management plans for Creswick and Clunes.
Pollutant run-off (e.g. heavy metals) from mining sites	Exposure of mine sites to rainfall events	Direct impacts on waterway ecosystems and groundwater	Current - L Future - L	Site specific analysis of contamination levels and rehabilitation of affected sites.
Habitat fragmentation – terrestrial systems	Overgrazing, land clearing, senescence of veteran paddock trees	Much of the damage has already occurred	Current – H Future - H	Protect remaining habitat and develop vegetation corridors – natural regeneration, stock exclusion and re-planting to increase extent and connectivity of terrestrial ecosystems.
Decline in condition and connectivity of riparian ecosystems	Stock access to waterways, land management practices, legacy effects, flow regime change	Loss of indigenous values, culture and connection to land	Current - H Future - H	Protect remaining habitat and develop riparian vegetation corridors – natural regeneration, stock exclusion and re-planting to increase extent and connectivity of riparian lands. Restoration of keystone and significant species.

Threats to values	Underlying cause/s	Potential impacts on assets and values	Level of threat ¹⁰ – VH, H,M,L	Potential actions
		Direct impacts in significant species, ecosystems and processes		Restoration of in-stream habitat features and complexity. Replacement of weeds (e.g. willows, blackberry, gorse) with indigenous species.
Decline in condition of wetlands	Overgrazing and cultivation		Current - H Future - H	Fencing, stock exclusion and restoration of key wetlands.
Salinity	Legacy effect of landscape clearing and land management	Reduced water quality and ecosystem impacts Increasing salinity in reservoirs at times of low flow	Current - L Future - M	Direct actions to reduce surface run-off and groundwater intrusion. Operation of desalination plant at Maryborough WTP. Blending of water sources to improve water quality.
Increased frequency and intensity of flooding	Climate change and variability combined with land management practices	Damage to economic and social assets – most risk to Clunes and Creswick	Current - M Future - M	Levee banks. Large scale catchment planting. Planning amendments to reduce risk to assets. See North Central Regional Floodplain Management Strategy for additional detail ¹¹ .

¹¹ <u>http://www.nccma.vic.gov.au/resources/publications/north-central-regional-floodplain-management-strategy-0</u>

Key assets and values

Consider the information on key assets and values documented in Table 2:

- How well have the values associated with the various assets been captured? Is there anything you disagree with or that is missing?
- Are the estimates of threats to specific assets accurate? If not, why not?
- Are there any errors of fact or omission in Table 2?

An overview of the catchment assets, values and threats is provided in Table 2. In the context of this ICMP an asset is the thing we hope to protect, improve or manage better through a proposed project (a suite of actions). It could be large or small, degraded or pristine, localised or dispersed. An asset could be a single localised thing (for example, a particular wetland or river), or it could be a collection of smaller assets, such as remnant vegetation on farms in a region, or agricultural land in a region. It can be defined to be part of a larger asset (e.g. one river reach within a river) or the entire larger asset (the whole river), depending on what the project is intended to achieve. An asset based approach is used because it supports the INFFER analysis that is being used to underpin the development of the ICMP as well as helping to gain a collective understanding of key assets in the catchment.

The first three columns in Table 2 provide a list of relevant assets and values suggested as within the scope of the ICMP. This was developed from a range of sources including RMCG (2019), documents from CHW and the North Central CMA and our knowledge. Additional supporting information regarding Dja Dja Wurrung cultural values can be found in Appendix D. *It should be noted that the asset list is comprehensive, with some assets included for contextual purposes (e.g. assets outside the catchment but part of the CHW water supply system, as well as within catchment assets where it is understood that they will not be the focus of ICMP actions).*

The values of significant assets can be affected by a range of different but often inter-related threats. Part of the project refinement will be to agree which threats will be addressed and the extent of asset works and management that will be undertaken. Key threats to specific assets that have the potential to be addressed in this ICMP project are summarised in Table 2. The highest threats to water assets have largely been drawn from CHW Risk Registers and discussion with stakeholders. Tables 1 and 2 provide the basis for agreeing on the scope of the INFFER analysis including goals and actions to be undertaken to address some of the threats posed.

Table 2 also contains a list of major soil types and land uses within the catchment. The main land uses of cropping (cereals and potatoes) and grazing are likely to remain the dominant land uses in the catchment, albeit that potato cropping trends will be largely determined by buyer and processor needs¹².

¹² RMCG (2019). Potato stakeholder needs analysis and extension strategy development. Report to Hort Innovation http://www.rmcg.com.au/app/uploads/2019/08/PT18003-Potato-strategy_Final-report.pdf

Table 2: Summary o	f assets and	values for the	Tullaroop catchment.
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Asset class	Asset group	Values	Level of threat (VH, H, M, L VL ¹³)
Waterways	High priority waterways in	Economic: Water supply, stock water	<u>High</u>
	North Central Waterway Strategy, e.g. Birch's Creek (Reach 21), Tullaroop Creek (Reach 19)	Environmental: Waterway ecosystems habitat and	High for sediments and nutrients.
		significant species. Includes river blackfish, mountain galaxias, flat-headed gudgeon, Australian smelt, Australian water-rat (Rakali) and platypus ¹⁴	Medium for contaminated runoff from biosolids recycling facility enters Birch's Creek (Note that facility has storm water retention and is connected
		<u>Cultural:</u> Heritage Victoria has identified several	to the Clunes Wastewater Treatment Plant).
		European heritage sites ¹³ . All waterways are culturally sensitive areas that trigger the <i>Aboriginal</i> <i>Heritage Act 2006</i> . Cultural food and fibre resources, significant species associated with tradition and ceremony, abundant Cultural Heritage, evidence of occupation and legacy, significant cultural landscape features, contemporary use. <u>Social:</u> Popular for fishing, landscape and amenity values and passive recreation	High threat from urban storm water from Creswick and Clunes and Wastewater Treatment Plan (WWTP).
	Other waterways, e.g.	Economic: Water supply, stock water	High
	Creswick Creek, Coghills Creek and tributaries	<u>Environmental:</u> Some tributaries support significant flora ¹⁶ , fish and mammal species	High threat of sediments and nutrients ¹⁷ . High threat from urban storm water from Creswick
		Cultural: as for high priority waterways	and Clunes and WWTP.
		Social: Passive recreation, landscape and amenity values	
Seasonal Herbaceous	High value wetlands – Merin	Environmental: Wetland ecosystems habitat and	<u>High</u>

 ¹³ VH Very high; H High, M Medium; L Low; VL Very low.
 ¹⁴ North Central Catchment Management Authority Basin 7 – Loddon Management Unit 5 – Tullaroop Creek Catchment Stream – Birch's Creek (7/1-48-25) August 2006.
 ¹⁵ North Central Catchment Management Authority Basin 7 – Loddon Management Unit 5 – Tullaroop Creek Catchment Stream – Birch's Creek (7/1-48-25) August 2006.
 ¹⁶ Hairy Anchor Plant (rare) and Plains Yam-daisy (vulnerable) recorded along Creswick Creek.
 ¹⁷ VH VERSE Construction of the stream of the st

¹⁷ North Central Catchment Management Authority Basin 7 – Loddon Management Unit 5 – Tullaroop Creek Catchment Stream – Coghills Creek (7/1-48-29) August 2006

Asset class	Asset group	Values	Level of threat (VH, H, M, L VL ¹³)
Wetlands (Freshwater) of the Temperate Lowland Plains – are these a separate category or past of high and low value wetlands	Merin and Middle swamps, Long Swamp ¹⁸ plus other smaller wetlands (e.g. Brolga Swamp) of the Moolort complex (these typically drain to groundwater with no surface flow to Tullaroop Creek but remain significant catchment features)	significant species <u>Social:</u> significant landscape and amenity values <u>Cultural:</u> as for high priority waterways	Merin Merin and Middle Swamps are public land (managed by Parks Victoria), while Long Swamp has permanent protection through a Trust for Nature covenant. Level of threat is moderate from pest plants and animals, while impact of climate change is High to Very high. Smaller wetlands (privately owned) threatened by overgrazing and cropping (High) and climate change (High to Very high).
Water storages ^{19 20}	Tullaroop Reservoir ²¹ (74,000 ML, CHW annual entitlement 1,200 ML with potential for 900ML carryover)	Economic: Irrigation (downstream water users) is dominant use, Maryborough partial potable water supply, domestic and stock use Environmental: Aquatic habitat, drought refuge, fish stocks Social: Recreation including boating (non-motorised) and fishing	 <u>Very high</u> Very high for <i>E.coli</i> or Total Coliforms, virus non- compliance, <i>Cryptosporidium</i> and <i>Giardia</i>, algal blooms²² resulting from agricultural land use and stock access. High for erosion²³. High for <i>E.coli</i> or Total Coliforms, virus, protozoa non-compliance from waste water discharge, human interference and recreational activities/non- compliance²⁴. High Salinity high TDS GW and base flows throughout catchment, any high flow reduction will reduce the ability to freshen up reservoirs and require use of the desalination plant.

¹⁸ Artificially connected to Tullaroop via a drain and drains into Tullaroop Creek below Tullaroop Reservoir.

¹⁹ Note that Evansford (1,346 ML) which partly supplies Maryborough is not within scope. Its issues are high bacteriological counts and high turbidity from main land uses (grazing, cropping and potatoes). Evansford has same level of threat from CHW Maryborough Risk Register as for Tullaroop.

²⁰ Talbot Reservoir (846 ML) which partly supplies Maryborough is not within scope. Talbot has the same level of threat from CHW Maryborough Risk Register as for Tullaroop.

²¹ Water quality: pH exceeded in 6/10 years; EC exceeded 2/10 years when levels low; Turbidity generally ok, exceed 1/10 years; TN exceeded SEPP 6/10 years; TP exceeded SEPP 4/10 times, FRP 3/10; chlorophyll exceeded 5 times, phaeophytin 0. BGA 5/10 years; WQ Index good (pH, EC, turbidity and P excellent; N poor; chorophyll and BGA very poor). From GMW Major Storages 2018 Water Quality Report

²² WQRMP Appendix D 20200122 Maryborough Risk Register incl summary.xlxs

²³ WQRMP Appendix D 20200122 Maryborough Risk Register incl summary.xlxs

²⁴ WQRMP Appendix D 20200122 Maryborough Risk Register incl summary.xlxs

Asset class	Asset group	Values	Level of threat (VH, H, M, L VL ¹³)
	Centenary Reservoir (180 ML)	<u>Economic:</u> Storage prior to Maryborough Water Treatment Planwater from Tullaroop, Evansford and Talbot Reservoirs and Moolort and Stoney Creek borefields (groundwater).	Noted for context – out of scope for ICMP actions
	Newlyn Reservoir ^{25 26} (3,280 ML, CHW entitlement 500 ML)	<u>Economic:</u> Supplies Tullaroop through Birch's Creek. Also supplies Ballarat (including Creswick) water supply, irrigation, domestic and stock use <u>Environmental:</u> Aquatic habitat, drought refuge, fish stocks Social: Fishing only	High Assessment based on GMW storages report re chlorophyll and BGA
	Hepburn Lagoon ^{27 28} (3,040 ML)	Economic: Hepburn supplies Tullaroop through Birch's Creek. Irrigation, stock and domestic use Social: Recreation including boating (non-motorised) and fishing Environmental: Aquatic habitat, drought refuge, fish stocks and supports a large birdlife population	Very high Assessment based on GMW storages report re chlorophyll and BGA
	Dean Reservoir (164 ML)	Economic: Offline storage for Dean (not in use). Dean is supplied by groundwater while Dean Reservoir is purely for recreation. Environmental: Aquatic habitat, drought refuge, fish stocks Social: Fishing only	Noted for context – out of scope for ICMP actions
	Cosgrave Reservoir (680 ML)	Economic: Supplies Tullaroop and also Ballarat water supply (including Creswick)	Very high Very high for cattle grazing for <i>E.coli</i> and virus,

²⁵ pH ok; Turbidity usually ok; EC in normal SEPP range but increasing; TN commonly exceeds SEPP; TP commonly exceeds SEPP; FRP ok; Chlorophyll and phaeophytin commonly exceed ANZECC but no BGA alerts to 2018; WQ Index Good (excellent for pH, turbidity, EC and BGA; good for P; very poor for N and chlorophyll)

²⁶ In upper reaches of Birch's Creek catchment

²⁷ pH increasing trend; EC generally ok but increasing trend; Turbidity and BGA problematic; TP exceeds ANZECC every year and FRP on about half of years; chlorophyll exceeds ANZECC in all years and phaeophytin sometimes; WQI score is poor (chlorophyll and BGA very poor; turbidity, pH and N poor; P fair; EC excellent).

²⁸Also in upper reaches of Birch's Creek catchment on Langdon Creek.

Asset class	Asset group	Values	Level of threat (VH, H, M, L VL ¹³)
		Environmental: Aquatic habitat, drought refuge, fish	Cryptosporidium and Giardia ²⁹
		stocks	High for turbidity ³⁰
		Social: Fishing only	High for septic tank failure for <i>E.coli</i> and virus, Cryptosporidium and Giardia ³¹
			High for Cyanobacteria and other odourous algae bloom in reservoir ³²
			Very high for illegal human access ³³
			High for illegal dumping of pollutants ³⁴
Groundwater sources used for drinking water supplies	Moolort borefields – within mid Loddon Groundwater Management Area (GMA)	Economic: Supplementary drinking water source for Maryborough and connected towns	Noted for context – out of scope for ICMP actions
	Stoney Creek borefields ³⁵ (Upper Loddon) – within the Loddon Highlands Water Supply Protection Area (WSPA) – McCallums Creek catchment	Economic: Supplementary drinking water source for Maryborough and connected towns	Noted for context – out of scope for ICMP actions
	Clunes bores 1-3 - within the Loddon Highlands Water Supply Protection Area (WSPA)	Economic: Drinking water for Clunes	HighHigh from cattle grazing (<i>E.coli</i> , Total Coliforms, virus, <i>Cryptosporidium</i> and <i>Giardia</i>)36Medium from sewer leaks37Low from industrial land use (e.g. service stations,

²⁹ BI 12 5197 Appendix D 202010 20 WQRMP Ballarat Risk Register. xlxs

³⁰ BI 12 5197 Appendix D 202010 20 WQRMP Ballarat Risk Register. xlxs

³¹ BI 12 5197 Appendix D 202010 20 WQRMP Ballarat Risk Register. xlxs

³² BI 12 5197 Appendix D 202010 20 WQRMP Ballarat Risk Register. xlxs

³³ BI 12 5197 Appendix D 202010 20 WQRMP Ballarat Risk Register. xlxs

³⁴ BI 12 5197 Appendix D 202010 20 WQRMP Ballarat Risk Register. xlxs

³⁵ Stoney Creek borefield (near Talbot Reservoir) which partly supplies Maryborough - not in scope.

³⁶ BI 12 5200 WQRMP Appendix D Clunes Risk Register incl summary. xlxs

³⁷ WQRMP Appendix D 20200122 Maryborough Risk Register incl summary.xlxs

Asset class	Asset group	Values	Level of threat (VH, H, M, L VL ¹³)
			mechanics etc.) ³⁸
			Also for noting: Trihalomethanes (THMs) ³⁹ ranged
			between 0.15-0.24 mg/L (std must not exceed 0.25)
	Dean bore	Economic: Drinking water for Dean	Noted for context – out of scope for ICMP actions
Native vegetation and	Grey Box (Eucalyptus	Environmental: Ecosystem service provision and	High to very high
habitat	microcarpa) Grassy	habitat for threatened species	Only small remnants remain across the VVP and
	Woodlands and Derived	<u>Cultural:</u>	these are threatened by a suite of interacting threats
	Eastern Australia		(e.g. over grazing, weed invasion, firewood removal)
			as well as the legacy effects of past cleaning.
legnia cregios	Diaturaus	Environmentely Keystene energies in aquetic	
iconic species		environments	
	Australian water-rat (Rakali)	Cultural: Food sources, totem species (platypus)	Declining water quality, nabitat loss and degradation and loss of hydrological connectivity
		symbolism in lore and Dreaming, important	
		connections to Country, source of food and fibre,	
		species of Traditional importance.	
Threatened species -	Brolga, swift parrot,	Environmental: species of conservation importance	High to very high
fauna	Australian painted snipe,	Cultural: Food sources, totem species (brolga),	Decline in extent and quality of habitat, predation by
	Treckled duck, river blackfish	women's business (brolga), ceremonial (brolga)	cats and foxes
		symbolism in lore and Dreaming, source of food and	
Threatened energies	Chiny rice flower bytton		Lligh to yon high
flora	wrinklewort	Environmental: species of conservation importance	<u>Align to very nign</u>
		<u>cultural:</u> species of Traditional Importance, source of	Relict populations susceptible to habitat loss and
Towns	Croquiek Clupes	Feenemia, secial and sultural values	Madium
TOWNS	Creswick, Clunes	conomic, social and cultural values	
			Flooding risk

³⁸ WQRMP Appendix D 20200122 Maryborough Risk Register incl summary.xlxs

³⁹ Trihalomethanes (THMs) are a range of organic compounds formed when chlorine reacts with naturally occurring organic matter in water supplies. At elevated levels, THMs have been associated with negative health effects such as cancer and adverse reproductive outcomes.

Asset class	Asset group	Values	Level of threat (VH, H, M, L VL ¹³)
Localities	Newlyn ⁴⁰ , Kingston, Smeaton, Dean and several smaller ones within catchment	Economic, social and cultural values	Noted for context – out of scope for ICMP actions
Agricultural and rural land	Basalt – productive, well drained and well structured	Economic: Potatoes, cereals, grazing	Medium Threats on individual properties can be very high but
	Basalt – poorly drained, low permeability, can be sodic	Economic: Cereals and grazing	overall commercially oriented farms are managed with protection of the soil asset base in mind.
	Basalt – stony crests	Economic: Grazing	
	Ordivician sediments – red and yellow duplex	Economic: Grazing	
	Volcanic landscapes	<u>Cultural:</u> The volcanic cones associated with the Tullaroop catchment are recognised for their contribution to landscape significance ⁴¹ and components of cultural landscape elements (e.g. stone arrangements and walling)	Medium Major threat arises from inappropriate development (e.g. housing) on significant landscape elements.

 ⁴⁰ Newlyn, Smeaton and Kingston are unsewered.
 ⁴¹ Landscape significance is the designation of a particular landscape as special or important arising from its cultural landscape values, including aesthetic values (both visual and non-visual) historic, environmental, scientific, social or other values (see DPCD South West Victoria Landscape Assessment Study, Planisphere, 2013)

Preliminary thinking on SMART objectives

Thinking about the purpose of the ICMP ...

- What do you think should be the main objectives and how might you word them to be SMART?
- Looking at the actions in Table 3, which ones do you see as being the most effective to meet the purpose of ICMP?
- Of these actions what do you see as the main challenges in terms of:
 - Technical feasibility?
 - Adoption by landholders?
 - Cost?
 - Implementation by the key organisations and agencies coordinating the ICMP?

While the foundational RMCG work for this project identified a variety of different, in most cases complementary, visions for the Tullaroop catchment, as well as a suite of priority actions, the ICMP will be developed to support a business case for catchment investment.

This requires, amongst other things, that the ICMP is underpinned by SMART objectives, well described methods, uses sound available evidence (scientific, social, economic, cultural and local knowledge) and demonstrates the capacity for adaptive management in response to new knowledge or changing circumstances.

SMART refers to specific, measurable, achievable, relevant and time-bound. It is critical for ICM projects to have such objectives for at least three reasons: 1) it encourages rigour and shared understanding of what the project is aiming to achieve; 2) enables assessment of whether the project methods are sound and can achieve the aims; 3) enables evaluation of whether objectives have been achieved.

Ideally SMART objectives are developed in relation to the key values that catchment stakeholders seek to protect and are described in a way that enables the benefits and costs of achieving these objectives to be assessed in a robust and transparent way. An example of a SMART objective is:

- By 2040 there is no uncontrolled livestock access to Tullaroop Creek, Birch's Creek and Creswick Creek through fencing to protect riparian areas to a width of 20 m from the top of bank.

Given the scope of the project is around water supply protection including riparian management and protection of cultural values, broad scale habitat restoration is not anticipated except where it is critical to protect other values.

Table 3 provides the basis upon which to develop SMART objectives through agreeing which assets and the types of actions required are within the scope of the INFFER analysis. Anything that is within scope will have a SMART objective developed along with then estimates of area/length of action required and cost (initial and on-going costs). In addition to protecting assets another key decision is whether the ICMP will address reduced water availability through climate change impacts, given both the supply and demand projections foreshadowed⁴².

⁴² Reduced water availability from climate change impacts is expected to be embedded in the Northern SWS. The ICMP should look to the likely impacts to catchment values given a reduction in streamflow and change in climate (Peter Field, pers. comm.).

Table 3: Assets and actions within and out of scope for the ICMP.

Asset class	Asset group	Potential actions which need to be undertaken	Agreed as within scope or out and additional comments
Waterways	High priority waterways in North Central Waterway Strategy, e.g. Birch's Creek (Reach 21), Tullaroop Creek (Reach 19)	Stock exclusion from waterways through fencing and riparian protection (20 m minimum width) from top of bank).	In scope. Key part of catchment protection and North Central CMA priorities
	Other waterways, e.g. Creswick Creek, Coghills Creek and tributaries	Stock exclusion from waterways through fencing and riparian protection (suggested to be 20 m from top of bank).	In scope. Important from the perspective of better protecting drinking water supplies as well as improving environmental values
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains – are these a separate category or past of high and low value wetlands	High value wetlands – Merin Merin and Middle swamps, Long Swamp.	Merin Merin and Middle Swamp on public land and Long Swamp (Trust for Nature) so largely protected except for weed/pest control. Weed/pest control actions. Regulation control structure at existing western outlet ⁴³ .	In scope. Important from cultural and environmental perspective, not directly important for drinking water supply protection.
	Smaller wetlands of the Moolort complex, e.g. Brolga Swamp	Stock exclusion through fencing and riparian protection for remaining unfenced wetlands (some already protected).	In scope. Important from cultural and environmental perspective, protection of wetlands from intensive agriculture (nutrients from poultry, nutrients and chemicals from cropping) indirectly affects drinking water supply from groundwater.
Water storages ^{44 45}	Tullaroop Reservoir	Fencing is in place to restrict access near urban offtake as this is a high risk from WS perspective. Reservoir already has water access. Given this fencing and stock exclusion seems of limited use unless there are large	In scope. CHW would like to encourage and/or partner GMW in the development of a management plan to manage risks to water quality surrounding the storage. GMW may be reluctant as stock access enables

 ⁴³ 150 metres to the east of the Cotswold Road.
 ⁴⁴ Note that Evansford (1,346 ML) which partly supplies Maryborough is not within scope. Its issues are high bacteriological counts and high turbidity from main land uses (grazing, cropping and potatoes). Evansford has same level of threat from CHW Maryborough Risk Register as for Tullaroop.

⁴⁵ Talbot Reservoir (846 ML) which partly supplies Maryborough is not within scope. Talbot has the same level of threat from CHW Maryborough Risk Register as for Tullaroop.

Asset class	Asset group	Potential actions which need to be undertaken	Agreed as within scope or out and additional comments
		avoided costs in drinking water treatment costs.	weed control.
	Centenary Reservoir	Reservoir Is surrounded by a security fence and is regularly patrolled. Actions would be increased patrolling and surveillance to ensure no illegal entry.	Noted for context – out of scope for ICMP actions
	Newlyn Reservoir	Fence remaining areas and provide trough water to stock (most areas fenced already ⁴⁶).	In scope. Will reduce chances of algal blooms and most of reservoir is already excluded for stock.
	Hepburn Lagoon	Stock do not access Hepburn Lagoon ⁴⁷	In scope. No actions required from a drinking water perspective but high environmental values due to water depth.
	Dean Reservoir	Reservoir already fenced – the 80 ha surrounding the storage is owned by CHW and leased for agricultural use. Actions would be increased patrolling and surveillance to ensure no illegal entry. Dean bore water is high risk for <i>E.coli</i> , total coliforms & viruses.	Noted for context – out of scope for ICMP actions Used for local fishing. Future management of lease is mixed farming. May be deemed surplus to requirements. Land is freehold and may be sold.
	Cosgrave Reservoir	Very high risk for cattle grazing (pathogens and turbidity) and septic tank failure, high algae blooms, very high for illegal human access and high for illegal dumping of pollutants.	In scope. Will reduce chances of algal blooms and most of reservoir is already excluded for stock.
Groundwater sources used for drinking water supplies	Moolort borefields	Is there potential for greater protection through the Loddon Highlands WSPA?	Noted for context – out of scope for ICMP actions
	Stoney Creek borefields	Actions would need to address arsenic and pesticide dumping from old mining sites, chemicals from cropping and septic tanks for legacy issues.	Noted for context – out of scope for ICMP actions
	Clunes bores 1-3	Actions could address risks from some or all of cattle grazing, sewer leaks, industrial land use through	In scope.

 ⁴⁶ Email from Greg Smith 4th December 2020
 ⁴⁷ Email from Greg Smith 4th December 2020

Asset class	Asset group	Potential actions which need to be undertaken	Agreed as within scope or out and additional	
			comments	
		actions and trihalomethanes (through water		
		treatment?). Bore is next to the Maryborough –		
		Ballarat railway line.		
		Is there potential for greater protection through the Loddon Highlands WSPA?		
	Dean bore	Bore is suspected to be strongly influenced by localised	Noted for context – out of scope for ICMP	
		surface water/groundwater interactions.	actions	
Native vegetation and habitat	Grey Box Grassy	Fencing, natural regeneration and planting.	In scope - where actions are relevant to ICMP	
	Woodlands and Derived		goals	
	Native Grasslands			
Iconic species	Platypus	Waterway restoration actions will have		
	Australian water-rat	complementary benefits for aquatic species.		
	(Rakali)			
Threatened species - fauna	Brolga, swift parrot,			
	Australian painted snipe,			
	freckled duck, river			
	blackfish			
Threatened species - flora	Spiny rice-flower, Button	Largely distant from waterways so unlikely to be		
	wrinklewort	specific actions through ICMP.		
Towns	Creswick, Clunes	Urban stormwater management is a potential action.	Out of scope - Flood protection of towns is not	
			within ICMP scope.	
Localities	Newlyn and others in Table	For unsewered towns and localities - actions could	Out of scope - Locality protection is not within	
	1	include better septic monitoring and compliance	ICMP scope.	
		program.		
Agricultural and rural land	Basalt well drained	Best management practices to maintain groundcover	Only within scope if there are direct actions	
	Basalt poorly drained	and appropriate chemical use.	that have a major and direct effect on water	
	Basalt stony crests		messaging around good land management	
	Ordivician soils		practices will be appropriate.	
	Volcanic landscapes			

Current projects and initiatives

Available works and actions, relevant to integrated catchment management and completed by organisations are shown in Table 4.

Table 4: Works and actions information supplied

Theme	Responsible organisation	Summary of actions	
Waterway and wetland protection	North Central CMA and Landcare groups	22.8 km fencing, 41.8 ha changed riparian grazing management, 444.7 ha revegetation, 29 off stream watering systems and 192.4 ha weed control across Tullaroop catchment asset area (2011-2020), 40.1 km fencing installed along Birch's Creek ⁴⁸ (additional 2019/20 data to be added).	
	Parks Victoria	Merin Merin and Middle Swamp management.	
Water quality	CHW Local government	Drinking Water Quality Risk Management Plan Catchment procedures to identify and control risks to water quality including • Sanitary Survey • Risk Control • Stakeholder Communications Plan • Catchment Hazard Reporting • Catchment Incident Response. • Planning Permit Assessment To be confirmed.	
Water resources	CHW ⁴⁹	Cosgrave Reservoir: 276ha fenced to exclude stock. Bushland is a biodiversity offset site. Informal mountain bike trail around storage. Shoreline fishing permitted.	

⁴⁹ There are a number of declared water supply catchments supplying potable water to Maryborough and district, The McCallum Creek Water Supply Catchment (out of scope) includes the Evansford and Talbot Reservoirs catchments. The area proclaimed comprises the natural catchments to Talbot and Evansford Reservoirs and the catchment to the channel linking McCallum Creek with Talbot Reservoir. The bulk of land in the both catchments is used for farming, both grazing and cropping, and stock generally has unrestricted access to the streams and foreshores of the storages. In addition there are many kilometres of roads all contributing at different times to water quality problems in streams in so far as urban supplies are concerned.

	Dean Reservoir: 116ha land reserve. 80ha leased for agricultural. Riparian zone is fenced
GMW	Tullaroop Reservoir: fencing is in place to restrict access near urban offtake. Some rock armour completed along eastern side of Tullaroop (2km) to reduce the effects of erosion.
	Hepburn Lagoon: Stock do not access
	Newlyn Reservoir: Some stock access to Newlyn Reservoir but most areas fenced off and water provided in troughs.

Information quality and knowledge gaps

There is always imperfect knowledge and it is useful to make comment on the level of uncertainty of various pieces of information. These are shown in Table 5.

Table 5.	Information	and k	knowledge	gaps
	mormation	unui	momeage	Bubs

Issue	Quality of existing	Comment
	information/data	
Future climate change impacts on catchment flows	Low/Moderate	Updated modelling of catchment run-off under future climate scenarios will be required to inform water resource and ICM planning.
Blue-green algal blooms	Low/Moderate	Whilst there is good information on the frequency and severity of algal blooms for GMW storages the causal factors are not well understood ⁵⁰ or not articulated.
Extent and success of past works and actions	Moderate	Some information available (e.g. 56% Birch's Creek has been protected) but requires collation and analysis, for example length of waterways fenced/requiring fencing.
Catchment condition	Moderate	Reasonable information on waterway health, less so for agricultural land and habitat.
Current threats – impact and intensity	Moderate	General information but lack of detailed understanding on relative intensity/importance of issues.
Future threats – impact and intensity	Moderate	Future climate trends indicate a warmer, drier climate with increased intensity of episodic events. Limited knowledge of possible synergistic effects with other threats.
Landholder adoption of recommended land and water management practices	Moderate	Likely to be reasonable anecdotal information but limited hard data on farm scale economics and likelihood of adoption ⁵¹ .
Technical feasibility of recommended practices/actions	Moderate	Will rely on improved knowledge of catchment behaviour, priority issues and actions – likely to be reasonable.

ICMP development process

The Integrated Catchment Management Plan will be developed using a participatory and collaborative approach underpinned by the use of INFFER.

The key steps will involve:

- 1. Development of a Background Paper (this document)
- 2. INFFER Workshop #1 information gathering and development of goals and objectives
- 3. Agreement on ICMP options and INFFER analysis
- 4. INFFER Workshop #2 review results of the INFFER analysis and recommendation of selected option for ICMP
- 5. Development of ICMP

 $^{^{\}rm 50}$ Discussions with GMW confirmed that causes are not particularly well understood.

⁵¹ LGA profiles in the social benchmarking report are the major source (pp 110-112).

Traditional Owner engagement and incorporation of cultural values and aspirations into the analysis and ICMP will be a thread throughout the process.

The INFFER analysis and ICMP will form the basis of future North Central CMA/CHW co-funding investment bids through the Victorian Government and Water Pricing Submissions.

Benefit: Cost Analysis (INFFER)

The Investment Framework for Environmental Resources (INFFER[™]) is a structured decision-making process to assess the benefits and costs of making investments in the environment. INFFER (Pannell, et.al, 2012) takes into account all factors that need to be considered in making transparent and robust decisions about the most cost-effective options to manage the environment and natural resources. INFFER uses available and relevant knowledge and information (science, expert judgement and local knowledge) to estimate the benefits and costs of alternative management options.

It is a proven method (published in peer-reviewed scientific and economic journals) and is recognised across Australia and internationally as a state-of-the-art approach to environmental decision-making. INFFER has been used successfully to develop business cases to implement large-scale environmental projects, including waterway management plans.

Suggested next steps

In addition to North Central CMA reviewing the background paper and providing correction/comment if/as needed, we suggest holding a meeting to get greater clarity on scope ahead of the first INFFER meeting. The main questions are:

- Spatial extent Tullaroop catchment or expanded to include additional areas of high cultural values below Tullaroop Reservoir. Also need to confirm that McCallums Creek catchment is out of scope.
- Agreement on priority threats to be included in the analysis using Table 1 as the basis for discussion (with modification if needed)
- Agreement on priority assets to be included within scope using Table 2 as the basis for discussion (again with modification if needed)
- Discussion re timing of modified AWA (planned for March 2021 at this stage with AWA for Long Swamp planned for early 2021, including providing management recommendations for TfN) and incorporation of Dja Dja Wurrung aspirations
- Clarity on whether issues such as management of septic tanks, urban stormwater runoff, flooding and/or farm dams are within scope
- General discussion on preliminary goals including whether increased use of planning mechanisms (e.g. Environmental Significance Overlays, increased use of provisions associated with water supply protection areas) are in or out of scope
- Recreation are there any figures for numbers of people visiting reservoirs and whether
- there is increasing demand
- CHW to source indicative costs of water treatment (see Table 9). This will enable us to figure out benefits in terms of avoided costs.
- Once priority assets and actions are agreed we will need to get specific information on areas/kms remaining to be protected and costs.

References

Department of Environment Land Water and Planning (DELWP, 2016). Overview of Victoria's Catchment Management Framework, Fact Sheet No 1, March 2016).

Department of Sustainability and Environment (DSE, 2012), Loddon Highlands Water Supply Protection Area Groundwater Management Plan

Dhelkunya Dja, Dja Dja Wurrung Country Plan, Dja Dja Wurrung Aboriginal Clans Corporation, 2014-2034

Natural Decisions (2018), Investing in Integrated Catchment Management – Final Report to the Department of Environment, Land, Water and Planning.

RMCG (2019), Integrated Catchment Management Plan Scoping – Tullaroop Catchment, Final Report to the North Central Catchment Management Authority

North Central Catchment Management Authority Basin 7 – Loddon Management Unit 5 – Tullaroop Creek Catchment Stream summaries, August 2006

Water Technology (2013), Clunes Flood Mitigation and Urban Drainage Plan, Final Study Report to the North Central CMA.

Water Technology (2012), Creswick Flood Mitigation and Urban Drainage Plan, Final Study Report to the North Central CMA.

Other references included as footnotes throughout the document.

Appendix A: Integrated Catchment Management Principles

From Natural Decisions, 2018

Based on a review of the literature, assessment of a number of recent ICM projects and a co-design workshop of DELWP and Catchment Management Authority (CMA) staff, seven ICM principles are proposed. The idea is that a 'good' ICM project, which is one that merits government investment, is able to demonstrate that it satisfies all seven principles to an acceptable level. The principles, and associated guidance, to help ICM project developers are:

- <u>Scale:</u> There is a clearly identified and stated geographic (commonly catchment) and temporal scale.
- <u>Codesign:</u> The project involves the local community and partners in project design and provides on-going and inclusive community involvement including Traditional Owners.
- <u>Triple bottom line</u>: The project has explicitly considered environmental, social-cultural and economic dimensions and identified the potential for environmental benefits and trade-offs.
- <u>Method and evidence</u>: The project has defined SMART objectives, well described methods, uses sound available evidence (scientific, social, economic and local knowledge) and demonstrates the capacity for adaptive management in response to new knowledge or changing circumstances.
- <u>Co-delivery</u>: There are clearly described roles and responsibilities for funding and implementation and alignment with relevant strategies/plans.
- <u>Value for money</u>: Ensure that the expenditure of public funds is done in appropriate ways and in which value for money can be assessed.
- <u>Evaluation</u>: There is a clearly documented process for evaluation that enables adaptive management and supports assessment of impact, effectiveness, efficiency, appropriateness and legacy.

Appendix B: Roles, responsibilities and strategic plans

Table 6. Main plans and strategies of relevance for the Tullaroop ICMP.

Stakeholder	Role / responsibility	Relevant plans and strategies	
North Central CMA	The North Central CMA is charged with the responsibility of taking a	North Central Waterway Strategy 2014 – 2022	
	whole-of-catchment approach to natural resource management in the region. Their primary role is to ensure the protection and restoration of	North Central Regional Catchment Strategy	
	land and water resources, the sustainable development of natural resources-based industries and the conservation of our natural and cultural heritage. Under Part 10 of the Water Act 1989, the North Central	North Central Sustainable Agricultural Strategy	
	CMA is the designated responsible manager of waterways, drainage and floodplains.		
Central Highlands Water	Central Highlands Region Water Authority is a regional urban water authority, which supplies urban and rural water and wastewater services to communities across central Victoria. As outlined in the <i>Safe Drinking</i>	CHW Urban Water Strategy 2017 - A 50-year water outlook for our communities in the Central Highlands Region CHW Annual Water Outlook (December 2020)CHW Drought Preparedness	
	Water Act (2003) CHW is responsible for ensuring that water storages	Plan CHW Sustainability Framework	
	with the Safe Drinking Water Regulations (2005) and the Water Act	CHW Sustainability Francework	
	(1989).	CHW Strategic Asset Management Framework.	
State Government (Department of Environment, Land, Water and	The Department of Environment, Land, Water and Planning (DELWP) is the lead agency for water and waterway management. It is responsible	Northern Region Sustainable Water Strategy (2009) – update in progress	
Planning, Parks Victoria, Department of Economic	for the development of waterway policy, co-ordination of regional delivery and prioritisation of Government investment in waterways.	Our Catchments Our Communities Integrated Catchment Management i Victoria 2016–19	
Resources)	DELWP and DEDJTR are also responsible for aspects of natural resource management relevant to waterways, including:	Protecting Victoria's Environment – Biodiversity 2037	
	ensuring the sustainable management of Victoria's water resources	Victorian Waterway Management Strategy (2013)	
	overseeing the catchment planning framework to promote		
	Integrated catchment management throughout Victoria		
	managing blodiversity and threatened species management of public land, including Crown frontages		
	hushfire management on public land		
	 delivering sustainability and environment services at the regional 		
	level, including some services that relate to waterway management		
	 managing fisheries and recreational fishing in waterways to 		
	optimise economic and social value while ensuring the sustainability of		

Stakeholder	Role / responsibility	Relevant plans and strategies
	 resources investing in and delivering farming programs on private land where waterways occur overseeing the management of biosecurity, including aquatic invasives 	
Local Government (Hepburn, Central Goldfields and the City of Ballarat)	Councils are involved in the management of waterways in Victoria through their role as responsible planning authorities, managers of stormwater drainage and onsite domestic wastewater systems, users of integrated water systems, land managers, emergency management bodies, and supporters of community groups. Specifically with regard to water quality and waterways, local government have the following roles and responsibilities: • incorporate waterway and catchment management objectives, priorities and actions into strategic and statutory planning processes • develop and implement urban stormwater plans • manage on-site domestic wastewater systems	 Hepburn Shire Plans and Strategies Municipal Strategic Statement Clause 21.06 - Reticulated water supply is available to larger towns. This will enable future development to be accommodated and directed to these areas. Water supply and storage capacity for Daylesford needs to be expanded. Clause 21.07 - There is a need to promote, protect and encourage sustainable management of natural resources including mineral springs that attract local investment. Clause 21.09 - The Shire is located in proclaimed catchments. Future planning must accommodate the long-term protection of proclaimed water supply catchment areas across the Shire. Council Plan 2013 -2017 Goal: Our environment and landscape is protected and sustained. To protect the natural diversity and uniqueness of the landscape and wildlife. To ensure responsible management of our natural environment. To plan for, and adapt to climate change. Domestic Waste Water Management Plan The plan identifies actions that can be undertaken to: comply with current on-site domestic wastewater legislation, minimise the impacts of domestic wastewater on human health and the environment, direct the management of current Onsite Wastewater Treatment Systems (OWTS) One of the primary objectives of this DWMP is the protection of environment to which domestic wastewater is discharged.
Goulburn- Murray Water	Goulburn Murray Water's statutory functions include irrigation supply and drainage systems, surface water diversions and groundwater in its region. Goulburn Murray Water also promotes best practice land use and development within the catchments to its storages for water quality and biodiversity purposes. CMW// attactions of relevance to the	Loddon Highlands Water Supply Protection Area – Groundwater Management Plan Mid Loddon GMA Local Management Rules

Stakeholder	Role / responsibility	Relevant plans and strategies
	Integrated Catchment Management Plan are licencing of surface and groundwater.	
Farmers / land managers	Landholders are vital to the successful implementation of this Integrated Catchment Management Plan, as most works are on privately owned land or affect areas that require private co-operation, and their land management practices have a vital role in catchment health. Under the <i>Catchment and Land Protection Act 1994</i> landholders are required to: • protect water resources • avoid causing or contributing to land degradation which causes or may cause damage to land of another owner • conserve soil • eradicate regionally prohibited weeds and prevent the growth and spread of regionally controlled weeds • prevent the spread of, and as far as possible eradicate, established pest animals.	Local industry groups – Central Highlands Agribusiness groups.
Indigenous community (Dja Dja Wurrung)	Dja Dja Wurrung are the Traditional Owners of the land covered by the Tullaroop ICMP. DDW have entered into a Recognition and Settlement Agreement in 2013 with the State of Victoria. Traditional Owners with recognised native title rights or formal agreements with the State are important in land and water management. Dja Dja Wurrung is also a member of various confederations such as Murray Lower Darling Indigenous Nations (MLDRIN) and the Federation of Victorian Traditional Owners Committee (FVTOC), actively representing the rights of Traditional Owner groups in water policy and governance across the Murray-Darling Basin and state of Victoria.	Dhelkunya Dja, Dja Dja Wurrung Country Plan 2014-2034 Recognition and Settlement Agreement under the Traditional Owner Settlement Act 2010 (Vic) between Dja Dja Wurrung Clans Aboriginal Corporation and The State of Victoria <u>https://www.justice.vic.gov.au/your-rights/native-title/dja-dja-wurrung-settlement-commences</u>
	Dja Dja Wurrung may also be represented by the Kapa Gatjin (To Know Water) Advisory Group, the water focused subdivision of Dja Dja Wurrung Enterprises. Kapa Gatjin's purpose is to support and advise the Dja Dja Wurrung Water Unit on the execution of the 'Rivers and Waterways' chapter of the Dja Dja Wurrung 'Dhelkunya Dja' Country Plan.	
Landcare Networks and Landcare Groups	 Local information sharing and awareness raising Direct implementation of projects Community capacity building 	Regional Landcare Support Plan 2018 – 2023 (North Central CMA)

Appendix C: Additional information on assets, values and threats

A collection of additional information collected during the development of this background paper is provided below.

CHW Bulk entitlements

CHW has four bulk entitlements within the Tullaroop catchment

- Loddon System Part Maryborough (1200ML/year with up to 900ML carryover)
- Evansford- Talbot System Part Maryborough (total up to 3000ML/year from Centenary)
- Creswick 500 ML
- Bullarook System (Newlyn Res) 500ML

Surface water resources

Table 7. Water treatment systems and source water supplies to be considered in Tullaroop ICMP. NB: Creswick now supplied from Ballarat

Water treatment system	Towns/localities supplied	Source water type ⁵²		Population supplied ⁵³ Av ann. demand (ML/yr)		Comments ⁵⁴
		Surface water	Groundwater			
Clunes	Clunes		Primary	1,679	218	High quality groundwater TDS wise; Trihalomethanes ⁵⁵ (THMs) ranged between 0.15-0.24 mg/L (std must not exceed 0.25)
Dean	Dean has 22 connections	-	Primary	48	13	Sourced from local groundwater
Maryborough	Maryborough and surrounding towns (Alma, Bet Bet, Carisbrook, Daisy Hill, Majorca, Maryborough, Talbot, Timor)	Primary	Primary	13,128	1,401	Supplied from Tullaroop, Evansford and/or Talbot Reservoirs (stored in Centenary Reservoir). Moolort and Stoney Creek groundwater are supplementary sources.

⁵² Central Highlands Water Annual Resource Summary 2019

⁵³ Central Highlands Water 2019-20 Water Quality Report

⁵⁴ Central Highlands Water 2019-20 Water Quality Report

⁵⁵ Trihalomethanes (THMs) are a range of organic compounds formed when chlorine reacts with naturally occurring organic matter in water supplies. At elevated levels, THMs have been associated with negative health effects such as cancer and adverse reproductive outcomes.

Table 8. Water storage details and groundwater sources (directly within scope and those which may have indirect impacts).

Name	Size of storage (ML)	Major water quality	Values	Issues		
		issues				
Within Tullaroop catchment – those marked with * are out of scope for ICMP						
Tullaroop	74,000 ML	Blue green algae ⁵⁶	Mostly irrigation,	Turbidity,		
Reservoir		blooms regularly	Maryborough partial	pathogens, nutrients		
		EC when storage	water supply,	and chemicals from		
		levels are low	domestic and stock	intensively cropped		
			use	land (including		
				potatoes) and		
				erosion hazards.		
				Waste discharge		
				from recreational		
				facilities		
Newlyn	3,280 ML (CHW	Risk for blue green	Ballarat (partial)	Nutrients		
Reservoir 57	entitlement 500	algae ⁵⁸ , but hasn't	water supply,			
	ML)	had outbreaks	irrigation, domestic			
			and stock use			
Hepburn	3,040 ML	Blue green algae ⁶⁰ ,	Irrigation, stock and	Nutrients		
Lagoon 59		blooms regularly	domestic use			
*Dean Reservoir	164 ML		Water supply for	Surface water		
			around 22	interacts with		
			connections	groundwater and		
				WTP receives		
				turbidity spikes		
Cosgrave	680 ML			High pathogen risk		
Reservoir				from human use.		
				No amenities or		
				toilet facilities onsite		
*Moolort		High TDS		Needs to be treated		
borefields				though reverse		
				osmosis (expensive)		
Confirmed as n	ot within scope of ICMI	P (included here as they	provide water sources to	o CHW which may be		
	relev	ant to Maryborough wa	ter supply)			
Evansford	1,346	High bacteriological	Maryborough partial	Pathogen and		
Reservoir ⁶¹ –		counts and high	water supply	nutrient loading		
not within		turbidity from main		from unfenced		
scope of ICMP		land uses (grazing,		waterways		
		cropping and		Frequent algal		
		potatoes)		blooms		

⁵⁶ Water quality: pH exceeded in 6/10 years; EC exceeded 2/10 years when levels low; Turbidity generally ok, exceed 1/10 years; TN exceeded SEPP 6/10 years; TP exceeded SEPP 4/10 times, FRP 3/10; chlorophyll exceeded 5 times, phaeophytin 0. BGA 5/10 years; WQ Index good (pH, EC, turbidity and P excellent; N poor; chorophyll and BGA very poor). From GMW Major Storages 2018 Water Quality Report

⁵⁹Also in upper reaches of Birch's Creek catchment

⁵⁷ In upper reaches of Birch's Creek catchment

⁵⁸ pH ok; Turbidity usually ok; EC in normal SEPP range but increasing; TN commonly exceeds SEPP; TP commonly exceeds SEPP; FRP ok; Chlorophyll and phaeophytin commonly exceed ANZECC but no BGA alerts to 2018; WQ Index Good (excellent for pH, turbidity, EC and BGA; good for P; very poor for N and chlorophyll)

⁶⁰ pH increasing trend; EC generally ok but increasing trend; Turbidity and BGA problematic; TP exceeds ANZECC every year and FRP on about half of years; chlorophyll exceeds ANZECC in all years and phaeophytin sometimes; WQI score is poor (chlorophyll and BGA very poor; turbidity, pH and N poor; P fair; EC excellent).

⁶¹ drains into McCallums Creek that comes into Carisbrook below Tullaroop (then into Laancoorie)

Talbot	846 ML	Maryborough partial	High pathogen risk
Reservoir ⁶² - not		water supply	from human use.
within scope of			No amenities or
ICMP			toilet facilities onsite
Stoney Creek	Poor yield		Needs to be treated
borefields			though reverse
			osmosis (expensive)
Shared (with			Source water from
Coliban Water)			the Goulburn and
sections of			Campaspe systems
Goldfields			
superpipe			

Water treatment

 Table 9. Water treatment in the Tullaroop catchment.

WTP	Water Treatment ⁶³	Indicative cost (\$/ML)
Clunes	Treatment: Ozonation, Cartridge Filtration, Dealkalisation (Ion Exchange), Chlorination	To be determined if required for benefit estimation
	Added substances: Sodium Hydroxide Chlorine Gas Ozone Gas	
Dean	Disinfection	
	Added substances: Sodium Hypochlorite	
Maryborough	Prechlorination, Coagulation + Flocculation,Sedimentation/Clarification Granular Media Filtration, Reverse Osmosis, Ultra Violet (UV) Light, Chloramination, Fluoridation	
	Added substances: Soda Ash, Aluminium Sulphate, Poly Electrolyte Chlorine Gas, Aqueous Ammonia, Fluorosilicic Acid ,Sodium Hypochlorite, Antiscalant, Powder Activated Carbon, Potassium Permanganate	

Groundwater resources

Groundwater in the upper Loddon catchment is highly valued and is shared between the environment, domestic and stock users, irrigated agriculture and growing urban communities⁶⁴. As shown in Table 7 groundwater is the primary water source for a number of communities.

The consumption of groundwater from Victoria's aquifers is managed by geographical area. In Victoria, groundwater units are identified as Groundwater Management Areas (GMAs), Water Supply Protection Areas (WSPAs) or Unincorporated Areas⁶⁵.

⁶² drain into McCallums Creek that comes into Carisbrook below Tullaroop (then into Laancoorie)

⁶³ Central Highlands Water 2019-20 Water Quality Report.

⁶⁴ https://www.g-mwater.com.au/downloads/gmw/Groundwater/Loddon_Highlands_WSPA/Nov_2013_-

_Loddon_Highlands_WSPA_Plan_A4_FINAL-fixed_for_web.pdf

There are 38 GMAs in which groundwater has been intensively developed, or has the potential to be developed. They are geographically defined as such for the purposes of ongoing management of the aquifer and are carefully monitored via the Department of Environment, Land, Water & Planning (DELWP) State Observation Bore Network.

WSPAs are areas declared by the Minister for Water under the Act to protect stressed groundwater or surface water resources through the implementation of a detailed management plan for the area. 25 areas have so far been declared in Victoria.

Unincorporated Areas are areas where no significant development of the groundwater resource has occurred. This is usually because the resource is low yielding, or its quality has traditionally severely limited its use.

The Tullaroop catchment falls largely within the Loddon Highlands WSPA which extends from Newlyn and Learmonth in the south to Dunolly in the north. Within the Tullaroop catchment it incorporates the townships of Creswick, Waubra, Clunes, Talbot and Maryborough. We understand that the Moolort borefields are also just within the Upper Loddon WSPA rather than in the Mid Loddon GMA (the Moolort zone being one of three zones in the Mid Loddon GMA)⁶⁶. The Loddon Highlands WSPA contains five management zones (Blampied, Newlyn, Ascot, Talbot, Waubra)⁶⁷. The Loddon Highlands WSPA was developed to provide protection for existing users and the environment by supporting a cap on licence entitlement; restricting the extraction of groundwater when triggered; and placing limits on the concentration of groundwater pumping. It was developed following the drop in groundwater level across the region in response to the dry conditions experienced in the late 1990s and 2000s. In some local areas, the fall in groundwater levels was greater due to the concentration of groundwater pumping.

Temporary and permanent transfer of groundwater entitlement is permitted within and between zones subject to conditions that protect the integrity of the aquifer; provide environmental benefits and minimise the potential for unacceptable impacts on existing groundwater users⁶⁸.

It was recognised during the development of the Loddon Highlands Groundwater Management Plan that there was (and still remains) a need for more work to be undertaken to better understand the impact of groundwater pumping on creeks and determine the water needs of any high value groundwater dependent ecosystems.

Annual summaries⁶⁹ for groundwater management provide detailed information on allocation, use, levels and quality.

Waterways - streams

The Loddon River, Tullaroop and Birch's creeks are regulated due to the operation of Tullaroop, Laanecoorie, Cairn Curran, Newlyn reservoirs and Hepburn Lagoon. Both irrigation and environmental entitlements are held in these storages. Environmental entitlements are used to

⁶⁸ https://www.g-mwater.com.au/water-resources/ground-water

⁶⁵ https://earthresources.vic.gov.au/legislation-and-regulations/guidelines-and-codes-of-practice/groundwater-licensing-and-trading

⁶⁶ https://www.g-mwater.com.au/downloads/gmw/Hydrographs/2020/20201117_MID-LODDON_GMA.pdf

⁶⁷ https://www.g-mwater.com.au/downloads/gmw/Hydrographs/2020/20201117_LODDON_HIGHLANDS_WSPA.pdf

⁶⁹ https://www.g-mwater.com.au/water-resources/ground-water/management/loddonhighlandswspa

meet key environmental objectives for the Birch's Creek, Tullaroop Creek, Loddon River and wetlands located in the lower Loddon catchment.

The Tullaroop Creek (Reach 19) and Birch's Creek (Reach 21) are identified as priorities in the North Central Waterway Strategy (North Central CMA 2014). The 2010 Index of Stream Condition results indicate that the condition of the major waterways in the Tullaroop catchment varies from very poor to poor. Tullaroop Creek (reach 29) and Birch's Creek (reach 22) were rated in poor condition, while Creswick Creek which joins Tullaroop Creek just north of Clunes is rated in very poor condition. The majority of waterways in the catchment flow largely through cleared agricultural land.

The Tullaroop catchment is made up of named waterways (North Central CMA, 2006) with finegrained information on the history, geomorphology, hydrology, ecosystem features and condition as well as a description of water quality and management issues available for each named waterway. While this information is somewhat dated it provides a valuable resource for understanding the characteristics and condition of the catchment.

Waterways - wetlands

The Tullaroop catchment features a number of significant wetlands, notably the Middle and Merin Merin swamps complex⁷⁰ just north of Clunes. These two wetlands are designated Wildlife Reserves and managed by Parks Victoria. They are of major ecological significance as well as being recognised for their cultural significance by the Dja Dja Wurrung⁷¹.

While not directly linked to the Tullaroop catchment the wetlands of the Moolort Plains, and in particular Long Swamp and associated wetlands on private land (e.g. Brolga Swamp) have major ecological and cultural significance. Long Swamp was connected to the Tullaroop Creek via a constructed drain in 1965 due to a concern that the wetlands was becoming salinized. The North Central CMA and Trust for Nature have been active in a number of projects to protect these wetlands over the past decade.

Agricultural land

Land Inventory of the Loddon River catchment - a reconnaissance survey was prepared by Noel Schoknecht of the former Department of Conservation, Forests and Lands, Victoria and published in 1988⁷². This is a very useful resource document and provides detailed maps and information on land features – geology and physiography, soils, climate, native vegetation, land use and land degradation.

Soils derived from basalt parent material predominate throughout the catchment. These soils range from the red gradational types with fine structure found on the gentle hills in the moist southern areas, to the grey calcareous sodic clay types typical of the plains in the northern catchment. The gently undulating to flat plain between these areas is dominated by the coarsely structured yellow/brown calcareous sodic duplex soils found on the long slopes. All the above soils are deep,

⁷⁰ http://vro.agriculture.vic.gov.au/dpi/vro/nthcenregn.nsf/pages/nthcen_enviro_monitoring_sites12

⁷¹ https://www.gma.vic.gov.au/__data/assets/pdf_file/0004/481531/State-Game-Reserves-in-Dja-Dja-Wurrung-Country.pdf

⁷² http://vro.agriculture.vic.gov.au/dpi/vro/nthcenregn.nsf/pages/nthcen_landform_geo_loddon_land

with clay to clay loam textures. Excepting for the well-structured soils in the south, internal drainage is very slow; consequently surface ponding across the plain is common following rain.

Characteristic soils of the cones are the finely structured stony red gradational types. Drainage lines generally have uniformly textured black cracking clay soils with low permeability. Soils derived from the Ordovician sediments are predominantly red duplex or yellow duplex types which occur on the longer and gentler slopes from the ridges. Higher and steeper positions in the landscape are generally occupied by red gradational types with crests characterised by shallow stony gradational types where the surface textures are gravelly loam. Coarse sand soils have developed on the steep slopes and outwash fans of the granite in the south-west. A mottled duplex soil with ironstone occurs on the intermediate slopes.

With few exceptions freehold land outside the urban areas has undergone development for agriculture, with grazing the major activity overall. Stock is predominantly sheep but cattle numbers are tending to increase. In the south the well-structured red soils support intensive agriculture with potato production the major enterprise in a potato/cereal/grazing rotation. Summer irrigation of potatoes is common throughout this region with many large farm dams providing for these needs. To the north the heavier and less permeable clay soils of the flatter plain are farmed under a cereal/pasture rotation with the upper slopes and crests of volcanic cones generally restricted to grazing.

Native vegetation and biodiversity values

The Tullaroop catchment falls largely in the Victorian Volcanic Plains (VVP) bioregion, with some areas of the Central Victorian Uplands bioregion in the upper catchment around Creswick and to the west of Clunes and the Goldfields bioregion further north between Clunes and Carisbrook.

The dominant vegetation types on the VVP prior to extensive clearing associated agricultural development was native grasslands, grassy woodlands with extensive occurrences of freshwater wetlands. While significant grassy ecosystem sites remain they are generally small in size and often restricted to linear reserves such as roadsides, rail reserves and cemeteries.

Two nationally significant ecological communities occur in the catchment.

- 1. Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains ecological community are temporary freshwater wetlands that are inundated on a seasonal basis, typically filling after winter-spring rains, and then drying out.
- 2. Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia ecological community occupies a position in the landscape that is transitional between the temperate woodlands and forests of the lower slopes and tablelands of south-eastern Australia, and the semi-arid communities further inland.

Across the entire catchment less than 30 % of native vegetation remains⁷³. A number of significant species of fauna, including threatened species can still be found in the Tullaroop catchment. These include the iconic species such as the platypus, Australian water-rat (Rakali) as well as EPBC listed species brolga, swift parrot, Australian painted snipe and freckled duck.

⁷³ 27% (19,701 ha) based on 2017 NC extent layer (Beck Horsburgh, NCCMA)

The North Central CMA has undertaken woody habitat reinstatement works in Birch's Creek in an effort to improve the habitat and breeding conditions for the river blackfish (Gadopsis marmoratus), a species of regional significance.

Significant threatened flora includes the spiny rice-flower⁷⁴ and button wrinklewort⁷⁵.

Key threats and issues

Degraded riparian vegetation and stock access

Stock with unrestricted access to waterways and reservoirs effect the condition of waterways by trampling vegetation, increasing erosion of banks, and impacting on waterway health and water quality by introducing;

- pathogens from stock faeces, causing an increased risk of human disease
- nutrients from stock faeces and urine, causing an increased risk of blue-green algal blooms sediments from erosion and the disturbance of stream banks, which harms aquatic life and clogs streams⁷⁶.

For water authorities, better water quality at the source means that water treatment is likely to be more effective and less chemicals are needed⁷⁷.

Riparian restoration activities have been a priority for the North Central CMA and community groups in the Tullaroop catchment through the previous River Health Strategy and remain a priority under the current Waterway Strategy (North Central CMA 2005; North Central CMA 2014). As outlined previously Table 4, the North Central CMA have undertaken a range of catchment works, but more remains to be done and this will be agreed as part of the INFFER analysis.

Excluding stock from waterways through fencing, locating juvenile stock away from waterways, monitoring to verify risk were three potential actions identified in other similar catchments (e.g. Coliban) to reduce the risk of contamination of waterways from pathogens (Billington et al. 2011).

Agricultural/rural land runoff

Runoff from agricultural and rural land has the potential to impact on water quality. Potential water quality issues in rural landscapes include:

- Runoff of nutrients and uncontained wastewater from intensive animal industries and forestry and urban stormwater.
- Runoff of nutrients and chemical leaching from intensive agriculture, such as potato farming.
- Unsustainable land management practices in rural areas (such as overgrazing) that reduce groundcover to less than optimal levels.

https://www2.health.vic.gov.au/getfile/?sc itemid=%7b4CA00B1F-EF50-44E2-B9F2-

⁷⁴ Spiny Rice-flower http://spatial.ala.org.au/?q=lsid:http://id.biodiversity.org.au/node/apni/2917786

⁷⁵ Button Wrinklewort is known from a small number of records in the North Central region, all of which are outside the target zones. See the following link for location details

https://biocache.ala.org.au/occurrences/search?q=lsid:http://id.biodiversity.org.au/node/apni/7062437#tab_mapView https://www2.health.vic.gov.au/getfile/?sc_itemid=%7b4CA00B1F-EF50-44E2-B9F2-64206B2C12CB%7d&title=Protect%20our%20waters,%20protect%20our%20health%20-%20brochure

⁶⁴²⁰⁶B2C12CB%7d&title=Protect%20our%20waters,%20protect%20our%20health%20-%20brochure

Intensive agriculture, including cereal cropping and horticulture occurs across significant areas in the catchment associated with the more productive soils, with extensive grazing occurring over a large proportion of the cleared parts of the catchment.

Some soil types in the area are susceptible to land degradation. This combination presents many challenges for farmer's intent upon achieving good soil structure, healthy productive landscapes and sustainable land management. The maintenance of a strong soil structure is a key variable in realising optimum plant-water vegetation interactions that avoid degrading processes, including dryland salinity and soil erosion (North Central CMA, 2013). Maintaining groundcover is key to protection of soil resources and the extent to which this occurs depends upon the farming system and management practices adopted. The Upper Loddon and Avoca Landcare Network is in this area i.e. Chris Pollock's group and they were a Farming for Sustainable Soils group, as well as the Central Victorian Regenerative Farmers.

Landcover mapping for the catchment shows a significant trend towards dryland cropping (mustard colour in Figures 2 and 3) in recent decades.



Figure 2: Landcover in the Tullaroop catchment (1985-1990)



Figure 3: Landcover in the Tullaroop catchment (2010-2015)

Domestic wastewater management systems

Effluent from waste water management systems contains bacteria, chemicals and high levels of nutrients and can run off into waterways as a result of poorly drained soils; small lot sizes; high usage; ageing septic tanks; and lack of proper maintenance of septic tanks (Hepburn Shire Council 2014). Contamination from effluent runoff has risks for public health and environmental values.

Illnesses that are contracted from effluent contaminated water include Gastroenteritis, Shigellosis, Giardiasis, Cryptosporidiosis and Hepatitis. Septic tanks contribute high rates of nitrogen and phosphorous to water catchments due to surface runoff. Septic tanks create direct bacterial contamination of the environment stimulating algal and weed growth (Hepburn Shire Council 2014).

Whether inclusion of septic tanks needs further investigation will depend upon the scope agreed within the ICMP.

Land development (urban and rural)

Increasingly, small parcels of land once used for grazing are being converted to intensive uses (such as cropping, irrigated horticulture, orchards, vines and intensive animal production) in the catchment.

Urban runoff

The threat of urban stormwater on the water quality of the Tullaroop Creek is primarily associated with the two major towns in the catchment, Creswick and Clunes.

Whether ICMP will address urban stormwater management needs to be decided.

Recreational access to water storages

The following table shows the level of recreational access allowed at water reservoirs and storages.

Water storage	Values	Level of recreation permitted ⁷⁸
Tullaroop Reservoir ⁷⁹ (74,000	Mostly irrigation, Maryborough	Fishing and boating (paddle boats and
ML, CHW entitlement 2,100	partial water supply, domestic and	electric craft, not motorboats)
ML)	stock use	
Centenary Reservoir (180 ML)	Economic – storage to distribute	None
	water from Tullaroop, Evansford and	
	Talbot Reservoirs and Mooloort and	
	Stoneyfields groundwater	
Newlyn Reservoir ^{80 81} (3,280	Supplies Ballarat system (including	Shoreline fishing, no swimming or
ML, CHW entitlement 500	Creswick) water supply, irrigation,	boats
ML)	domestic and stock use	
	Newlyn also supplies Tullaroop	
	through Birch's Creek	
Hepburn Lagoon ^{82 83} (3,040	Irrigation, stock and domestic use	Shoreline fishing, no swimming or
ML)	Hepburn also supplies Tullaroop	boats
	through Birch's Creek	
Dean Reservoir	Storage for water supply to Dean	Shoreline fishing, no swimming or
		boats
Cosgrave Reservoir (680 ML)	Supplies Ballarat system (including	Shoreline fishing, no swimming or
	Creswick) and also to Tullaroop	boats
	Reservoir	

Table 10. Permitted recreational access on Tullaroop storages with the ICMP scope

Flooding

While the recent major floods of 2010-2011 are well documented flood events have occurred in the Tullaroop catchment at regular intervals through recorded history.

While flooding prior to September 2010 was a rare occurrence, there have been anecdotal records of similar, large flood events in the past. The last significant flood event on Creswick Creek was in 1933. Prior to the 1933 flood a series of large floods occurred in 1869, 1870, 1871 and 1893 (Water Technology, 2013).

As a consequence of the 2010-2011 floods major flood studies have been undertaken for both Creswick (Water Technology 2012) and Clunes (Water Technology, 2013) to develop options for flood mitigation. Interestingly neither of these studies examines the likelihood and risks associated with the effects of future climate change on frequency and intensity of flooding.

⁷⁸ <u>Reservoir Fishing | Central Highlands Water (chw.net.au)</u> for Newlyns, Hepburn, Deans and Cosgrave.

⁷⁹ Water quality: pH exceeded in 6/10 years; EC exceeded 2/10 years when levels low; Turbidity generally ok, exceed 1/10 years; TN exceeded SEPP 6/10 years; TP exceeded SEPP 4/10 times, FRP 3/10; chlorophyll exceeded 5 times, phaeophytin 0. BGA 5/10 years; WQ Index good (pH, EC, turbidity and P excellent; N poor; chorophyll and BGA very poor). From GMW Major Storages 2018 Water Quality Report

⁸⁰ pH ok; Turbidity usually ok; EC in normal SEPP range but increasing; TN commonly exceeds SEPP; TP commonly exceeds SEPP; FRP ok; Chlorophyll and phaeophytin commonly exceed ANZECC but no BGA alerts to 2018; WQ Index Good (excellent for pH, turbidity, EC and BGA; good for P; very poor for N and chlorophyll)

⁸¹ In upper reaches of Birch's Creek catchment

⁸² pH increasing trend; EC generally ok but increasing trend; Turbidity and BGA problematic; TP exceeds ANZECC every year and FRP on about half of years; chlorophyll exceeds ANZECC in all years and phaeophytin sometimes; WQI score is poor (chlorophyll and BGA very poor; turbidity, pH and N poor; P fair; EC excellent).

⁸³Also in upper reaches of Birch's Creek catchment

The highly cleared nature of the catchment means that flooding will continue to be a significant hazard to urban communities and infrastructure. The impacts away from Creswick and Clues are less clear.

Water security

From: Loddon Campaspe Climate Projections (2019).

Water security is a major threat to the values in the study area. Water security threats come from projected climate change impacts as well as increasing competition for water resources due to growing population and agricultural intensification.

Climate change projections for the Loddon-Campaspe region⁸⁴ suggest the following trends:

- Maximum and minimum daily temperatures will continue to increase over this century (very high confidence)
- By the 2030s, increases in daily maximum temperature of 0.8 to 1.7°C (since the 1990s) are expected
- Rainfall will continue to be very variable over time, but over the long term it is expected to continue to decline in winter and spring (medium to high confidence), and autumn (low to medium confidence), but with some chance of little change
- Extreme rainfall events are expected to become more intense on average through the century (high confidence) but remain very variable in space and time
- By the 2050s, the climate of Bendigo could be more like the current climate of Shepparton

From Department of Environment, Land, Water and Planning; Bureau of Meteorology; Commonwealth Scientific and Industrial Research Organisation; The University of Melbourne (2020), Victoria's Water in a changing climate. ISBN 978-1-76105-349-8 (pdf/online/MS word).

- Page 49- an upstream tributary of the Loddon River (Figure 3.3b) experienced an 11% reduction in average annual rainfall since 1997, which translated into an unexpectedly large 55% reduction in average annual streamflow over that period.
- Page 50 Some catchments in central and western Victoria have up to 80% reduction in streamflow Figure 3.4).
- Page 54 Catchment behaviour has shifted for the Loddon and has not recovered from the Millenium drought.

From: email correspondence from Pat Russell, Strategic Water Resources Engineer, 9th February 2021.

The Maryborough average annual bulk demand (i.e. from the headworks) is currently sitting on a 5 year average of just under 1400 ML/yr and projected to be over 1600 ML/yr by 2065 (as per Figure 4). The Bulk entitlement for Tullaroop provides 1200 ML annual allocation and we can carryover 900 ML to the new season. So with 100 % new season allocation and full carryover we could have a

⁸⁴ https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0039/429879/Loddon-Campaspe-Climate-Projections-2019_20200219.pdf

maximum of 2100 ML in the water account. The allocation to CHW is the same as to the irrigators although we do have a slight advantage of getting 50% allocation if allocation is <50%.

You need to think water system yield rather than maximum allocation to understand how the Maryborough system performs. The system yield is based on the system staying out of restrictions 95% of the time and this is shown on the supply demand plot shown above (taken from our 2017 Urban Water Strategy). It shows system yield around 1400 ML/yr reducing under high climate change to only 600 ML/yr in 2065.

The yield assessment is done using our system model which includes all the water resources (Evansford, Talbot, Tullaroop and Moolort). Tullaroop water is unusable when the total resource goes down very low (like it did in the Millenium drought) due to high Total Dissolved Solids or blue Green Algae, or both. The actual level we stop using Tullaroop depends on actual water quality monitoring but generally levels become unacceptable in the 5,000 – 15,000 range. Also remember that allocations from Tullaroop can be quite low in drought years (5% I think in about 2006).

The priority for use from the different sources varies with operational conditions but generally local surface water and Tullaroop is used before Moolort borefields. Moolort should not be thought of as emergency use but rather it is part of the overall system but generally used later because it is more expensive to treat. Groundwater can carryover 15% of licence volume. Remember also there is a waste stream from the RO for groundwater treatment. I don't think we would every shift entirely to groundwater for many reasons including those above and as well the current licence volume is not sufficient to meet full demand.



MARYBOROUGH - Future water supply and demand scenarios

This graph has been compiled as part of the CHW 2017 Urban Water Strategy. Supply yield has been modelled with SOURCE and future demand has been modelled with behaviour based demand model Simulait. Further details of these modelling approaches are provided in Chapter 4 of the main report.

Figure 4. Projected water supply impacts for Maryborough.

From Maryborough Integrated Water Management Plan (2019). Prepared by E2 Design Lab and RMCG.

Page 2- Uncertainty regarding the scale of impact from future climates means that new supplies could be needed as soon as 2023 or not until 2049 to maintain a good level of water supply service for Maryborough (as per Figure 4).

Loss of habitat quality, fragmentation and connectivity

Due to the fertile soil and favourable climate, only about 6 per cent of native vegetation remains in the Victorian Volcanic Plains bioregion due to vegetation clearance and intensive human utilisation of the land.

The major threats to native vegetation on the Victorian Volcanic Plains include over-grazing, land use intensification (e.g. cropping of native grasslands and wetlands), weed invasion and inappropriate fire regimes. Loss of native vegetation along rivers and streams poses a threat to water quality and aquatic native species. The expansion in recent times of rural residential areas around regional centres has the potential for significant impacts (both positive and negative) on nature conservation values.

Climate change has potential for serious impacts in the bioregion.

Appropriate protection and management of private land is needed to provide ecological viability and integrity of populations, species and communities.

Appendix D: Dja Dja Wurrung Cultural values – supporting information

NAME	NOTES	USE
Common Reed (<i>Phragmites australis</i>) Purple flax lily (<i>Dianella sp</i> .)		Traditionally used to make baskets, fish traps/nets, rope/string and used reed spears and messaging sticks
Drooping Sheoak (Allocasuarina verticillata, formerly Casuarina stricta)		Wood is traditionally used to make clubs and boomerangs. The cones are contemporary used in jewellery-making today.
Red Gum (Eucalyptus camaldulensis) Grey box (Eucalyptus macrocarpa)	Grey box woodlands were included in the ICMP assets but not Red Gum The two can be interchangeable in terms of use. Some exceptions to this	Used to make canoes or shields when scarring of a tree occurred. The root of a red gum was made into a club or 'waddy' – throwing club. Hardwood from trees was also used as a finishing touch-up when making stone tools. Bark used to make huts and shelters at campsites
Bracken Fern (<i>Pteridium</i> <i>exculentum</i>)	Long Swamp being in a protected valley is the one of the only places near Moolort that is likely to have had bracken (requires re-establishment). There are areas in the Hepburn Shire that retain patches of remnant bracken	The curl or pith is eaten as a nutritional food source whilst the fern itself also provides shade from the sun.
Basalt (Igneous sp.)		Fine grained mineral used for grinding dishes. Used for making flour, crushing seeds, and making ochre.
Sandstone		Used for the grinding of greenstone and other stone tools. Using generous amounts of water, muscle and patience eventually the hard greenstone blank would smooth down and reshape, changing colour from the original cortex. Axe grinding was mostly favoured and made easier along rocky waterways or outcrops near lakes where both elements existed at the same time.

Emu (Dromaius novaehollandiae)	Used as a food source in the Katji-Kari (warm) season when their fat levels were low. Maya-Mirriyn (cold) season was the time to hunt emu for the fat. This fat would be applied to the body then wrap themselves in possum-skin cloaks for warmth. Traditionally women also used emu fat mixed with ochre to paint their bodies. Feathers are used by women for dance ceremonies. The egg was collected and eaten; the yolk was often blown out and used in egg carvings or paintings.
Possum (Common brushtail)	Possums are important because our ancestors needed them to make possum skin cloaks (djarun) to keep warm in the cold season. Like our ancestors, today we make cloaks that also contain artwork recording of our stories, culture and lore
Fresh Water Mussels (Hyiidae)	Collected and eaten. Mussels were stored in the ground and dug up during drought due to their hibernation. The shell was used as a sharp tool for carving or scraping. Shells can also be reshaped and used as jewellery.

Language for Tullaroop area

Current	Aboriginal language	Meaning
Mt Kooroocheang	Kooroocheang	Spring for brolgas
Mt Moorookyle	Moorookyle	Red clay i.e basalt soil
Mt Stewart	Moorootah	Red earth
Joyce's Creek	Kneerarp	Reed spear
Long Swamp	Moolart	Bracken
Fawcett's Crossing, Tullaroop	Wall Walp	
Creek		
Tullaroop/Loddon junction	Thalak Thalak	reeds
Tullaroop Creek	Tullaroop	Reed (variant of above)
Eddington	Nyarritch	Austral hollyhock
Yandoit Hill	Yandoort	Sure water or brown snake
Middle Creek	Minere Minne	Minne = camp oven
		Good description of where Djaara
		would've camped
Inhabitants of the above	Baayn Baayn	People who inhabited the area,
		meaning 'many swamps'

Language can be used to tell a story about a place. For example, 'minne' means camp oven, which indicates that this is a place where Djaara ancestors would have camped.