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Colac Otway Shire Council

Domestic Wastewater Management Plan

Technical Document

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Prepared for: Colac Otway Shire Council

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Synopsis:	This document has been developed to accompany and direct the Operational Plan (revised 2015) to assist with detailed assessment of lots within the Shire to accommodate wastewater on-site. Together, both documents form the Domestic Wastewater Management Plan (DWMP). It provides additional detail and guidance on the relevant background documents (codes, policies, plans, legislation, regulations and standards) and the various constraints which impact upon or, is impacted upon, by domestic wastewater management (DWM) in the Shire.
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Disclaimer

The information contained in this report is based on independent research undertaken by Whitehead & Associates Environmental Consultants Pty Ltd (W&A). To our knowledge, it does not contain any false, misleading or incomplete information. Recommendations are based on an appraisal of site conditions subject to the limited scope and resources available for this project, and follow relevant industry standards. The work performed by W&A included a limited system audit and site and soil investigation in addition to a desktop review, and the conclusions made in this report are based on the information gained and the assumptions as outlined. Under no circumstances, can it be considered that these results represent the actual conditions throughout the entire Shire due to the regional scale of this study.

Copyright Note

Document Certification

This Domestic Wastewater Management Plan has been prepared following the standards and guidelines set out in the following documents, where applicable:

- EPA Victoria (2016) 891.4 Code of Practice – *Onsite Wastewater Management*;
- Department of Sustainability and Environment (2012) *Planning permit applications in open, potable water supply catchment areas*;
- EPA Victoria (2018) *State Environmental Protection Policy*: Waters of Victoria;
- Municipal Association of Victoria (2014) *Victoria Land Capability Assessment Framework*, 2nd Ed; and
- AS/NZS 1547:2012 *On-site Domestic Wastewater Management* (Standards Australia/ Standards New Zealand, 2012).

To our knowledge, it does not contain any false, misleading or incomplete information. Recommendations are based on an honest appraisal of the sites' opportunities and constraints, subject to the limited scope and resources available for this project.

Supporting Author

Supporting technical contribution for this document was provided by Dr. Robert Van de Graaff (van de Graaff and Associates). Dr. Van de Graaff undertook detailed (field) soil investigation and has provided primary soil data and interpretation which has been utilised in the development of the methodology outlined in this document.

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Acronyms

AEP	Annual Exceedance Probability
ARI	Annual Recurrence Interval
AHD	Australian Height Datum
AWTS	Aerated Wastewater Treatment System
CMA	Catchment Management Authority
CA	Certificate of Approval
COS	Colac Otway Shire Council
DEM	Digital Elevation Model
DEPI	Department of Environment and Primary Industries (now known as DELWP)
DELWP	Department of Environment, Land, Water and Planning
DIR	Design Irrigation Rate
DLR	Design Loading Rate
DSE	Department of Sustainability and the Environment (former)
DSM	Decentralised Sewage Model
DWM	Domestic Wastewater Management
DWMP	Domestic Wastewater Management Plan
DWSC	Declared Water Supply Catchment
EPA	Environment Protection Authority
GIS	Geographic Information System
GMAs	Groundwater Management Area
HPO	Health Protection Officer
LAA	Land Application Area
LCA	Land Capability Assessment
LGA	Local Government Area
LPED	Low-Pressure Effluent Distribution System
LRA	Land Resource Assessment
MAV	Municipal Association of Victoria
PIC	Plumbing Industry Commission
SEPP	State Environment Protection Policy
SILO	Scientific Information for Land Owners
VCAT	Victorian Civil and Administrative Tribunal
VVG	Visualising Victoria’s Groundwater (Project)
WC	Water Corporation(s)
WMIS	Water Measurement Information System
WSPAs	Water Supply Protection Area(s)

1 Introduction

This document forms the Domestic Wastewater Management Plan (DWMP) together with the Operational Plan (2015), and has been prepared in order to assist with the detailed assessment of unsewered (developed and undeveloped) lots in the Colac Otway Shire municipal area (COS or "the Shire"). It provides additional detail and guidance on relevant background documents (codes, policies, plans, legislation, regulations and standards), an overview of on-site domestic wastewater management (DWM) within COS, the various constraints which impact upon or are impacted by on-site DWM, system sizing tables and DWM sensitivity analysis for locality and town/settlement prioritisation. The document also provides guidance for sustainable development in unsewered areas as detailed in the individual Locality Reports.

The amended *Environment Protection Act 2017* and *Regulations 2021* provide a foundation for a transformation of Victoria's environment protection laws and EPA. It includes a new approach for the prevention of harm under 'General Environmental Duty' (GED). There will be inherent changes to the way wastewater is managed in Victoria over the next few years, with the repeal or amendment of the SEPP (Waters) 2018 yet to be determined in light of the amended *Environment Protection Act 2017*.

2 Council Policies and Plans

The DWMP has been developed to complement other Council policies and plans through the actions identified in the Operational Plan. The following is a brief outline of the various Council plans which have been included in the development of this DWMP.

2.1 Council Plan 2021 – 2025

Council's Vision Statement applies to all Council policies including the DWMP. The Strategic Vision of COS is:

"By 2050, Colac Otway Shire will be a destination where people come to appreciate our unique and diverse environment and friendly communities. We value the wisdom of this land's first caretakers, the Gulidjan and Gadabanud peoples, and recognise all those who have cared for the land since. We work to preserve what makes our place special. We focus on environmental sustainability to protect our precious natural assets. We are a proud and resilient community that values our welcoming spirit. We embrace new people, new business, new ideas. Our region is a great place to learn, live, work and play" (COS, 2050)

The Vision and Mission statements will be achieved with the Council Plan structured around four key themes:

1. Valuing our natural and built environment – we mitigate impacts to people and property arising from climate change; we operate sustainably with a reduced carbon footprint; protect and enhance the natural environment; we will satisfy our community's reasonable expectations to reduce waste going to landfill, increase resource recovery and minimise waste charges; and provide and maintain an attractive and safe built environment;
2. Strong and resilient economy – affordable and available housing will support our growing community and economy; attract, retain and grow business in our Shire; key infrastructure investment supports our economy and liveability; Colac Otway Shire is a destination to visit; grow the Colac Otway Shire's permanent population by at least 1.5%;

3. Healthy, inclusive and connected community – all people have opportunity to achieve and thrive our Shire; people are active and socially connected through engaging quality spaces and places; we are safe, equitable and inclusive community; and
4. Strong leadership and management – we commit to a program of best practice and continuous improvement; we are a financially robust organisation; we provide exceptional customer service; and we support and invest in our people.

The Council Plan outlines outcomes which must be achieved in line with the key values; these outcomes will be aligned with the DWMP.

2.2 Municipal Public Health and Wellbeing Plan 2021 – 2025

The Colac Otway Shire Municipal Public Health and Wellbeing Plan has now been incorporated into the Council Plan 2021-2025 and it aims to enhance the health and wellbeing of the residents of COS. The main priorities in this plan are categorised into the following themes: improving mental health and wellbeing, gender equity, increasing active living, tackling climate change and its impact on health, and preventing all forms of violence.

2.3 Colac Otway Planning Scheme

The Colac Otway Planning Scheme, approved under the *Planning and Environment Act 1987*, sets out planning policies for the municipality, and contains information about zones, overlays and other provisions which affect how land can be used and developed in COS. It identifies triggers for planning permit applications, and outlines application requirements and decision guidelines for the use, subdivision and development of land in the different zones.

On land where DWM is required, a planning application may need supporting information such as a Land Capability Assessment (LCA) to show that the lot can accommodate a DWM system. Almost all applications within DWSCs must be referred to the relevant Water Corporation (WC). If the WC objects to the application, it must be refused by Council.

Under Section 173 of the *Planning and Environment Act 1987*, Council can enter into a legal agreement with the owner of land in its municipality, with the agreement binding the owner to the covenants specified in the agreement. Such S173 agreements can be used to prohibit, restrict or regulate the use of land, or can relate to conditions subject to which the land may be used or developed for specified purposes. A Planning Permit condition can require the owner to enter such a legal agreement, which is subsequently registered on the title of the property. Such a legal agreement may be required by Council or the WC's when planning applications are located within a DWSCs. In such cases, the Section 173 agreements often contain maintenance requirements for DWM systems, which on the sale of a property, transfer to an incoming owner.

2.4 Environment Strategy 2010 – 2018

The Colac Otway Shire Environment Strategy aims to protect and enhance the environment, promote sustainable use of natural resources, strengthen partnerships with key stakeholders and build community capacity through environmental education and awareness raising programmes. The Strategy is not an action plan, but does set targets and outline a process for identifying the actions that need to be undertaken in order to achieve the targets. The Strategy sets 41 targets for four (4) major areas: Council Managed Land; Planning and Regulations, Physical Works and General Services; and Education and Awareness Raising Programmes. Wastewater is addressed in the Planning and Regulations Targets 7 and 8;

- Implement recommendations in the COS Domestic Wastewater Management Plan, review the Plan's performance and renew by 2014; and
- Develop and implement standards for DWM systems near waterways and in water supply and ground water recharge areas by 2014.

2.5 Environment Action Plan 2013 – 2015

The Environment Action Plan was developed from the adopted Environment Strategy (2010-2018) to form the basis of integrated action across all areas of the Shire's operations and are a further refinement of the targets as set out in the Strategy. The Action's specified in this Plan pertaining to DWM are the responsibility of the COS Public Health Unit.

Target 7 Action; implement an education program, and ensure monitoring and maintenance of Township DWM systems.

Target 8 Actions; investigate funding opportunities to develop a local standard for DWM systems near waterways, water supply and groundwater, and develop DWM standards for all areas near waterways, water supply and groundwater.

2.6 Rural Living Strategy 2011

Council adopted a Rural Living Strategy in 2011 which considered the development potential of smaller towns/settlements in the municipality. The towns of Forrest, Birregurra, Beeac, Alvie, Cororooke and Coragulac were all identified as having moderate growth potential. Gellibrand, Lavers Hill and Beech Forest had "deferred" growth potential due to potential bushfire and water catchment constraints.

2.7 Council Budget

The Council Budget sets out finances for all Council projects and their management. To implement the DWMP, the Budget will need to provide scope for the management of the audit and inspection program required as part of the DWMP. The Budget currently allocates fees and charges for Septic Tank Permits. These fees and charges cover resources required to assess, discuss, permit the installation, inspect, and approve the use of new and modified systems. Council may need to consider options for implementing appropriate ongoing fees and charges for all unsewered properties to provide resources to undertake Actions and programs within the Operational Plan.

3 Legislation and Regulation

3.1 Legislation

3.1.1 Local Government Act 2020

The *Local Government Act 2020* recently received Royal Assent on the 1989 Act and is the most ambitious reform in the local government sector in 30 years. The new act will improve local government democracy, accountability and service delivery for all Victorians. The *Local Environment Act 2020* outlines the provisions under which Council operates and empowers Councils to have local laws and regulations for DWM. The *Local Government Act 2020* empowers Council to enact local laws and set special charges for Council activities. Council can use these powers to develop local regulations for wastewater management, as long as these regulations are consistent with state policy and legislation and to raise revenue for its wastewater management programs.

3.1.2 Environment Protection Act 2017

The Environment Protection Act 2017 replaced the superseded 1970 Act and has recently been amended and will come into force on 1 July 2021 (version 005). The Environment Protection Act is used to regulate DWM systems within Victoria. Council will be utilising the new EPA '*Regulating onsite wastewater management systems: local government toolkit'* (publication 1974: 2021) to assist them in regulating DWM systems within COS and adhering to the new Act.

The main change that the new Act brings is the prevention of harm, whereas the superseded 1970 Act focused on the consequences of harm. The pollution offences have been replaced by 'General Environmental Duty' (GED) which is the primary way that EPA will achieve a prevention to harm approach. GED is supported by new duties to notify EPA of certain pollution incidents and the duty to clean up after an incident, if it occurs. The GED makes it clear that it is the owner or authorised or unauthorised entities responsibility to reduce the risk to the environment. A delegation of functions and powers from EPA to Council under the new Act will allow for Council to take action under the GED.

The Act is supported by Regulations which provide criteria for Council to consider when assessing DWM permit applications and enforcement. The following sections outline the requirements specific to DWM within the proposed final Regulations:

- Part 3.3 – Permits (regulations 25 to 35);
- Part 5.7 – On-site Wastewater Management Systems (regulations 159 to 163);
- Part 8.4 – Permit fees (regulations 186 to 200); and
- Schedule 1 – Prescribed permission activities and fees.

Under the Regulations, Council will continue to administer permits for construction, installation, or alteration of a DWM system with a capacity up to 5,000L/day.

A new section has been incorporated into the proposed final Regulations, Part 5.7, for persons in management or control of land which a DWM system is located, including legacy systems that do not have a permit that were installed pre-1970 superseded Act. Persons have an obligation to take reasonable steps to maintain the DWM system in good working order, a duty to keep maintenance records, respond to any problems that arise, and notify Council of a failure and rectification steps.

As per Part 5.7 regulation 163, Council may order maintenance of a DWM system if they have received a notification under regulation 161(2), or has a reasonable belief that a DWM system poses, or may pose, a risk to human health or the environment or is not, or may not be, in good working order. Council will no longer be required to lodge a DWM report to the EPA at the end of each financial year.

3.1.3 Water Act 1989

Section 183 of the *Water Act 1989*, provides a Water Corporation (WC) with the power to inspect and monitor existing septic tank systems within their sewerage district, and if the system does not comply with the *Environment Protection Act 2017* (as amended) and the *Public Health and Wellbeing Act 2008*, then the WC can require the owner to connect to the sewer where it is available under Section 147 of the *Act*.

3.1.4 *Safe Drinking Water Act 2003* and Regulation 2005

The *Safe Drinking Water Act* 2003 and the associated Regulation 2005 requires a catchment to apply a multi-barrier approach to managing risks to water quality. This applies to both water suppliers and water storage managers, whom are required to:

- ensure that drinking water meets quality standards specified by the Regulators;
- prepare and implement a risk management plan;
- provide independent audits of their performance in implementing the plans;
- disclose various types of information relation to the quality of the drinking water they supply to the consumers; and
- report any known or suspected contamination of the drinking water to the Secretary of the Department of Health.

3.1.5 Planning and Environment Act 1987

The *Planning and Environment Act 1987* is 'enabling' legislation, with more detailed planning matters dealt with by subordinate instruments under the Act, such as the Victorian Planning Provisions, planning schemes, regulations and Ministerial Directions. Key components of the planning framework established by the Act include:

- The system of planning schemes that sets out how the land may be used and developed;
- The VPP, which provide the template for the construction and layout of planning schemes;
- The procedures for preparing and amending the VPP and planning schemes;
- The procedures for obtaining planning permits under planning schemes; and
- The procedures for settling disputes, enforcing compliance with planning schemes and other administrative procedures.

Planning schemes set out how land may be used and developed, including the requirements for obtaining planning permits. Where domestic wastewater is required, a planning permit may need supporting information such as a Land Capability Assessment (LCA) to show that the development can accommodate a DWM system.

All applications within drinking water catchments must be referred to the applicable WC. If the referral authority objects to the application it must be refused by Council.

As noted in Section 2.3 above, Under Section 173 of the *Planning and Environment Act 1987,* Council can require the preparation of a legal agreement. These agreements are often requested by Council or the Water Authorities when planning applications are located within a Declared Water Supply Catchment (DWSC). The Section 173 agreements often contain maintenance requirements for DWM systems, which on the sale of a property transfer to an incoming owner.

3.1.6 Public Health and Wellbeing Act 2008

The *Public Health & Wellbeing Act 2008* lists types of nuisances which may be dangerous to health or offensive; these nuisances include those arising from water or any matter which is dangerous to health or offensive, including wastewater. Council has a duty under this *Act* to remedy as far as is reasonably possible all nuisances arising in the Shire, and it is an offence to cause or allow a nuisance to occur. Under this *Act*, Council must investigate all complaints relating to a nuisance or the illegal management of domestic wastewater and take action to rectify the nuisance where necessary. This can include a direction from Council to the owner of a DWM system to cease to operate and/or upgrade their DWM system, by issuing a Prohibition Notice and/or an Improvement Notice to the owner.

3.1.7 State Environmental Protection Policy (Waters) 2018

There have been recent legislative changes to the State Environment Protection Policy (Waters) of the *Environment Protection Act* 1970, with a recent Victorian Government Gazette (No. S 499) released on 23 October 2018, and Parliamentary Advice released by the Victorian Auditor-General's Office (VAGO) on 'Managing the Environmental Impacts of Domestic Wastewater' Sept 2018.

The SEPP (Waters) provides a regulatory framework for the protection and management of water quality in Victoria, covering surface waters, estuarine and marine waters and groundwaters across the state.

The SEPP (Waters) imposes increased responsibilities for Council in managing DWM, and continues to require a Schedule 5 referral to the Water Corporations if located within a Declared Water Supply Catchment (DWSC) as per the *Catchment and Land Protection Act 1994*, with approvals to be issued for permits in accordance with the Ministers Guidelines (2012). The responsible authorities must ensure that permits are consistent with guidance provided in the Code of Practice (publication 891.4, 2016).

3.1.8 State Environmental Protection Policy Waters of Victoria

The SEPP Waters of Victoria provides a regulatory framework for the protection and management of surface water environments in Victoria. This SEPP has three main policy sections; beneficial uses, environmental quality objectives and attainment program. The SEPP aims to protect surface water for a number of reasons, including but not limited to, human consumption after appropriate treatment, human consumption of aquatic fauna, recreation, agriculture and aquaculture.

The discharge of domestic wastewater in a manner which could enter surface waters has the potential to impact on the use of the water for any of the beneficial uses described above. As such, the discharge of domestic wastewater must be in accordance with buffer distances outlined in the current EPA Code of Practice so as to minimise any potential negative impacts on surface waters.

Environmental quality objectives are used to indicate and measure if the beneficial uses are being protected. The use of water quality and biological indicators, flow measurement, sediment quality

and habitat indicators can be used in accordance with the policy to determine if the surface waters have been affected. The SEPP indicates the roles and responsibilities, and details actions and tools, for the protection of surface waters in Victoria.

This policy is used for assessing effluent disposal areas and in preparing LCAs. Clause 32 (b) allows EPA guidance and the current EPA Code of Practice to be mandatory. The policy requires regulatory authorities to assess the suitability of land with reference to EPA Publication 746.1 – Land Capability Assessment for On-site Wastewater Management and to ensure that permits comply with EPA Code of Practice and all EPA publications and bulletins.

There will be inherent changes to the way wastewater is managed in Victoria over the next few years, with the repeal or amendment of the SEPP (Waters) 2018 yet to be determined in light of the amended Environment Protection Act 2017.

3.1.9 State Environmental Protection Policy Groundwaters of Victoria

The SEPP Groundwaters of Victoria currently provides a regulatory framework for the protection and management of groundwater environments in Victoria. The reuse of domestic wastewater on-site can impact on groundwater via deep drainage. Careful design of systems can ensure impacts are minimised so that groundwater resources are not affected. The SEPP indicates the roles and responsibilities, and details actions and tools, for the protection of ground waters in Victoria. This policy requires effluent disposal to be carried out so as to protect groundwater. The preparation of a LCA must consider the potential impact, if any, on local and regional groundwater resources.

3.1.10 *Catchment and Land Protection Act 1994*

The *Catchment and Land Protection Act* 1994 requires Catchment Management Authorities (CMAs) to prepare and implement a Regional Catchment Management Strategy, which includes:

- an assessment of long term requirements and the prioritisation of these requirements;
- identification of threats to environmental, economic and soil values; and
- identification of opportunities for improving natural resource management processes.

The Act empowers CMAs and defines their powers and functions. The developed Strategy influences and informs planning processes. DWSCs are declared under Schedule 5 of this Act, with planning applications referred to the relevant WA.

The Act also requires property owners to take reasonable steps to protect the catchment, with particular regards to water resources, avoid soil disturbance, weed growth and pests.

3.1.11 Victorian Building Regulations 2018

Under Part 8 Division 2 of the Regulations (Building work in special areas), Regulation 132 (Septic tank systems) applies as follows:

(1) The report and consent of the relevant council must be obtained to an application for a building permit that requires:

(a) the installation or alteration of a septic tank system; or

(b) the construction of a building over an existing septic tank system.

(2) The report and consent of the relevant council need not be obtained to an application for a building permit referred to in sub-regulation (1) if a permit for the construction, installation or alteration of the septic tank system that is relevant to the application has been issued under Section 53M(5) of the *Environment Protection Act 2017* (as amended).

3.2 Regulatory Authorities

3.2.1 Council

Council is responsible for issuing permits for new DWM systems under the *Environment Protection Act 2017 (as amended)*. Council is also responsible for the management of all DWM systems within the Shire; this includes the inspection of existing systems and ensuring compliance with Council and EPA requirements. Council is responsible for all DWM systems generating <5,000L/day. The legal requirements of Council include:

- Council must issue a permit to install/alter before a DWM system can be installed;
- Application for a permit to install/alter must be completed by the owner/builder/installer and submitted to Council for assessment;
- A Council officer assesses application and plans and conducts site inspections. Further information may be requested from applicant;
- Permit to install issued with approved plan and conditions;
- System must comply with permit conditions and relevant EPA Certificate(s) of Approval;
- System is inspected by a Council officer during installation; and
- Council must issue a permit of use before the system can be used.

In addition, Council can enforce upgrades of systems which are failing and potentially causing human or environmental health impact. This is discussed further in the Operational Plan of the DWMP.

3.2.2 Environment Protection Authority Victoria (EPA)

EPA Victoria will continue to regulate under the *Environment Protection Act 2017 (as amended)* what types of DWM systems are approved for use. The new legislation took effect on 1 July 2021. DWM treatment system brands and models will need to be certified by an accredited conformity assessment body as conforming to the relevant Australian Standard. This accreditation will be given by the Joint Accreditation System of Australia and New Zealand or any other accreditation body approved by the Authority (assessment body). The assessment body must certify the treatment system as conforming to the relevant Australian and New Zealand Standard. The appropriate standards for the different types of treatment systems is as follows:

- Septic tanks (and vermiculture systems) – AS/NZS 1546.1:2008, on-site domestic wastewater treatment units, Part 1: Septic tanks.
- Waterless composting toilets – AS/NZS 1546.2:2008, on-site domestic wastewater treatment units, Part 2: Waterless composting toilets.
- Secondary treatment systems – AS/NZS 1546.3:2017, on-site domestic wastewater treatment units, Part 3: Secondary treatment systems.
- Sand filters – AS/NZS 1546.3:2017, on-site domestic wastewater treatment units, Part 3: Secondary treatment systems and s459 exemption applications for transitional arrangements.
- Domestic greywater system – AS/NZS 1546.3:2016, on-site domestic wastewater treatment units, Part 4: Domestic greywater treatment systems.

EPA holds a register of the DWM systems with valid Certificates of Conformance within Victoria (www.epa.vic.gov.au/your-environment/water/onsite-wastewater). Transitional arrangements will also apply to previously issue certificates that had not expired by 1 July 2021. For innovative DWM systems, an exemption from these requirements may be granted to a permit applicant by EPA under section 459 of the Act.

As part of a permit application to Council, the applicant will need to include a copy of the certificate of conformity from a conformity assessment body.

The EPA has developed policies and Codes of Practice to regulate the use of DWM systems. These policies and codes include:

- SEPP Waters of Victoria;
- EPA 891.4 *Code of Practice – Onsite Wastewater Management*, 2016;
- EPA 746.1 *Land Capability Assessment – Onsite Wastewater Management*, 2003; and
- EPA 760 *Guidelines for Aerated Onsite Wastewater Treatment Systems, 2002*.

The EPA is responsible for the following activities related to wastewater management:

- Regulate the issuing of Certificates of Conformance for each DWM system type;
- Approval of commercial wastewater management systems with wastewater loading in the range of 5,000 – 100,000L/day (EPA Works Approval, as discussed in the Operational Plan will be replaced by development and operating licences unless an exemption applies);
- Licencing commercial wastewater management systems with wastewater loading above 100,000L/day, and systems which discharge effluent to surface waters (as discussed in the Operational Plan);
- Inspection of licenced commercial wastewater management systems and review of Annual Performance Statements for licenced commercial wastewater management systems;
- Compliance and enforcement activities for commercial wastewater systems;
- Developing policies and Codes of Practice;
- Provision of technical advice to Councils, owners and installers; and
- Possible referral authority for subdivisions.

3.2.3 Victorian Building Authority

The Victorian Building Authority (VBSA):

- Licenses all plumbers, drainers and septic tank installers across Victoria; and
- Regulates the installation of all plumbing works including internal plumbing works on septic tank systems.

3.2.4 Municipal Association of Victoria (MAV)

MAV has developed a model LCA report and procedures for undertaking a LCA, to assist land capability assessors and regulators. This has been developed in accordance with EPA Codes and *AS/NZS 1547:2012*.

3.2.5 Water Corporations

Water and sewerage services within COS are provided by Barwon Water, with water also supplied by by Wannon Water to the Carlisle River town. This DWMP covers areas where reticulated sewer service is not provided by Barwon Water and, hence, are unsewered.

The WCs have interest in protecting the DWSCs which are susceptible to impact from DWM systems. Both Barwon Water and Wannon Water are statutory referral authorities under the *Planning and Environment Act 1987* for planning applications in the DWSCs within the southern region of the Shire. Where specified development or subdivision is proposed within a DWSC, the proposal must be referred to the relevant WC for assessment prior to Council issuing a planning permit. There are two types of referral authorities – a determining referral authority, which has the power to require a permit application to be refused or for certain conditions to be included in a permit, and a recommending referral authority, which can only comment on an application. Responsible authorities must consider the comments made by a recommending authority, but are not obliged to refuse the application or to include any conditions required by the authority. However, a recommending referral authority is able to seek a review at VCAT if it objects or it requests conditions that are not included by the responsible authority in the permit.

Clause 66 of the COS Planning Scheme identifies which authorities are determining authorities and which are recommending authorities. The schedule to Clause 66.04 of the COS Planning Scheme lists Barwon Water and Wannon Water (Water Authorities) as determining referral authorities in the DWSC areas along with Southern Rural Water within the Warrion Water Supply Protection Area. Corangamite CMA is the only recommending authority listed.

Where existing DWM systems are located in an area that has sewer available, the WC can require the property be connected to sewer if the system is found to be causing a health or environmental risk.

3.2.6 Department of Environment, Land, Water and Planning

The Department of Environment, Land, Water and Planning (DELWP) (formerly known as the Department of Environment and Primary Industries and Department of Sustainability and Environment) is responsible for the management of water resources, climate change, bushfires, public land, forests and ecosystems in Victoria. DELWP may be consulted by Council for specialist advice where a DWM system may impact on land or water resources.

3.2.7 Catchment Management Authority

COS falls within the Corangamite Catchment Management Authority (CMA) and has a large catchment area for a number of different water resources. Where DWM systems exist within sensitive catchments, close examination of a system, its operation and performance must be undertaken to ensure the protection of the asset. The CMA has policies and management tools to assist with the management of the waterways. The role of the CMA is:

- To ensure the sustainable development of natural resource based industries;
- To maintain and where possible, improve the quality of land and water resources;
- To conserve natural and cultural heritage;
- To involve the community in decisions relating to natural resource management within their region;
- To advise on matters relating to catchment management and land protection and the condition of land and water resources in the region; and

- To promote community awareness and understanding of the importance of land and water resources, their suitable use, conservation and rehabilitation.

3.3 Administrative Authorities

The Victorian Civil and Administrative Tribunal (VCAT) is a tribunal at which civil disputes, administrative decisions and appeals can be heard before a Judge or Tribunal Member. It provides a dispute resolution service for both government and individuals within Victoria.

In past cases throughout Victoria, VCAT has questioned the quality of LCAs for DWM, particularly where a site is located within a DWSC. VCAT has also questioned the rigour of some Council's evaluation of these LCAs, and how the minimum development guideline of 1 dwelling per 40 hectares should be applied in the DWSC.

3.4 Standards and Guidelines

3.4.1 EPA Code of Practice – On-site Wastewater Management

The EPA Code of Practice On-site Wastewater Management Publication 891.4 (EPA, 2016) outlines the measures which are required to sustainably manage household wastewater so as to minimise public health and environmental impacts. This Code is not limited to DWM systems; it also applies to systems at other premises including small scale commercial systems. The Code outlines planning requirements, system selection and system maintenance following installation.

3.4.2 Model Land Capability Assessment (2014)

The Municipal Association of Victoria Model Land Capability Assessment (2014) was revised to reflect the requirements of the current EPA Code of Practice and also provides further details on in-soil effluent assimilation processes and their influence on system design.

3.4.3 Land Capability Assessment (2003)

The Land Capability Assessment On-site Wastewater Management Publication 746.1 (2003) outlines the process to be undertaken when assessing a site for its suitability for DWM. An LCA must be conducted by a suitably qualified consultant experienced in on-site domestic wastewater land capability. Land capability assessors should follow the conservative and 'best practice' Model LCA Report (MAV, 2014). Council's role is to assess the land capability and risk assessment report, flow rates, land application calculations and design; it is not part of Council's role to undertake the calculations or design the land application system for the property owner.

3.4.4 AS/NZS 1547:2012 On-site Domestic Wastewater Management

AS/NZS 1547:2012 provides standardised guidance for the sizing, design and construction of Land Application Areas (LAAs). If there is an inconsistency between the Australian Standard (2012) and the current EPA Code of Practice, the Code takes precedence. Where the current EPA Code of Practice is silent on a topic, the relevant Australian Standard (2012) should be followed.

The Standard will be used to inform the selection of a suitable land application system, and where the standard sizing tables are not used, will inform the sizing of land application systems.

3.4.5 AS/NZS 1546.1-4 On-site Domestic Wastewater Treatment Units

AS/NZS 1546.1:2008- Part 1: Septic tanks

Specifies performance requirements and performance criteria for septic tanks, technical means of compliance and provides test specifications that enable septic tanks to be manufactured to comply with the performance requirements and performance criteria.

AS/NZS 1546.2:2008 – Part 2: Waterless composting toilets

Aims to: 1. Provide a set of performance statements that form a base against which any waterless composting toilet, conventional or innovative, may be assessed. 2. Provide manufacturers of waterless composting toilets with a performance evaluation test that will confirm the conditions under which it will function best (this will enable certification bodies to check that a product confirms to the Standard). 3. Ensure that the operation and maintenance of ta waterless composting toilet is done in a safe manner that meets basic health requirements given that it involves the removal or composted or partially composted material.

AS/NZS 1546.3:2017 – Part 3: Secondary treatment systems

Sets out the requirements for the design, commissioning, performance and compliance testing of secondary treatment systems and advanced secondary treatment systems designed to treat domestic wastewater up to 5,000L/day. Guidance on installation, operation and maintenance is also provided.

AS/NZS 1546.4:2016 – Part 4: Domestic greywater treatment systems

Specifies requirements for the performance, design, installation and testing of domestic greywater treatment systems and associated fittings for single domestic dwellings where adequate backflow protection is provided in accordance with *AS/NZS 3500.1.*

3.4.6 AS/NZS *3500.1-4:2021* Plumbing and Drainage

The Plumbing and Drainage Standard *AS/NZS 3500.1-4:2021* must be complied with for the installation of all plumbing work conducted on site.

Any design solution should be fitted and installed by a licensed plumbing contractor in compliance with the requirements of the Australian Standard (2021).

3.4.7 Guidelines for Development in Flood Affected Areas (DELWP, 2019)

The Guidelines for Development in Flood Affected Areas (DELWP, 2019) provide an assessment framework and method to assist decisions on development proposals in flood affected areas. Floodplain management authorities have the discretion to vary from the Guidelines to accommodate local floodplain issues.

Any development proposal should consider these Guidelines, with the design solution to meet the EPA Code of Practice 891.4 (2016) requirements in relation to flood prone land.

3.4.8 Auditor General of Victoria (2006) Protecting our environment and community from failing septic tanks

The Auditor General of Victoria released a performance audit report on *Protecting Our Environment and Community from Failing Septic Tanks* (2006). The aim of the report was to act as further stimulus in reducing the number of failing septic tanks throughout Victoria.

There is a historical legacy associated with failing DWM systems across the state which poses a threat to the environment and public health. A DWM system backlog program was generated, with rural Victoria falling under the Country Towns Water Supply and Sewerage Program (2005) initiated by DSE (now DELWP). The audit identified a clear need to improve backlog planning and

prioritisation processes, the legislation regulating septic tank management, and reporting and accountability mechanisms.

Records management and enforcement are two essential approaches to the management of environmental and public health risks caused by failing DWM systems. The following are the recommendations to reduce risks as outlined within the report:

- That the DSE, EPA and local government use available technical data sets such as LCAs, environmental monitoring, and cadastre (lot size) information to identify and monitor the impact of failing septic tanks across the state;
- That DSE, in consultation with CMAs, EPA, local government, DHS, water companies and authorities, establishes a mechanism to allow all stakeholders ready access to technical information such as LCA and environmental monitoring data, to improve risk identification and monitoring;
- That local government ensure that property owners and/or tenants understand that they have an existing septic tank system and that the owner has specific maintenance responsibilities for this system;
- That EPA, in consultation with local government, strengthens statutory requirements for local government to complete DWMPs by including an approval mechanism, periodic reviews and penalties for non-compliance; and

That local government reassess the resourcing levels needed to fulfil their legislative responsibilities for septic tanks.

4 Overview of DWM in Colac Otway Shire

4.1 The Local Environment

Colac Otway Shire is characterised by a unique environment including DWSCs covering approximately 30% of the Shire in the central region, large expanses of bushland and farmland, natural waterways and complex soils which all affect the way wastewater is managed on-site. There is lush hinterland, fertile grasslands, wetlands, rolling hills and volcanic cones. There are a number of State and National Parks in the Shire; notably, the Great Otway National Park and Otway Forest Park. The Shire contains three defined river Basins; Barwon, Corangamite and Otway Coast.

The Shire's major urban centre is Colac, with Apollo Bay being the other main centre in the south of the Shire. Most of the residential and commercial development outside of these towns exists within numerous small to medium sized towns/settlements, the majority unsewered. The Public Conservation and Resource Zones has been designated on public land, particularly along the coastline and the southeast of the Shire, with some privately owned land near the coast also in the Rural Conservation Zone. The Shire also has a significant percentage of land in Farming Zone, particular in the northern half of the Shire.

The diverse landscapes and climate patterns of the Shire present different opportunities and challenges for DWM. The constraints mapping (Section 6) describes in detail the different physical characteristics which are of most importance for sustainably managing treated effluent on-site, namely: climate, soils, slope, useable lot area and current Planning Scheme zone minimum lot size compliance.

4.1.1 Declared Water Supply Catchments

The Shire is drained by a number of large and small waterways, some of which enter the main drinking water supply for the Shire and surrounding regions. The protection of these waterways falls under the SEPP Waters of Victoria (2003). The active management of DWM systems in these special areas can help minimise any impacts on the surrounding environment.

The Shire incorporates a number of Declared Water Supply Catchments (DWSCs):

- Barwon Downs Wellfield Intake;
- Barham River;
- Gellibrand River;
- Gellibrand River South Otway;
- Upper Barwon;
- Pennyroyal Creek;
- Matthews Creek; and
- Gosling Creek.

These catchments provide drinking water to supply systems that are managed by Barwon Water and Wannon Water.

4.1.2 Soils

Site and soil investigations and sampling were conducted by Whitehead & Associates and Robert Van de Graaff & Associates on two separate occasions within the targeted localities and

towns/settlements to compare against the soil mapping collated by Robinson *et al.* 2003 LRA. The results were documented and adjusted accordingly in the soil suitability constraint mapping detailed in Section 6.2.6.

The geology and inherent soils of the Shire are separated into 3 distinct regions; the Volcanic Western Plans in the north underlain by extrusive igneous geology, a central region between Colac and Gellibrand that is underlain by variable geology including both marine, non-marine sedimentary and alluvial deposits, and the Otway Ranges which are part of the Otway Group and consist of non-marine sedimentary geology. Within the rural region in the north of COS, soils are predominantly gradational and texture contrast soils with clay subsoils derived from volcanic (basalt) lithology of the Western Volcanic Plains. The soils within the Otway Ranges are predominantly gradational soils with clay loam to loamy sand subsoils, while variable soil types occur within the central and coastal regions of the Shire. The specific soil types for the targeted localities and towns/settlements are discussed in the individual Locality Reports.

4.1.3 Climate

Climate, specifically rainfall and evaporation, plays a significant role in determining the appropriate loading rates of effluent and associated sizing of land application areas for DWM. The Shire was found to consist of four (4) distinct climate zones based on the climate analysis detailed in Section 6.2.2. The higher rainfall and low evaporation in the cooler months makes DWM problematic in all four climate regions.

4.1.4 Bushfire

Bushfire risk areas are not incompatible with DWM; however, bushfire risk has implications for planning town/settlement areas or allowing single dwellings, and can preclude residential intensification in certain areas.

4.2 DWM Systems and Trends in Colac Otway Shire

There are approximately 18,795 properties and 22,127 parcels within the Shire as of May 2021. The towns which are currently sewered are Colac, Elliminyt, Apollo Bay, Skenes Creek, Marengo and Birregurra, resulting in approximately 8,992 lots that are currently sewered. There are approximately 8,886 unsewered lots (properties and parcels within townships) which are not located within reasonable distance to a sewer, or to which no sewer connection exists; although it is not known how many of these are developed. Of these unsewered lots there have been 750 new unsewered lots that have been created since 2015. All non-developable lots (i.e. National Park, State Forest, waterway or road) were not included in the unsewered lot count and subsequent analyses.

Of those 8,886 lots, there are approximately 3,884 DWM systems (applications) on Council's permit management system. It is expected that there are a number of lots within the Shire which have DWM systems which are unknown to COS, either constructed without a permit, before permits were required, or where continuity of records has been interrupted during amalgamation. It is also expected that there are some lots with DWM systems with permits which are not recorded in the Council's current record system. Therefore, all of these numbers are approximate.

Historically, greywater was managed separately to blackwater and permitted to discharge off-site. Council no longer permits off-site discharge of greywater; however, there will be a number of systems still operating in this manner. The majority of older systems include a conventional septic tank (typically cylindrical, laid horizontally) with conventional absorption trenches. These can operate effectively in many cases; however, they do require regular maintenance. Common

practice with these systems in Victoria is to bury the septic tank underground. Thus, the septic tanks are often difficult to locate and many property owners cannot locate them. This typically results in inadequate maintenance of the septic tank and in particular inadequate desludging. Without periodic desludging (every 3-5 years depending on occupancy), tanks become overloaded with solids and do not provide adequate residence time for effluent to enable suspended solids to settle out. These solids then carry over to the land application system (typically an absorption trench) and usually cause the soil to block up over time, causing failure of the trench and surcharge of effluent to the ground surface.

Newer systems installed in COS tend to provide higher levels of treatment through the use of AWTSs, sand filters or greywater treatment systems, and no longer discharge greywater separately. These systems provide secondary treatment of the wastewater before discharge to LAA irrigation systems. These systems do require more maintenance than a septic tank and servicing every three months is a requirement of the system Certificate of Conformance.

From July 2015 to June 2021, there had been 444 DWM system applications; including the following treatment types: 137 septic primary systems, 279 AWTS, 13 sand filter, 1 pump out, and 14 worm farm systems. These have been included into Table 1 and 2 below. There has also been 387 Permits to Install issued and 253 Certificates to Use (some not yet issued/ outstanding), and 2,998 service reports receipted. In addition, there has been 474 inspections of premises under the *Food Act 1984* and *Public Health and Wellbeing Act 2008*, with any DWM systems servicing these premises also inspected.

Considering the date of issue of many of the permits, there may be a large number of systems operating which do not meet current Council or EPA requirements. There have been 21 notified wastewater complaints to Council regarding DWM systems and associated land applications that have been registered in Council's Health Manager database from 2015- 2021. These were all located within the township of Forrest. The reticulation/sewering of Forrest would be beneficial as wastewater management complaints are received in this township. There are a number of site constraints that are present within these township properties. Protecting the environment and public health through the sewering of Forrest would be supported.

Table 1 and Table 2 below provide a summary of the treatment and land application system types known in the Shire. The data was provided by COS (current June 2021) and represents currently registered DWM systems within COS's permit management system. For a number of reasons, there are a large number of unknown system types; however, this is generally not an indication of poor performance of these systems.

Table 1: DWM System Types

System Type	System Brand	Number of Systems Inspected
Septic Tank	Unknown	1,280
AWTS	Unknown	105
	AquaNova	58
	Aquacycle	3
	Aquatreat	3
	Alpha Treat DP10	4
	Biocycle	19
	BioFicient Series 1	5
	Biolytix	13
	Clearwater Bio-Filter	4
	Diston Bio-Rotor	1
	Econocycle	60
	Envirocycle	20
	Envirosepp	196
	FujiClean	44
	Global Roto-Moulding	1
	Graf	3
	Nova Clear	3
	Ozzi Kleen	232
	Ozzi Kleen greywater treatment system	16
	Septech	36
	Supertreat	1
	Taylex ABS	56
	20EP Sewage Plant	2
Composting	Biolet composting	1
	Clivus Multrum	3
	Ecolet	1
	Rota-loo	3
Sand Filter	Sand Filter	293
Other	Constructed Wetlands Reedbed	1
	Unknown	1
Worm Farm	A&A Worm Farm Waste Systems	38
	Zenplumb wormworx	1
	Unknown	6
Unknown	Unknown	779
Total (includes split treatment systems for blackwater & greywater)		**3,292**

Table 2: Land Application Methods

Effluent Disposal Method	Number of Systems
Drip Irrigation	224
Irrigation	75
Pressure Irrigation	95
Subsurface Irrigation	532
Trench	665
Transpiration Bed	47
ETA Bed	6
LPED	2
Wick Trench	42
Reln™ Drains	2
As Per Plan	41
Unknown	2,242
Pump out	5
Total	**3,978**

To date, 100% of systems with a permit in the Shire have been inspected by Council staff at least once. However, older systems without a permit, and those where tanks are buried and not able to be located, may not have been inspected by Council staff, either at the time of installation or since.

Since the appointment of a dedicated DWM officer from 2018-2021, 406 DWM audits have been undertaken as part of a targeted risk-based compliance monitoring program. The audits focused on the higher risk townships and those located within a DWSC; including, Beech Forest (95), Kennett River (152), Barwon Downs (67), Lavers Hill (41), and Gellibrand (51). The breakdown of the DWM treatment system types audited is as follows: AWTS 21%, septic (with trenches) 61%, worm farm 1.6%, sand filter 2.9%, composting toilet 0.8%, and unknown 11.3%. Of these DWM systems audited, only 71% contained effluent within the LAA; with 14% discharging to the surface on-lot and 15% discharging effluent off-site. There were an additional 110 audits undertaken by an external contractor in Forrest in 2017.

4.3 DWM System Inspections in Drinking Water Catchments

Site assessments were undertaken for a representative sample of properties in unsewered towns/settlements located in the Declared Water Supply Catchments (DWSCs) in September 2014. Approximately 10% of permanently-occupied households in selected towns/settlements were inspected, encompassing a typical range of land sizes. The results are considered to be broadly reflective of the towns/settlements assessed.

4.3.1 Wastewater Treatment Systems

The proportion of combined (blackwater + greywater) wastewater systems was often higher than expected, as well-established rural localities and associated towns/settlements commonly have separate greywater and blackwater systems. The newer houses (<20 years) were more likely to have combined systems than older houses (>20 years).

Regardless of whether blackwater and greywater streams were separate or combined, septic tanks were often unsatisfactory in terms of accessibility for maintenance, capacity and/or structural integrity. Frequently, septic tanks were buried under more than 150mm of soil, making identification and access difficult and in some cases, the resident/owner was not aware of the septic tank location. Most systems had not been serviced or pumped out within the past 10 years. Many septic tanks allowed stormwater ingress through cracks or gaps alongside the lids, which were typically installed at or below ground level.

There were relatively few secondary treatment systems or greywater treatment systems installed at the inspected properties.

4.3.2 Effluent Disposal Systems

Where greywater was managed separately, it was typically directed off-lot, either to the street drain at the front or beyond the back fence (to neighbouring public land or private agricultural land). Due to the cool weather and high rainfall of the inspection period (early spring), effluent did not drain away and was often present in stagnant odorous pools near the point of discharge. In many cases, the direct flow path to nearby surface waters, including drains, creeks and rivers, was less than 100m, posing a high risk to public and environmental health.

Blackwater or combined effluent septic tanks typically discharged to conventional absorption trenches. It was often difficult or impossible to determine the dimensions and layout of trench systems, particularly as wet weather did not cause preferential growth of grass over trenches (as is the case in drier seasons). However, it was evident that many if not most trenches were undersized for the expected wastewater load (number of bedrooms), particularly when the age and potential for 'creeping failure'[1] of the system is taken into account.

However, the existing trenches may be acceptable for the typically small number of occupants of most households (an average of approximately 2 – 2.5 across the Shire, according to ABS 2011 Census data); in which case upgrades may not be immediately necessary.

[1] Refers to the progressive clogging of a soil absorption (trench) system along a linear front from the loading end to its terminus.

5 Preliminary Data Collection (Stage 1)

The following section details data acquisition undertaken for the project and used to process information for input into the Sensitivity Analysis. Section 4.1 of the Operational Plan details the methodology and results of the Sensitivity Analysis and overarching Risk Assessment Framework. The background legislative/regulatory requirements are discussed above in Sections 2 and 3.

5.1 Data Acquisition

Geographic Information System (GIS) data, covering a wide variety of physical and planning components, has been acquired from COS, the Department of Environment, Land, Water and Planning (DELWP), Wannon Water, Barwon Water, Southern Rural Water, FedUni, Visualising Victoria's Groundwater (VVG) Project by University of Ballarat and the former Department of Sustainability and the Environment (DSE).

The data obtained included: property and parcel (for targeted localities only) information (cadastre), roads, local government area (LGA) and locality boundaries, sewer network, septic system information, topography, LIDAR, planning scheme zonings and overlays, surface elevation contours (a range of levels), hydrology and drainage, potable reservoirs and offtake points, climate data including rainfall and evapotranspiration, flood prone land (land subject to inundation), 1 in 100 year annual recurrence interval (ARI) flood level, soil landscape, lithology and land system information, groundwater bore locations and information, watertable depths and potable water catchment boundaries. All data was received during late 2014, except for the parcel cadastre layer which was updated as of June 2015. The Sensitivity Analysis was reviewed in 2021, with the revised cadastral data used to ensure that planning and development changes since 2015 were incorporated into the assessment and assigned a Sensitivity Risk Rating in relation to DWM. The only other layer that was also updated within the 2021 review was the COS planning scheme zonings and overlays. Comparisons with the other layers showed that there was no to little change in attributes between 2015 and 2021 so they were not updated within the Sensitivity Analysis.

The GIS data supplied was used for the development of individual constraint maps, informative maps and overlay maps of the Shire. This information provided a comprehensive basis for risk assessment.

5.2 Property (Parcel) Characterisation

Using cadastral data supplied by Council as part of the 2021 review, the analysis identified approximately 18,795 'properties', comprising of 22,127 'parcels' within the Shire. For analysis presented throughout the DWMP, the parcel dataset was used within the targeted localities and associated towns/settlements, with the property dataset used for the remainder of the Shire.

All non-developable lots (i.e. National Park, State Forest, recreation or conservation area, waterway or road etc.) are not included in the unsewered lot count and subsequent analyses in the DWMP. Towns which are currently sewered; including Colac, Elliminyt, Apollo Bay, Skenes Creek, Marengo and Birregurra, have also been excluded from the analysis.

Further, parcels that were <400m^2 in area were excluded from the analysis as they represent a land area too small to sustainably accommodate unsewered development (building/associated improvements and DWM) on-site. These areas most likely represent dataset irregularities (i.e.

artefacts), or Council or utility sites. If necessary, assumptions can be drawn from the constraints of the surrounding lots.

Based on the raw dataset, and the exclusions described, there are approximately **8,886 unsewered lots** which are not located within reasonable distance to a sewer, or to which no sewer connection exists; although it is not known how many of these are developed. Of these 8,886 unsewered lots; 750 new lots have been created since 2015. The regions excluded from analysis as outlined above are shown as white regions (cadastre) on the subsequent Constraint and Sensitivity Analysis maps.

Some discrepancies may be found between other published total lot numbers and those used, due to issues associated with lot amalgamation and subdivision over time and the current version of cadastre provided by the Council. The cadastre dataset used in this analysis will be progressively updated by Council to include the changes made to the lots within the Shire overtime; as exhibited during this 2021 review

6 GIS Data Analysis (Stage 2)

6.1 Domestic Wastewater Management Constraints

The individual constraint maps were created using a GIS, through QGIS™, which applied constraint classes for a number of built constraints and land capability constraints, including site and soil parameters. Five constraints were selected, which when consolidated, contribute to assessing the overall land capability for DWM systems, and were used as an input into the Sensitivity Analysis. These were selected based on the availability of digital data, and in the light of experience gained in designing and auditing DWM systems. The discrete constraints selected were:

- Climate;
- Useable Lot Area;
- Current Planning Scheme Zoning Minimum Lot Size Compliance (updated 2021 review);
- Slope (surface elevation); and
- Soil Suitability.

Sensitivity Analysis mapping refers to all unsewered lots, irrespective of whether they are developed or not. Lots that were excluded from the Sensitivity Analysis included those, sewered, <400m^2 in area, zoned Public Park and Recreation Zone, Public Conservation and Resource Zone, and Road Zone as per the COS Planning Scheme, and areas that are categorised as waterbodies in the soil landscape mapping.

Thematic informative maps were also generated for existing lot size, current planning scheme zoning, vegetation, and geology. A sensitivity overlay was developed for landslip hazard and depth to groundwater to assist in refining the final risk rating as necessary for each lot as generated by the Risk Assessment.

There were other parameters that could have been considered in a more detailed constraint assessment; however, such data was not available for this Risk Assessment and the scope of the project did not permit its collection. Nevertheless, the constraints chosen were considered acceptable for the purpose of quantifying the constraints for the broad-scale Risk Assessment outlined in the Operational Plan . The maps have been produced for use at a broad scale (~1:330,000) and the limitations of the data used in the creation of these maps for input in the Sensitivity Analysis must be recognised and is detailed in Section 4.1 in the Operational Plan.

6.2 DWM Constraint Mapping

6.2.1 Constraint Classification Framework

For each of the constraints mentioned above, the degree of constraint in relation to DWM for all lots within the Shire was assessed and individually assigned a constraint class that is then used as an input into the Sensitivity Analysis. The criteria used to determine constraint categories were based on previous constraint assessments for unsewered towns in Australia undertaken by W&A and relevant Australian and Victorian guidelines for DWM.

Table 3 provides a rationale for the interpretations that were used to derive the constraint classes. The constraint classes give guidance towards the DWM requirements as stipulated by Council. For existing DWM systems, the level of constraint will commonly reflect the level of challenge that

has been experienced in managing the system. This information will help guide property owners and Council in the ongoing management of existing systems.

Table 3: Rationale for DWM Constraint Ratings

Constraint Class	Description
Very High	The constraint is present at a very high level and this significantly restricts opportunities for sustainable DWM. Traditional systems are 'typically' not appropriate and a detailed site and soil evaluation would be required to determine if DWM is achievable at all. If achievable, specialised, advanced treatment and land application systems may be required to overcome the constraint.
High	The constraint is present at a high level and this substantially restricts opportunities for sustainable DWM. Traditional systems (i.e. septic tanks and trenches) are 'typically' not appropriate and a detailed site and soil evaluation would be required to determine if they are supported. Otherwise, specialised, advanced treatment and land application systems may be required to overcome the constraint.
Moderate	The constraint is present at a moderate level and this limits the range of DWM options that are appropriate for the site. A detailed site and soil evaluation is required to identify the most appropriate DWM system and mitigation measures to be employed.
Low	The constraint is present at a low level and is unlikely to substantially limit opportunities for DWM. In most cases appropriately designed and managed conventional systems will be acceptable.

6.2.2 Climate

Climate, specifically rainfall and evaporation, plays a significant role in determining the appropriate loading rates of effluent and associated sizing of land application areas for DWM. The climate feature of most interest to DWM is the excess of rainfall over evaporation (more specifically evapotranspiration), which is denoted here as "moisture surplus". Moisture surplus can result in surface runoff, an increase in soil moisture storage (up to saturation point), and increasing deep infiltration to groundwater.

There are 21 Bureau of Meteorology (BoM) stations located throughout the Shire which record daily rainfall, including five on the Otway Ridge, which receives Victoria's highest average annual rainfall (up to 1,950mm/year). However, none of these stations measure pan evaporation. The closest station to the Shire that records pan evaporation is at Durdidwarrah, located approximately 45km from the north-eastern Shire boundary. Pan evaporation data for the period 1973-2000 is available at this station.

To overcome this data limitation, this project uses interpolated, gridded data from SILO. SILO (Scientific Information for Land Owners) is a climate and meteorological data service developed and hosted by the Queensland Government, which provides representative data for the entire continent, produced using real climate data collected over long time periods by the BoM. The service provides a realistic representation of a broad range of climate statistics (including rainfall and evapotranspiration) for most areas which are not serviced by local BoM stations. However, it is acknowledged that, due to the sparsity of raw data (BoM) sites and significant orographic influence, the interpolation for the Otway Range tends to underestimate the rainfall along the ridge.

Monthly rainfall and evapotranspiration data for 64 SILO data points at approximately 0.1 degree (~8.8km) grid spacings was collected for the entire Shire. Figure 1 shows the rainfall distribution pattern throughout the Shire based on annual 70th percentile rainfall for each SILO data point. The percentile rainfall data was interpolated using GIS across the Shire to produce a grid with approximately 300m cell size. With the exception of the Otway Ridge rainfall, the data is considered to be a realistic representation of climate patterns throughout the Shire on a long term basis, suitable for use in DWM investigations and designs. The data was also used in the System Sizing Tables, discussed in Section 7.

SILO potential evapotranspiration (ET_0) estimates are calculated using the FAO Penman-Monteith formula with a default wind value of 2 m/s. The Penman-Monteith formula also requires radiation, air temperature and humidity as an input. These data are readily available from existing BoM stations.

For each SILO data point for each year, the monthly water 'excess' totals were calculated by subtracting the total monthly rainfall from total monthly average evapotranspiration. When a water excess occurs within any given month, the rainfall exceeds the evapotranspiration, resulting in meteorological water being retained within the soil profile. From this, the total number of 'wet' months for each year were calculated and the median taken for each SILO data point. The number of 'wet' months has been gridded and the interpolated values have been converted to the nearest integer. The distribution of the number of 'wet' months throughout the Shire is shown in Figure 2. From this, four (4) distinct climate zones were identified based on the number of months where rainfall exceeds evapotranspiration and were categorised as detailed below. Each lot within the Shire was assigned to a climate zone as shown in Figure 3.

- Zone 1: 0 – 4 soil moisture surplus (70th percentile rainfall exceeds mean evaporation) months of the year;
- Zone 2: 5 – 6 soil moisture surplus (70th percentile rainfall exceeds mean evaporation) months of the year;
- Zone 3: >7 soil moisture surplus (70th percentile rainfall exceeds mean evaporation) months of the year; and
- Zone 4: average annual rainfall >1,600mm.

A lot is assigned the more conservative climate zone if it is located along a climate zone boundary. Table 4 details the results of the climate zone constraint analysis for the Shire.

Similarly, the longest run of consecutive 'wet' months in each year was also determined and the median longest run was calculated for each SILO data point. The number of consecutive 'wet' months has been gridded and the interpolated values have been converted to the nearest integer. The distribution of the number of consecutive 'wet' months throughout the Shire is shown in Figure 4.

Overall, there is a strong trend in greater rainfall towards the south of the Shire, particularly along the Otway Range. This is consistent with higher topography and coastal conditions in those regions. The 'wet' months are typically found to coincide with the winter calendar months and had a similar increasing trend towards the south of the Shire. All of the targeted localities and towns/settlements are located within climate zones 2 - 4.

The acquired climate data obtained for this assessment is available to Council and will provide a very useful resource for Council in the preparation and review of LCAs in the future. Monthly 70th percentile rainfall and average evapotranspiration data is available for the majority of the

unsewered localities and towns/settlements from Council for input into monthly water balances as part of a site specific LCA.

The climate data that was used in the development of the System Sizing Tables is attached in Appendix C. The BoM 70th percentile rainfall presented in Appendix C should be used instead of the SILO data for all localities along the Otway Ridge (i.e. Beech Forest, Ferguson, Lavers Hill, Wyelangta and Weeaproinah). This appended climate data also includes additional data for surrounding unsewered localities. Land Capability Assessors are also able to use site-specific SILO Data Drill and BoM climate data for LCA reports and DWM designs for particular lots. The use of such data should be clearly referenced and justified in the LCA report in each instance.

Table 4: Climate Zones Constraint Map Summary

	Total Lots (Original (new >2015))	Total Number in Assigned Constraint Class			
		Zone 4	Zone 3	Zone 2	Zone 1
		Average Annual Rainfall >1,600mm	>7 months soil moisture surplus	5 – 6 months soil moisture surplus	0 – 4 months soil moisture surplus
Shire (Overall)	8,136 (750)	571 (18)	3,496 (391)	3,861 (317)	208 (24)
Alvie Town (Locality)	157 (4)	0 (0)	0 (0)	157 (4)	0 (0)
Barham River (Apollo Bay) Settlement (Locality)	309 (83)	0 (0)	309 (83)	0 (0)	0 (0)
Barongarook Settlement (Locality)	260 (2)	0 (0)	260 (2)	0 (0)	0 (0)
Barwon Downs Town (Locality)	252 (8)	0 (0)	251 (8)	1 (0)	0 (0)
Beeac Town (Locality)	628 (14)	0 (0)	0 (0)	628 (14)	0 (0)
Beech Forest Town (Locality)	329 (3)	293 (3)	36 (0)	0 (0)	0 (0)
Carlisle River Town (Locality)	245 (1)	1	241 (1)	3 (0)	0 (0)
Coragulac Town (Locality)	175 (13)	0 (0)	0 (0)	175 (13)	0 (0)
Cororooke Town (Locality)	254 (31)	0 (0)	0 (0)	254 (31)	0 (0)
Forrest Town (Locality)	344 (5)	0 (0)	315 (5)	29 (0)	0 (0)
Gellibrand Town (Locality)	260 (5)	0 (0)	260 (5)	0 (0)	0 (0)
Kawarren Settlement (Locality)	212 (3)	0 (0)	175 (0)	37 (3)	0 (0)
Kennett River Town (Locality)	183 (0)	0 (0)	2 (0)	181 (0)	0 (0)
Lavers Hill Town (Locality)	189 (5)	176 (5)	13 (0)	0 (0)	0 (0)
Separation Creek Town (Locality)	129 (0)	0 (0)	0 (0)	129 (0)	0 (0)
Wye River Town (Locality)	376 (13)	0 (0)	0 (0)	376 (13)	0 (0)

Legend

—— 70th Percentile Rainfall Contours (50mm Intervals)

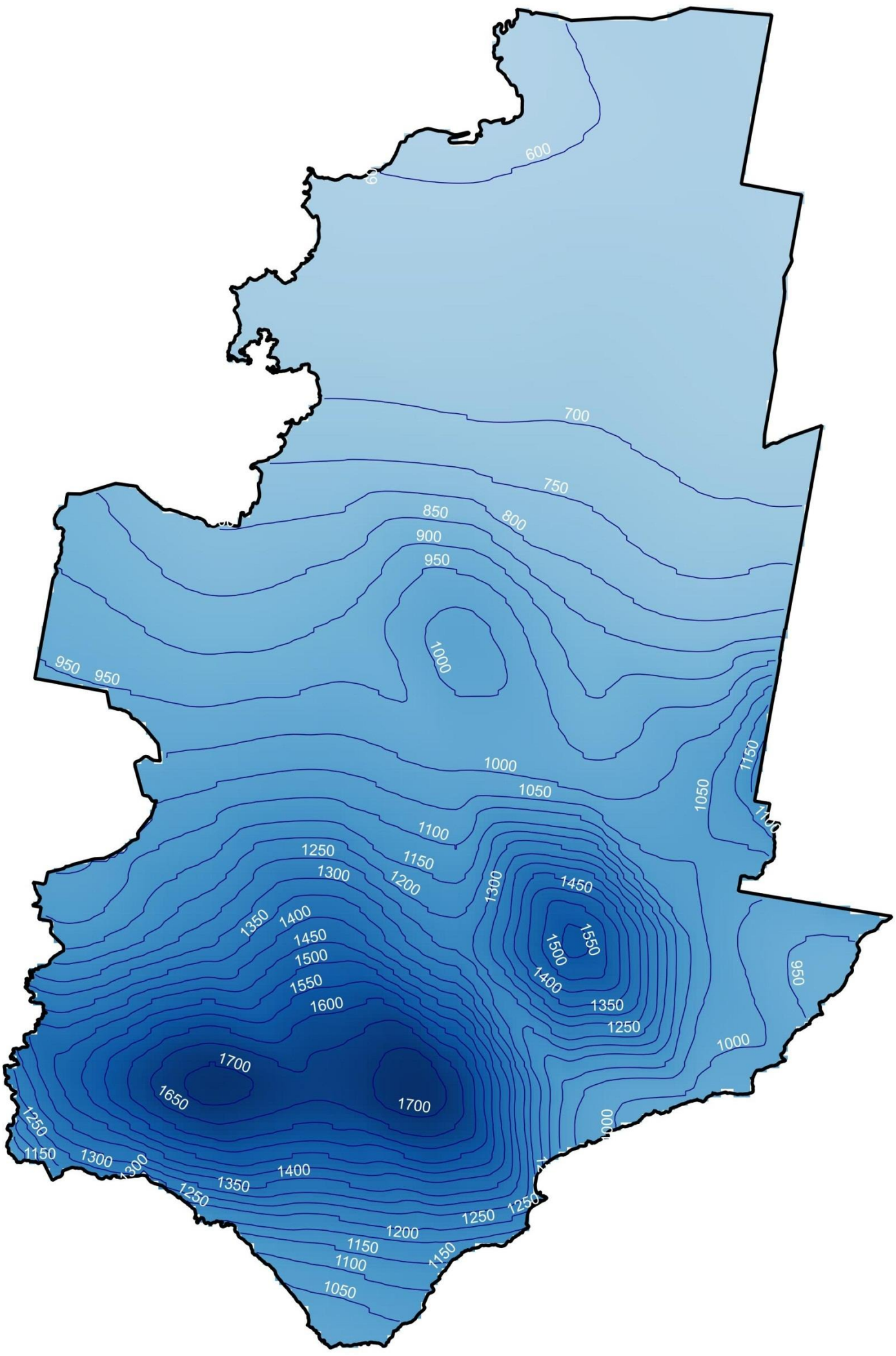

Figure 1: 70th Percentile Rainfall Distribution - Shire

Colac Otway Shire DWMP Review

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Environmental Consultants

0 6 12 18 24 30 km

(Approx Scale)

Revision	1
Drawn	JK
Approved	MS

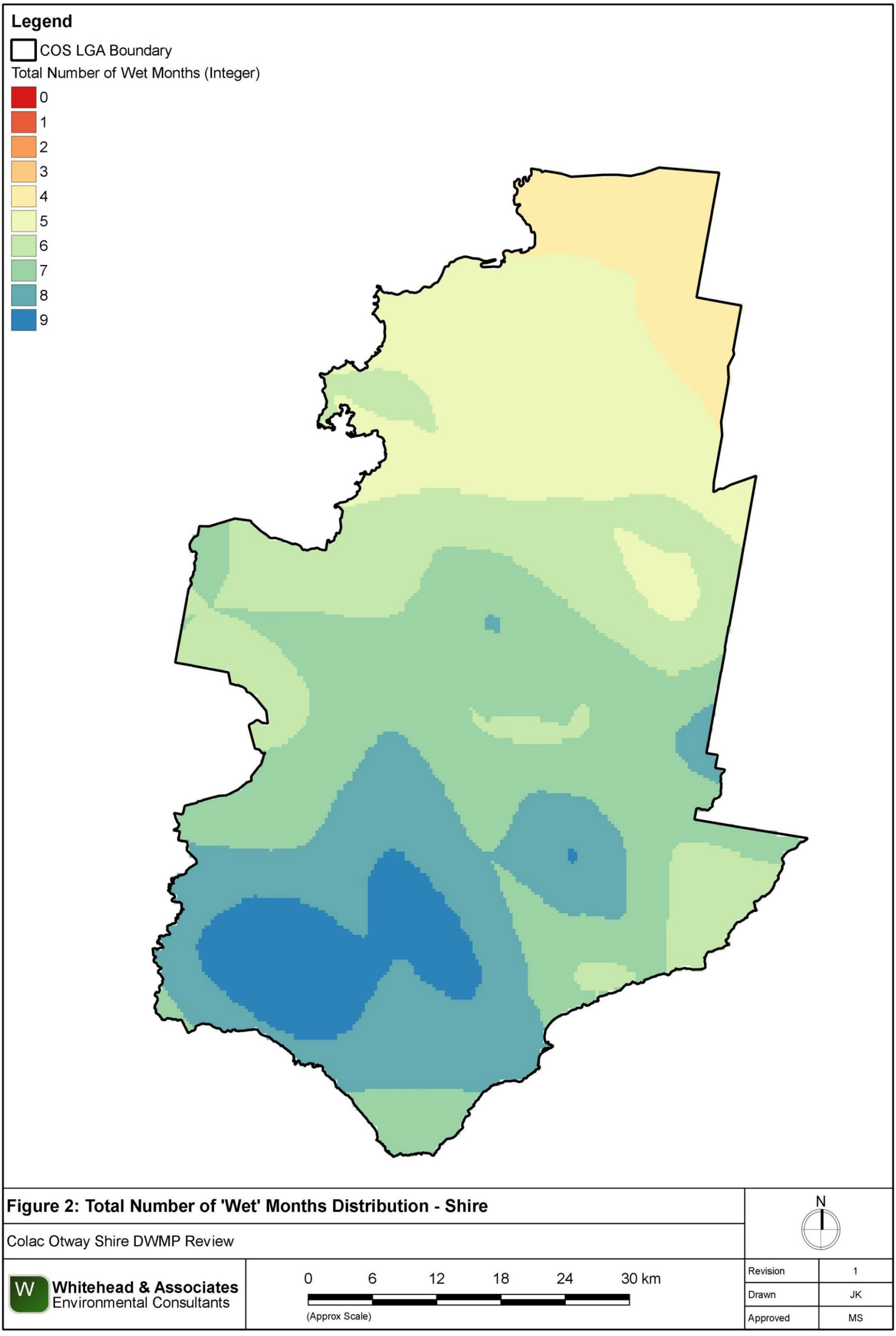

Figure 2: Total Number of 'Wet' Months Distribution - Shire

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Revision	1
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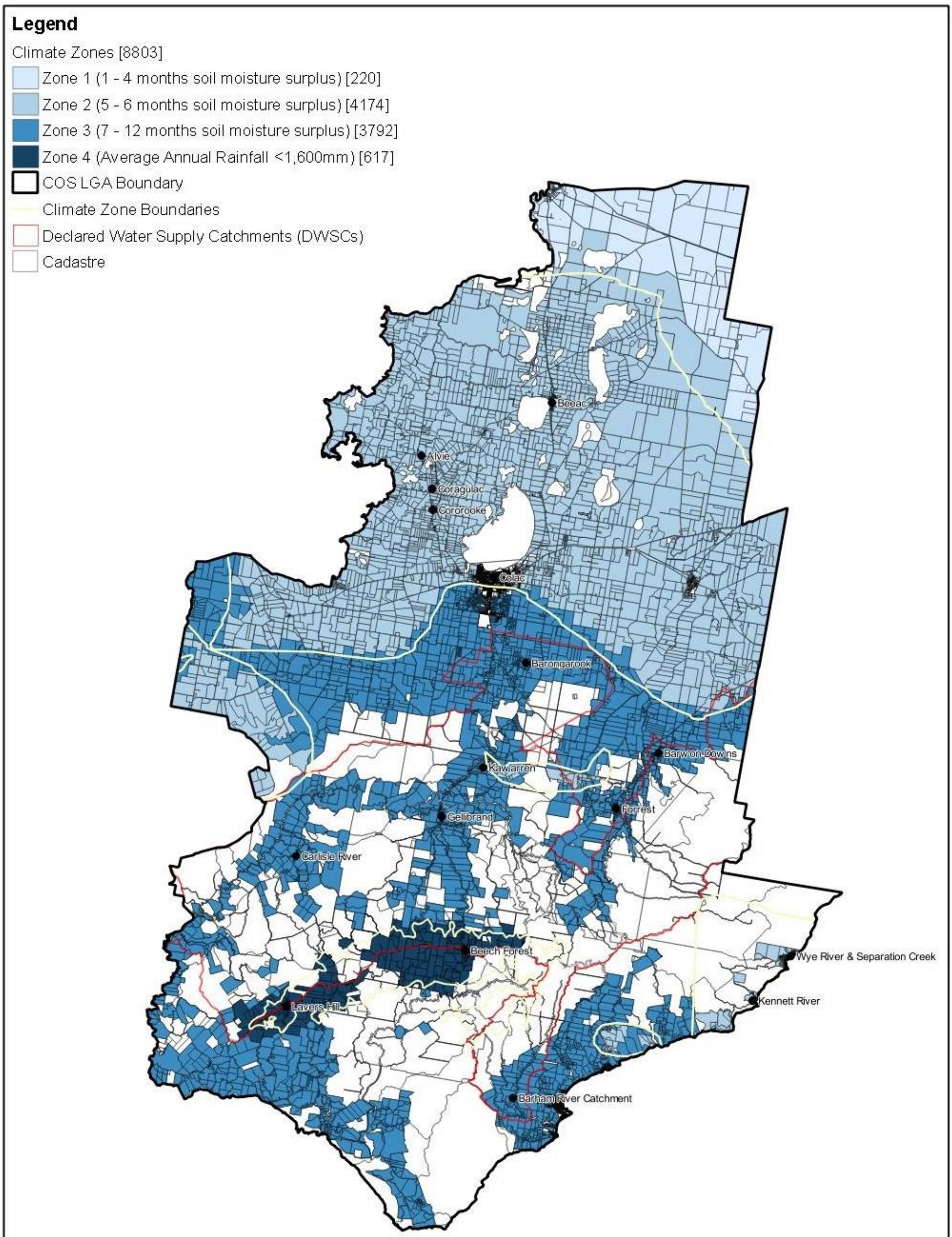

Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure 3: Climate Zones Distribution - Shire

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Drawn	JK
Approved	MS

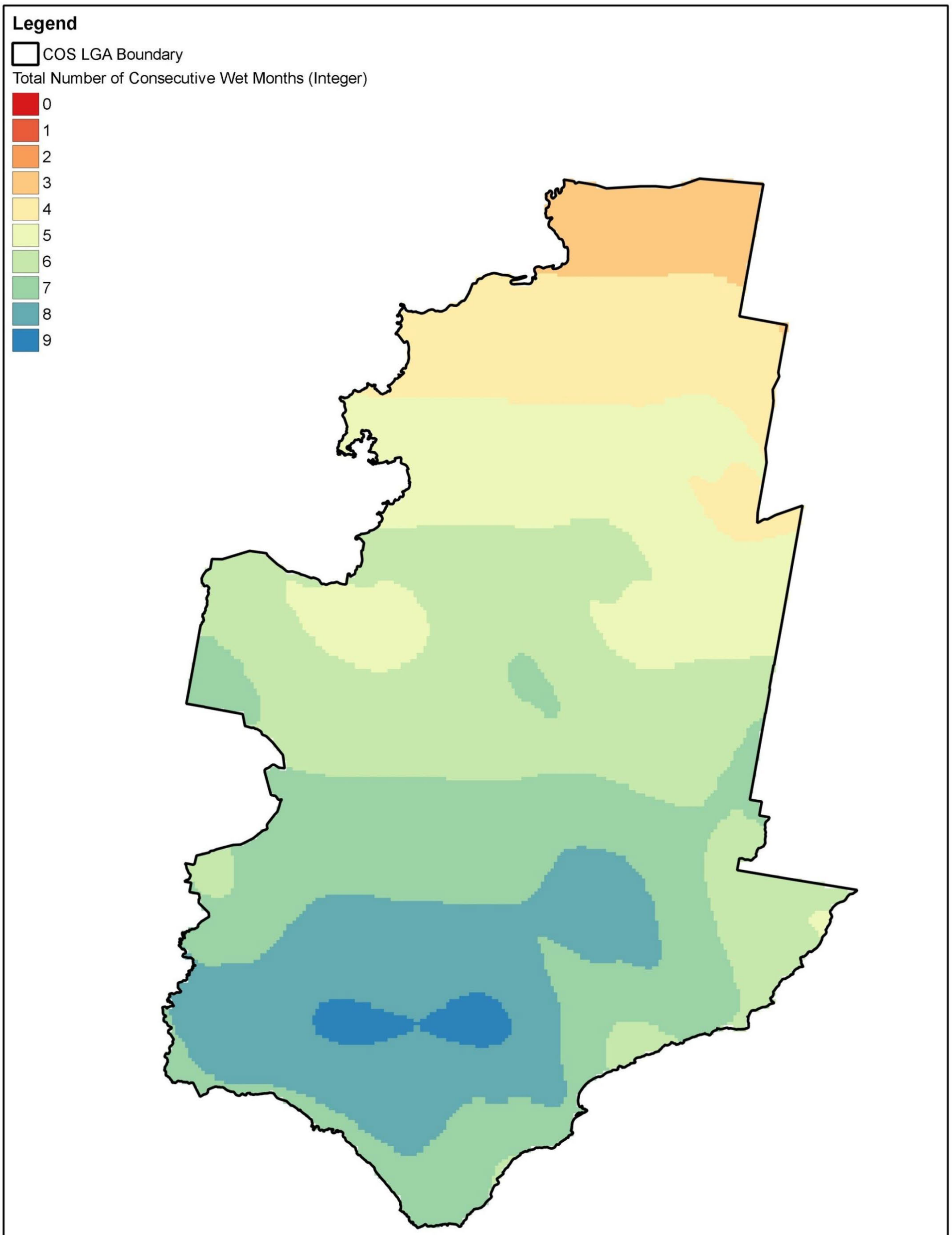

Figure 4: Total Number of Consecutive 'Wet' Months Distribution - Shire

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Revision	1
Drawn	JK
Approved	MS

6.2.3 Useable Lot Area

The potential for sustainable DWM and the determination of suitable DWM system options is dependent on the amount of adequate area available for DWM. The useable lot area for effluent management broadly refers to available land (i.e. not built out or used for a conflicting purpose) where DWM will not be unduly constrained by site and soil characteristics.

The smaller the lot, the more difficult it is to treat and retain wastewater onsite in accordance with legislative requirements. A properly sized land application area provides for long-term, sustainable effluent loading rates that match the assimilative capacity of the soil and vegetation systems. Conversely, improperly designed or undersized land application areas are more likely to fail and lead to potential adverse impacts on both public health and the environment. In recent years, understanding of sustainable effluent loading rates has improved and it is now commonly identified that many older existing systems, such as septic absorption trenches and evapotranspiration beds, are undersized by today's standards.

Useable lot area, irrespective of total lot size, plays a key role in determining a lot's capacity for sustainable long-term DWM and influences the selection of appropriate DWM systems. However, as a general rule, the smaller the lot, the less land that will be available for effluent management after allowing for other development on the land. Older development controls and design standards (Codes etc.) did not always consider site-specific land capability constraints and, as a consequence, many existing and vacant residential lots may be too small to accommodate sustainable DWM systems, particularly by today's more informed standards.

There is no defined rule about what constitutes an appropriate minimum effluent management area, or in fact minimum useable area that is capable of providing such areas. This will vary depending on the physical constraints present on the lot, the nature of the development, as well as the type of treatment and land application system used. The constraint class boundaries reflect the likelihood of a lot having sufficient effluent management area available after allowing for typical improvements.

There are many factors that determine the available area on any given lot, including:

- Maintenance of appropriate setback buffers from boundaries, buildings, driveways and paths, groundwater bores, dams, intermittent and permanent watercourse; and
- Total development area (including the dwelling, sheds, pools, driveways and garden paths, gardens unsuitable for effluent reuse, and any other hardstand areas, etc.).

Available areas may be unsuitable or constrained for DWM due to other factors, including (but not limited to):

- Excessive slope;
- Excessively shallow soils;
- Heavy (clay) soils with low permeability;
- Climate in regards to the degree of soil moisture surplus;
- Excessively poor drainage and/or stormwater run-on; and
- Excessive shading by vegetation.

For this study, the useable lot area was determined by the setbacks to surface waterways, groundwater bores and land subject to inundation. The following sections detail the methodology and results for each analysis and the determination of the final useable lot area.

6.2.3.1 Proximity to Surface Waters

This section seeks to explain how the distance to waterways, lakes, dams and drinking water catchments influences the useable lot area calculation which forms part of the constraint mapping. This is of particular importance for lots within the DWSCs.

COS is located entirely within the Corangamite Catchment Management Area (CMA) and consists of the following defined three river basins; Barwon (to the east), Corangamite (north and west), and Otway Coast Basin (to the south).

A large portion (28%) of the Shire is located within a Declared Water Supply Catchment (DWSC). There are seven DWSCs located within the Shire; Gosling Creek, Pennyroyal Creek, Matthew Creek, Upper Barwon, Lorne, Barham River, Gellibrand River, Gellibrand River (South Otway), and Barwon Downs Wellfield Intake. Three of these DWSCs, Upper Barwon, Gellibrand River, and Gellibrand River (South Otway), have Special Area Plans. These DWSCs are detailed on the 'proximity to surface waterways informative map' in Appendix A and regionally below in Figure 5.

Buffer distances (setbacks) are usually provided between land application areas (including all pipes and fittings associated with the DWM system) and sensitive receptors, such as surface watercourses, to help prevent adverse impacts on water quality, particularly should the DWM system fail. There is no simple and defined method for objectively determining safe buffer distances, so regulators often recommend conservative, minimum buffer distances that would be expected to satisfy the objective in the majority of situations.

The current EPA Code of Practice recommends three tiers of setback distances from surface waterways that are applicable to the Shire. Further, the Code specifies differing setback distances for primary (i.e. septic/trench) systems, secondary and greywater systems, and advanced secondary greywater systems. The following (primary) buffers have been conservatively adopted and applied to the appropriate surface watercourse/waterway using data (1:25,000 scale) provided by DELWP. The resultant map is appended in Appendix A.

- 60m for non-potable watercourses, dams, wetlands, estuaries and surface water features (including the mean coastal high-tide mark and dams);
- 100m for potable watercourses[2] and surface waterway river bodies; and
- 300m for potable reservoirs or storages.

300m setbacks, similar to those applied for potable reservoirs, were also applied to the Water Corporation source points (i.e. offtake points, weirs, pumping stations, etc.) to ensure that the sensitivity of these local environments are accounted for.

No setbacks were applied to man-made drains or waterfalls, which would likely be accounted for within other watercourse/waterway setbacks.

Intuitively, the risk of DWM systems impacting on nearby receiving areas increases with decreasing separation distance. For a broad-scale risk assessment, it is appropriate to analyse

[2] It should be noted that the surface water map does not distinguish between permanent and intermittent watercourses. Diversion channels have been defined as a watercourse for this particular purpose.

the separation distances that are available on a lot basis and assign constraint classes accordingly.

AS/NZS 1547:2012 and Table 5 in EPA Code of Practice 891.4 details instances where recommended setbacks from sensitive receptors can be relaxed to accommodate certain types of systems where standard buffer distances cannot be achieved. These systems would require individual assessment and design in order to meet the requirements of the Standard.

For lots constrained by proximity to surface waters, it might be possible to mitigate this constraint by:

- Secondary treatment with an AWTS or sand filter;
- Moving the LAA to increase buffer distance; or
- Replacing surface irrigation with subsurface irrigation.

As mentioned previously in Section 3.2.5, water services within the Shire are provided primarily by Barwon Water, with water also supplied by Southern Rural Water to the north of the Shire and by Wannon Water to the town of Carlisle River. Both Barwon Water and Wannon Water are referral authorities for developments within the DWSCs within the southern region of the Shire. The referral authorities for each DWSC in the Shire are detailed within Clause 66.04 and Schedule 3 of the Environmental Significance Overlay (ES03) of the COS Planning Scheme.

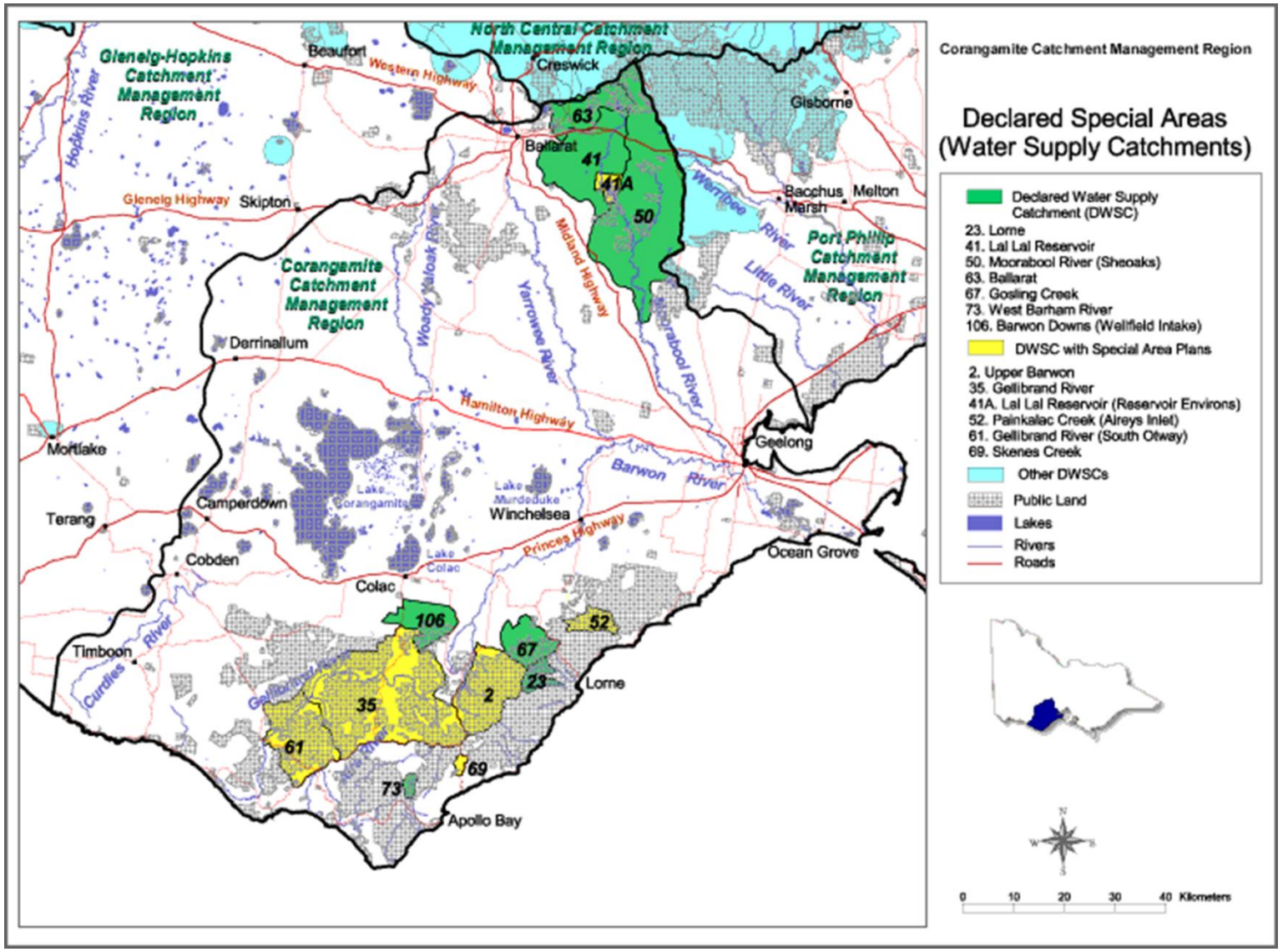


Figure 5: Corangamite CMA Declared Water Supply Catchments (DEPI, 2012)

6.2.3.2 Proximity to Groundwater Bores

This section seeks to explain how the distance from DWM systems to groundwater bores can affect the quality of groundwater.

The principal groundwater resources in Victoria fall south of the Great Dividing Range and are generally contained in Tertiary or younger unconsolidated sediments. The Shire is located within the Otway-Torquay groundwater basins, within the Hopkins-Corangamite and Otway-Torquay groundwater catchment areas.

A Groundwater Management Unit refers to either a Groundwater Management Area or Water Supply Protection Area as determined within the Groundwater Catchment. Water Supply Protection Area(s) (WSPAs) are declared under Section 27 of the *Water Act 1989* to protect groundwater or surface water resources through the development of a management plan which aims for equitable management and long-term sustainability. There are nineteen WSPA declared in Victoria. A Groundwater Management Area(s) (GMAs) is defined as an area where groundwater of a suitable quality for irrigation, commercial or domestic and stock use is available or expected to be available. There are 34 GMAs declared in Victoria. There are four GMAs found within the Shire; Gerangamete to the east (60m depth), Gellibrand centrally located (at or near surface), Paaratte to the west (>120m depth) and Newlingrook to the west (at or near surface). There is one declared WSPA within the Shire; Warrion WSPA, which is located within the north east of the Shire and within the targeted localities of Alvie, Cororooke and Coragulac. This is managed by Southern Rural Water. The western edge of Lake Corangamite forms the administrative boundary between Colac Otway Shire and Corangamite Shire Council and also a natural hydrogeological boundary to the Warrion WSPA. The principal aquifer is unconfined and predominantly consists of volcanic material, including fractured basalt and scoria. There is also a potential of the Hanson Plains Sand aquifer underlying the volcanic aquifer supplying groundwater to this system. DELWP and Southern Rural Water, on behalf of the Minister of Water, jointly monitor and manage groundwater resources within the Shire.

The location of land application areas in close proximity to groundwater bores increases the potential for contamination of the groundwater. When water is extracted from the groundwater bores a zone of influence is created, whereby the head level of the groundwater is altered. Buffer distances (setbacks) are recommended between land application areas and both potable and non-potable groundwater bores. The current EPA Code of Practice recommends a 50m setback (for Category 1 and 2a soils) and 20m setback[3] (for Category 2b to 6 soils) be maintained from such resources to protect human health. Setbacks in Category 1 and 2a soils can be reduced to 20m where treated and disinfected greywater or secondary treated (20/30/10 or better) effluent is applied and the property owner has a service contract for their DWM system. A conservative approach was taken when developing this DWMP and a setback distance of 50m was used for all the groundwater bores located within the Shire.

The spatial data of the groundwater bore locations within the Shire was acquired from the Water Measurement Information System (WMIS) Database Interface as managed by DELWP. Using GIS, the recommended groundwater buffer setback was applied to all of the groundwater bores located within the Shire. There was a total of 2,329 groundwater bores that were identified within the Shire. The resultant map is appended in Appendix A.

[3] For secondary sewage and greywater effluent

As previously mentioned, *AS/NZS 1547:2012* and EPA Code of Practice details instances where recommended setbacks can be relaxed to accommodate certain types of systems where standard buffer distances cannot be achieved. In most cases, the preferred result would be to have the identified bores condemned and capped to prevent further use, negating the need for setbacks from these resources. However, it is acknowledged that this outcome would not be acceptable to some owners who utilise the resource.

For lots constrained by proximity to groundwater bores, it might be possible to mitigate the constraint by:

- Secondary treatment with an AWTS or sand filter;
- Moving LAA to increase buffer distance; or
- Replacing surface irrigation with subsurface irrigation.

6.2.3.3 Land Subject to Inundation

The DWM system, including any tanks, fields or trenches should be sited above any land subject to inundation.

Land that is subjected to frequent or intermittent inundation by floodwater has a significantly higher constraint for effective on-site DWM. Effluent management areas should not be located within flood prone regions as floodwaters have a higher probability of inundation leading to insufficient treatment of the effluent and an increase in potential environmental and public health risks.

Flood prone land, in the case of this report, is defined as land that is subject to inundation based on the 1 in 100 year flood level (1% Annual Exceedance Probability (AEP)) that delineates the areas likely to be inundated through statistical modelling or as determined by the floodplain management authority. Land subject to inundation was buffered from the useable lot area; the resultant map is appended in Appendix A.

It might be possible to mitigate the lots constrained by flood prone land by:

- Secondary treatment with an AWTS or sand filter;
- Using pressure compensating subsurface irrigation; or
- Raising level of application by constructing a raised bed or sand mound.

6.2.3.4 Useable Lot Area Analysis

The cadastre data set supplied by Council was queried to determine the spatial relationship between each lot, its existing land area and the buffer zones (cohesively) to determine the useable lot area for each lot within the Shire; whether developed or not. The following criteria were used to determine the useable lot area classification with regards to DWM suitability:

- High: useable area <0.15ha;
- Moderate: useable area 0.15 – 0.4ha;
- Low: useable area >0.4 –<40ha; and
- Compliant: useable area ≥40ha.

Lots containing less than 0.15ha of useable area invariably have a very limited available effluent management area and so DWM contained entirely on-site is in the vast majority of cases unsustainable, necessitating site specific hydraulic design for wastewater management. This is

based on an assumed footprint of 500m^2 for an average building envelope and improvements (e.g. driveway) and allowing for an average appropriately sized LAA and reserve LAA on the remainder of the lot.

If DWM is to be provided, it will be necessary to provide a high level of treatment and specialised land application design using systems such as sand mounds or pressurised subsurface irrigation, to ensure long term sustainability. Other mitigation measures like the adoption of water conserving practices will be important in ensuring the system's effectiveness. Such systems are likely to have limited opportunity for expansion, as may be required if the household wastewater load changes in response to increased occupancy, or if a new reticulated water supply becomes available. It should be taken into consideration that a lot <0.15ha will not necessarily be totally unsuitable for DWM or currently be serviced by a failing system; however, it is likely to contain a number of significant limitations to the safe operation of DWM systems assessed at a broad scale.

In the case of properties/parcels with areas between 0.15ha and 0.4ha, and in the absence of any other significant physical constraints, the availability of land for effluent management usually increases proportionately with a corresponding improvement in the potential for sustainable DWM. The choice of options is likely to be slightly greater than that available for lots with useable area less than 0.4ha; however, detailed site and soil investigation is still important to identify the most appropriate solution as other bio-geophysical constraints may limit opportunities for sustainable DWM. Again, conventional systems may not be appropriate for these sites. These lots have been assigned a 'moderate' overall constraint class.

In most cases, lots larger than 0.4ha will have far fewer problems providing sufficient space for sustainable on-site DWM. For this reason, these lots have been assigned a 'low' constraint class. Overall constraint for DWM for these lots will be determined by the land capability constraints.

Lots with a useable area larger than 40ha already meet the criteria prescribed by the Minister for Water's Guidelines (DSE, 2012) and are deemed to be compliant.

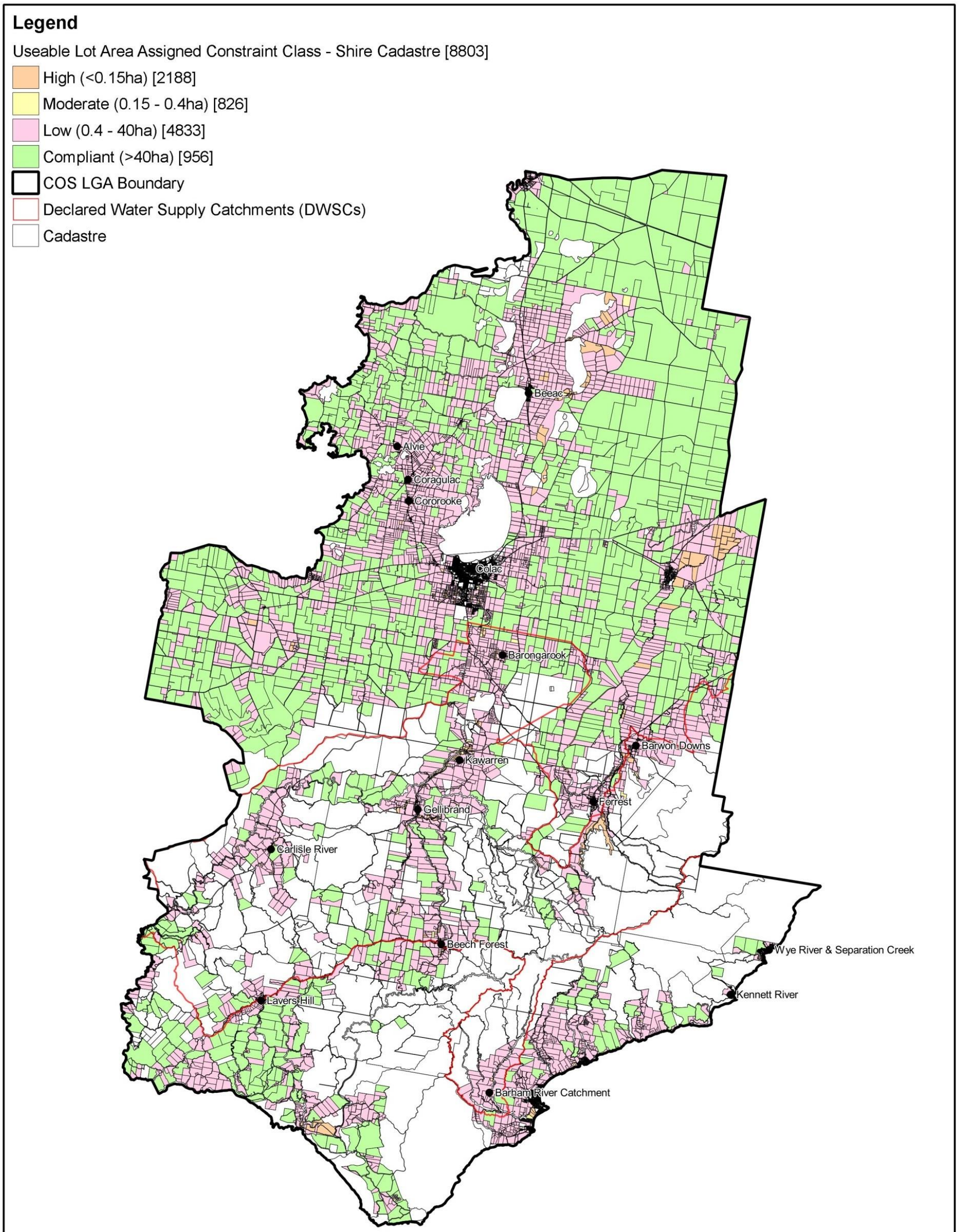
For lots constrained by useable area, it might be possible to mitigate this constraint by:

- Secondary treatment with an AWTS or sand filter;
- Secondary treatment with land application to trenches at higher loading rates as outlined in *AS/NZS 1547:2012*; or
- Increasing loading rate by use of sand mound.

Table 5 details the results of the useable lot area constraint analysis for the Shire. The associated DWM constraint map for the Shire is provided as Figure 6.

Table 5: Useable Lot Area Constraint Map Summary

	Total Lots	Total Number in Assigned Constraint Class			
		High	Moderate	Low	Compliant
		<0.15ha	0.15 – 0.4ha	0.4ha – 40ha	>40ha
Shire (Overall)	8,136 (750)	1,944 (273)	779 (49)	4,563 (325)	850 (103)
Alvie Town (Locality)	157 (4)	22 (0)	22 (0)	102 (3)	11 (1)
Barham River (Apollo Bay) Settlement (Locality)	309 (83)	33 (73)	21 (1)	250 (8)	5 (1)
Barongarook Settlement (Locality)	260 (2)	26(0)	16(0)	211(2)	7 (0)
Barwon Downs Town (Locality)	252 (8)	75 (2)	27 (1)	143 (5)	7 (0)
Beeac Town (Locality)	628 (14)	238 (4)	81 (2)	298 (5)	11 (3)
Beech Forest Town (Locality)	329 (3)	113 (1)	60 (2)	140 (0)	16 (0)
Carlisle River Town (Locality)	245 (1)	40 (0)	16 (0)	167 (0)	22 (1)
Coragulac Town (Locality)	175 (13)	36 (1)	30 (0)	109 (10)	0 (2)
Cororooke Town (Locality)	254 (31)	87 (15)	39 (5)	126 (8)	2 (3)
Forrest Town (Locality)	344 (5)	123 (2)	61 (1)	154 (2)	6 (0)
Gellibrand Town (Locality)	260 (5)	58 (0)	46 (0)	143 (5)	13 (0)
Kawarren Settlement (Locality)	212 (3)	69 (3)	16 (0)	121 (0)	6 (0)
Kennett River Town (Locality)	183 (0)	172 (0)	8 (0)	2 (0)	1 (0)
Lavers Hill Town (Locality)	189 (5)	61 (1)	24 (3)	92 (1)	12 (0)
Separation Creek Town (Locality)	129 (0)	121 (0)	1 (0)	7 (0)	0 (0)
Wye River Town (Locality)	376 (13)	319 (11)	44 (1)	10 (1)	3 (0)



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure 6: DWM Constraint Analysis - Useable Lot Area - Shire

Colac Otway Shire DWMP Review

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Revision	3
Drawn	JK
Approved	MS

6.2.4 Current Planning Scheme Zone - Minimum Lot Size Compliance

As discussed in Section 6.2.3, area plays a key role in determining a lots' capacity for sustainable long-term DWM and influences the selection of appropriate DWM systems. The COS Planning Scheme sets out policies and requirements for the use, development, subdivision and protection of land. The requirements and particular provisions for each zone are detailed within the COS Planning Scheme. The current zonings for the Shire were thematically mapped to assist Council with future development opportunities and identification of constraints in relation to DWM.

COS is seeking to maintain a relaxation of Guideline 1 of the Guidelines for Planning permit applications in open, potable water supply catchment areas (DSE, 2012) from the Water Corporations. When this relaxation is granted and a higher density of development within a DWSC is permitted, then one of the requirements that must still be adhered to in accordance with 'Planning permit applications in open, potable water supply catchment areas' is that the minimum lot size specified for that zone must be met. The planning scheme zones were summarised into the fifteen (15) following zones and are appended as a thematic map in Appendix A:

- General Residential;
- Neighbourhood Residential;
- Township;
- Low Density Residential;
- Farming;
- Rural Activity;
- Rural Conservation;
- Rural Living;
- Commercial (1 & 2);
- Industrial (1 & 3)
- Public Park and Recreation;
- Public Conservation and Resource;
- Public Use;
- Road; and
- Special Use.

The majority of the Shire is in three zonings; Farming Zone in the northern section of the municipality, Public Conservation and Resource Zone in the southern region (relative to the Otway Ranges) and Rural Conservation Zone along the coastline.

Along with sewered lots, land zoned Road Zone, Public Park and Recreation Zone and Public Conservation and Resource Zone, was excluded from the cadastral dataset as the suitability of this land for on-site DWM is irrelevant. A vegetation informative map was generated to provide a visual distribution of the National Parks and State Forests within COS and is attached in Appendix A.

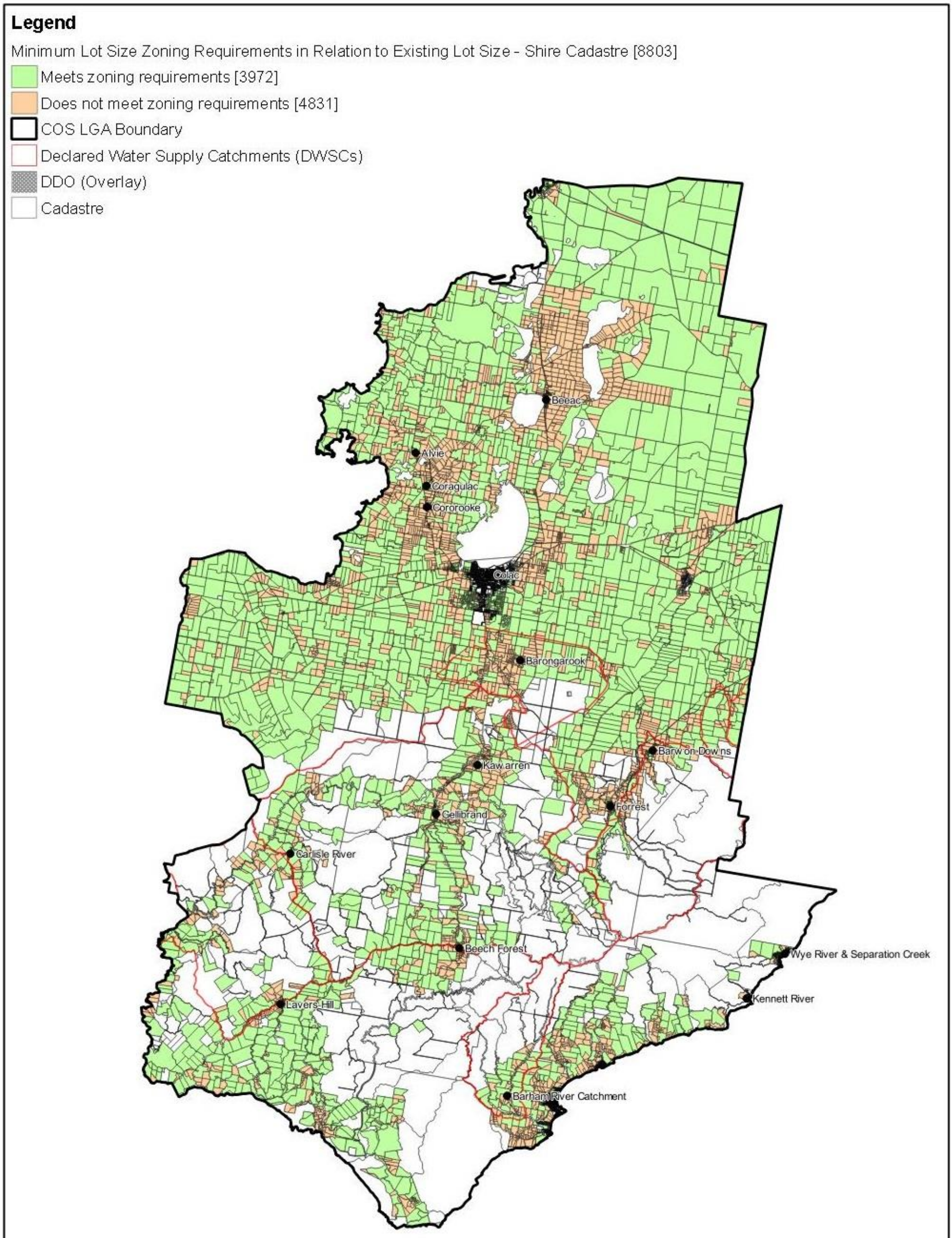
Existing land area and current zoning of the lots as per the COS Planning Scheme were used to determine whether existing lots complied with the minimum lot size as per the current zoning

requirements. The existing lot size was compared with the minimum lot size specified for the prescribed zone for each lot to determine its compliance. The COS Planning Scheme (2021) details the minimum lot size for each following zone: Farming zone 80 ha north of Princes Hwy and east of Ballarat Rd and 40ha elsewhere; Low Density Residential Zone 0.4ha if unsewered; Rural Activity Zone 0.5ha and 2ha for Colac East and 40ha elsewhere; Rural Conservation Zone 40ha; and Rural Living Zone 1.2ha for Elliminyt and 23ha elsewhere.

Table 6 details the results of the minimum lot size compliance with the planning scheme zoning requirements for the Shire. The associated DWM discrete constraint map for the Shire is provided as Figure 7.

Table 6: Current Planning Scheme Zone - Minimum Lot Size Compliance

	Total Lots	Total Number in Assigned Constraint Class	
		Non-Compliant	Compliant
Shire (Overall)	8,136 (750)	4,763 (243)	3,373 (507)
Alvie Town (Locality)	157 (4)	118(3)	39 (1)
Barham River (Apollo Bay) Settlement (Locality)	309 (83)	258 (6)	51 (77)
Barongarook Settlement (Locality)	260 (2)	248 (2)	12 (0)
Barwon Downs Town (Locality)	252 (8)	146 (4)	106 (4)
Beeac Town (Locality)	628 (14)	368 (6)	260 (8)
Beech Forest Town (Locality)	329 (3)	156 (1)	173 (2)
Carlisle River Town (Locality)	245 (1)	148 (0)	97 (1)
Coragulac Town (Locality)	175 (13)	127 (6)	48 (7)
Cororooke Town (Locality)	254 (31)	190 (8)	64 (23)
Forrest Town (Locality)	344 (5)	179 (0)	165 (5)
Gellibrand Town (Locality)	260 (5)	170 (2)	90 (3)
Kawarren Settlement (Locality)	212 (3)	188 (0)	24 (3)
Kennett River Town (Locality)	183 (0)	4 (0)	179 (0)
Lavers Hill Town (Locality)	189 (5)	88 (2)	101 (3)
Separation Creek Town (Locality)	129 (0)	12 (0)	117 (0)
Wye River Town (Locality)	376 (13)	22 (1)	354 (12)



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure 7: DWM Constraint Analysis - Minimum Lot Size Zoning Requirements - Shire

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0 6 12 18 24 30 km

(Approx Scale)

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Approved	MS

6.2.5 Slope

The slope of the land affects what type, or even whether you can have, any wastewater disposal on the land. This is closely linked to the soil type and the soil's absorption capabilities.

AS/NZS 1547:2012 (Table K1) details a range of factors likely to limit the selection and applicability of land application systems, with slope gradient identified as one critical factor.

Steep slopes, particularly when combined with shallow or poorly drained soils, can lead to surface breakout of effluent downslope of the land application area. Conventional DWM systems are likely to be unsuitable and these lots will require a detailed site assessment and specific system design to produce a sustainable outcome. These steeply sloping sites are generally unsuitable for trenches and beds and can also be problematic for surface irrigation techniques. Conversely, flat and gently sloping sites are less likely to experience such problems and are considered lower risk.

Surface elevation for the Shire was gridded with a maximum cell size of 20m for the entire Shire and 5m for the localities (including the towns/settlements), with no vertical exaggeration to create a DEM. Where the 5m grids were derived, they took precedence over the 20m grid and an overall combined DEM was generated which is shown in Figure 8. The surface elevation for the Shire ranges from approximately 0m to 630m Australian Height Datum (AHD). Gridded slope data was derived from the DEM and combined with the cadastre data set to calculate the average slope as percent grade for each lot within the Shire. The average slope was based on the centroid of each lot. The slope ranged from 0 – 138%.

The following criteria were used to determine the DWM constraint classification on the average lot slope:

- High: lots that have an average slope greater than 12%;
- Moderate: lots that have an average slope, inclusive of, and between 8% and 12%; and
- Low: lots that have an average slope less than 8%.

For lots constrained by steep slope, it might be possible to mitigate this constraint by:

- Applying a lower soil (effluent) loading rate over a larger area;
- Designing an irrigation system to ensure even distribution of effluent over the slope; or
- Terracing to create a level LAA.

Table 7 details the results of the average lot slope constraint analysis for the Shire. The associated DWM discrete constraint map for the Shire is provided as Figure 9.

Table 7: Average Lot Slope Constraint Map Summary

	Total Lots	Total Number in Assigned Constraint Class		
		High	Moderate	Low
		>12%	8 – 12%	<8%
Shire (Overall)	8,136 (750)	2,308 (93)	692 (69)	5,136 (588)
Alvie Town (Locality)	157 (4)	17 (0)	15 (0)	125 (4)
Barham River (Apollo Bay) Settlement (Locality)	309 (83)	267(18)	20 (21)	22 (44)
Barongarook Settlement (Locality)	260 (2)	15 (1)	48 (0)	197 (1)
Barwon Downs Town (Locality)	252 (8)	49 (0)	20 (2)	183 (6)
Beeac Town (Locality)	628 (14)	0 (0)	0 (0)	628 (14)
Beech Forest Town (Locality)	329 (3)	215 (1)	61 (1)	53 (1)
Carlisle River Town (Locality)	245 (1)	119 (1)	32 (0)	94 (0)
Coragulac Town (Locality)	175 (13)	1 (0)	1 (0)	173 (13)
Cororooke Town (Locality)	254 (31)	0 (0)	0 (0)	254 (31)
Forrest Town (Locality)	344 (5)	84 (0)	63 (0)	197 (5)
Gellibrand Town (Locality)	260 (5)	82 (2)	24 (0)	154 (3)
Kawarren Settlement (Locality)	212 (3)	58 (0)	74 (0)	80 (3)
Kennett River Town (Locality)	183 (0)	163 (0)	15 (0)	5 (0)
Lavers Hill Town (Locality)	189 (5)	95 (1)	53 (1)	41 (3)
Separation Creek Town (Locality)	129 (0)	111 (0)	5 (0)	13 (0)
Wye River Town (Locality)	376 (13)	362 (13)	7 (0)	7 (0)

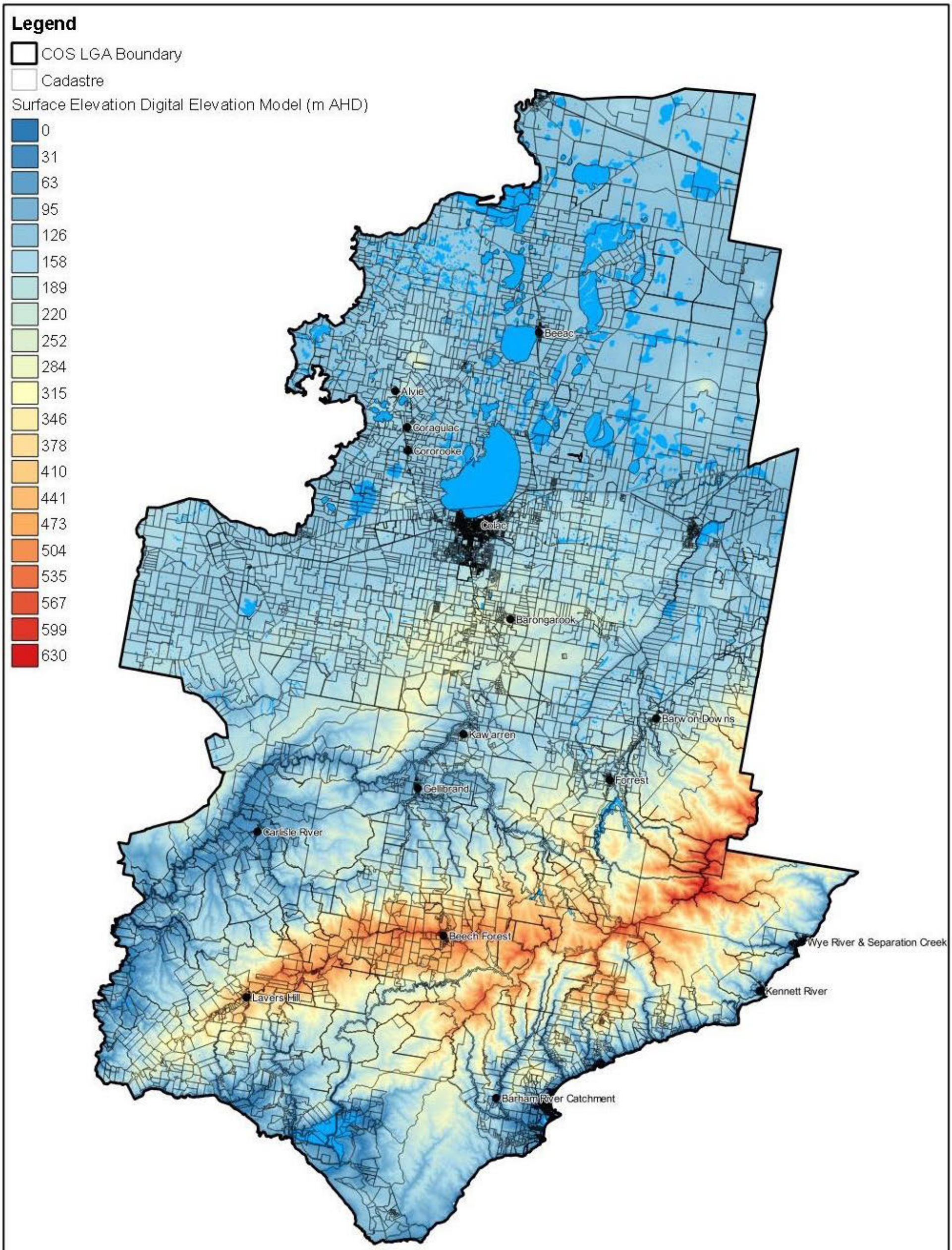


Figure 8: Surface Elevation Digital Elevation Model - Shire

Colac Otway Shire DWMP Review

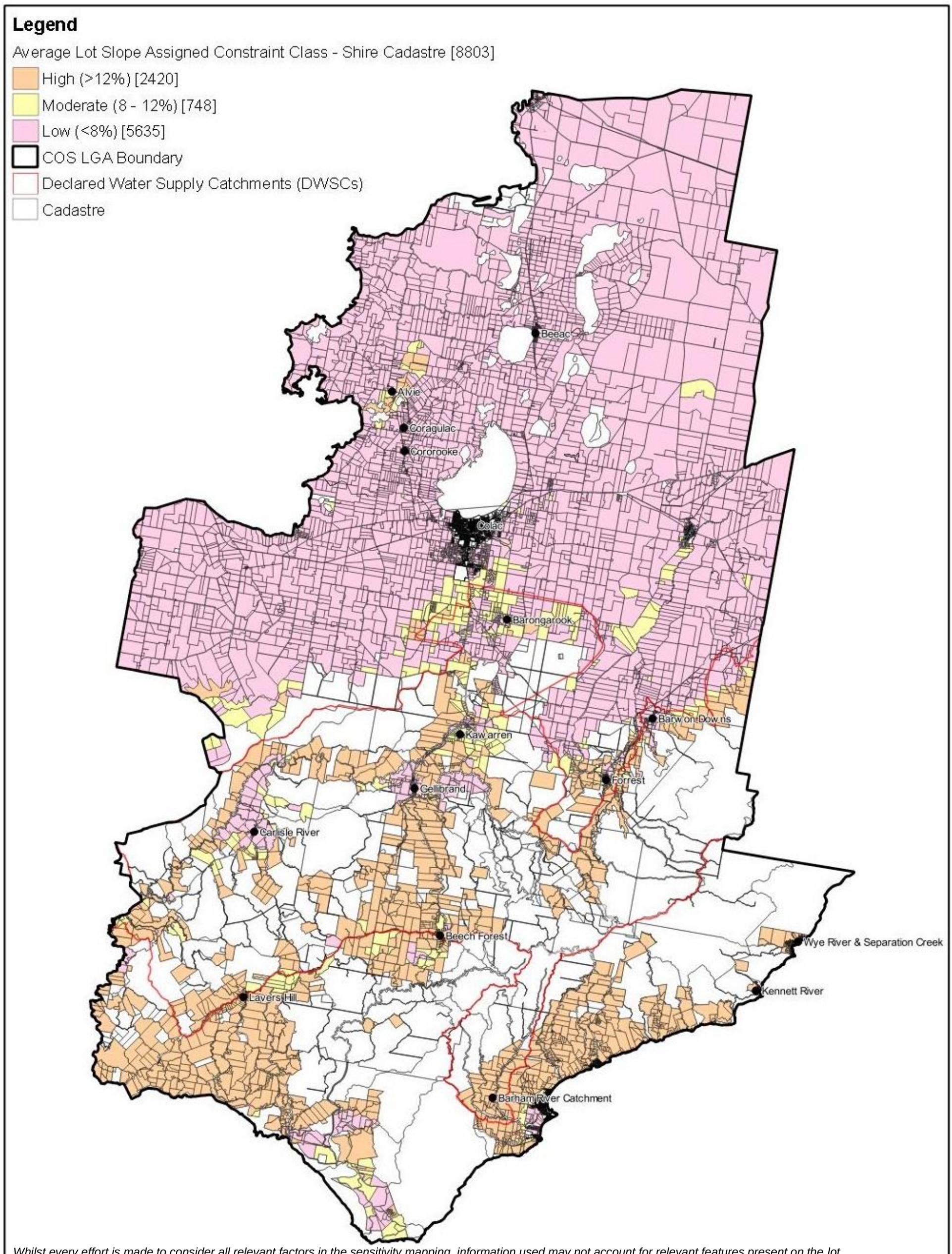
Whitehead & Associates Environmental Consultants

0 6 12 18 24 30 km

(Approx Scale)

N

Revision	4
Drawn	JK
Approved	MS



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure 9: DWM Constraint Analysis - Average Lot Slope - Shire

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 6 12 18 24 30 km

(Approx Scale)

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6.2.6 Soil Suitability

Geology was also used as a reference towards the understanding of the soil and landform characteristics of the Shire.

The soil type and its absorption capabilities in this report refer to effluent treatment and what type of wastewater system is suitable. Soil that is not suitable for effluent treatment may be ideal for other uses such as farming and vice versa.

Soils and landform elements, along with associated lithology, play a vital role in the design, operation and performance of DWM systems. Key soil properties can be evaluated to assess a soil's capacity for absorption of wastewater, including soil texture, structure, depth, permeability, drainage characteristics, and depth to limiting layers such as bedrock, hardpans or watertables.

The surface geology of the Shire is shown in Figure 10 and the geological units were based on the 'Surface Geology of Victoria' dataset (1:250,000) that was obtained from GeoSciences Victoria (DEPI, 2011). The Shire is underlain by twenty-three (23) different surface lithological groups, with the northern region and the Otway Ranges underlain primarily by the Newer Volcanic Group and Eumeralla Formation, respectively.

The most current soil-landform unit datasets were obtained from DELWP. The most current dataset, 'A Land Resource Assessment (LRA) of the Corangamite Region' (Robinson *et al.*, 2003), was used as the basis for the determination of soil suitability for DWM. The LRA draws substantially on earlier geology mapping and soil surveys, in particular those of Maher and Martin (1987) and Pitt (1981). Industry specific site investigations for dairying and cropping, a survey on a gas pipeline, and regional extension activities have provided other soil profile data. The purpose for this LRA was to integrate, within a new geomorphic framework for Victoria, map units and boundaries published in the earlier surveys to derive a consistent report and mapping for the region. The data (1:100,000) can only be effectively used as a strategic mapping tool for regional targeting of resources based on the location of susceptibilities in conjunction with other factors.

The LRA dataset provided different information on various soil and landform characteristics of the region; including, landform elements, slope, vegetation, soil description (Australian Soil Classification), topsoil and subsoil texture, depth of soil profile, soil structure, soil chemical characteristics, and many other productivity and land degradation constraints. There were fifty-seven (57) different soil landform units identified within the Shire. Figure 11 thematically identifies the different soil landform units and their associated locations. Refer to the accompanying LCA reports[4] for additional detailed descriptions on each of the soil landform units.

It is important to note that soil landform units are not homogeneous. Importantly, it should be noted that, at this mapping scale, soil attributes are expected to vary within soil landform units. Due to the degree of variance within each soil landform unit (e.g. due to the soil catena), the soil characteristics with the most dominant landform element proportion (e.g. greatest percentage) were used as a representation for that soil landform unit. Refer to the accompanying LCA reports for site specific data. Site specific investigations are required to confirm the broad scale assessment of the soil landform units, as the presence of a minor soil landform component could result in varying attributes to the predominant component used for the soil suitability constraint analysis.

[4] http://vro.depi.vic.gov.au/dpi/vro/vrosite.nsf/pages/soil-home

Legend

- COS LGA Boundary

Geology

- Koe - Eumeralla Formation (Otway Group)
- Nbh - Hanson Plain Sand (Brighton Group)
- Nhc - Clifton Formation (Heytesbury Group)
- Nhg - Gellibrand Marl (Heytesbury Group)
- -Pnd - Demons Bluff Formation (Nirranda Group)
- -Pnn - Narrawaturk Marl (Nirranda Group)
- -Po - Older Volcanic Group
- -Pwd - Dilwyn Formation - Wangeripp Group
- -Pwdp - Pember Mudstone Member (Dilwyn Formation)
- -Pwe - Eastern View Formation (Wangeripp Group)
- -Pwpm - Moomowroong Sand Member (Pebble Point Formation)
- -Pwpw - Wiridjil Gravel Member (Pebble Point Formation)
- Qa1 - Unnamed alluvium
- Qc1 - Unnamed colluvium
- Qc3 - Unnamed slump deposits
- Qdl1 - Unnamed coastal dune deposits
- Ql - Unnamed lunette deposits
- Qm1 - Unnamed swamp & lake deposits
- Qno1 - Newer Volcanic Group (Unnamed sheeflow basalt)
- Qno2 - Newer Volcanic Group (Unnamed stony rises)
- Qnp - Newer Volcanic Group (Unnamed phreatomagmatic deposits)
- Qns - Newer Volcanic Group (Unnamed scoria deposits)
- Qxr - Bridgewater Formation

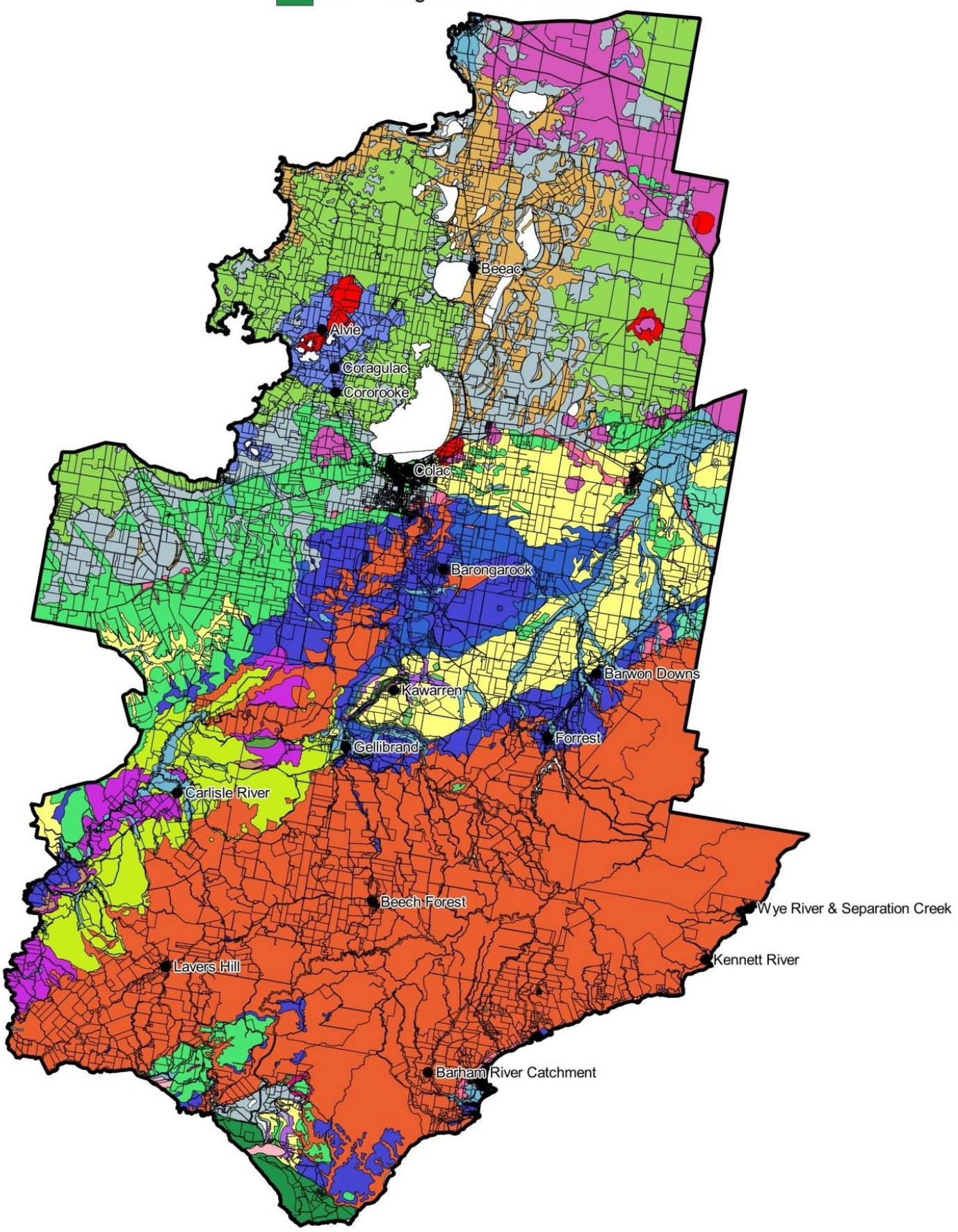

Figure 10: Geology - Shire

Colac Otway Shire DWMP Review

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Whitehead & Associates Environmental Consultants

0 10 20 30 40 50 km

(Approx Scale)

Revision	3
Drawn	JK
Approved	MS

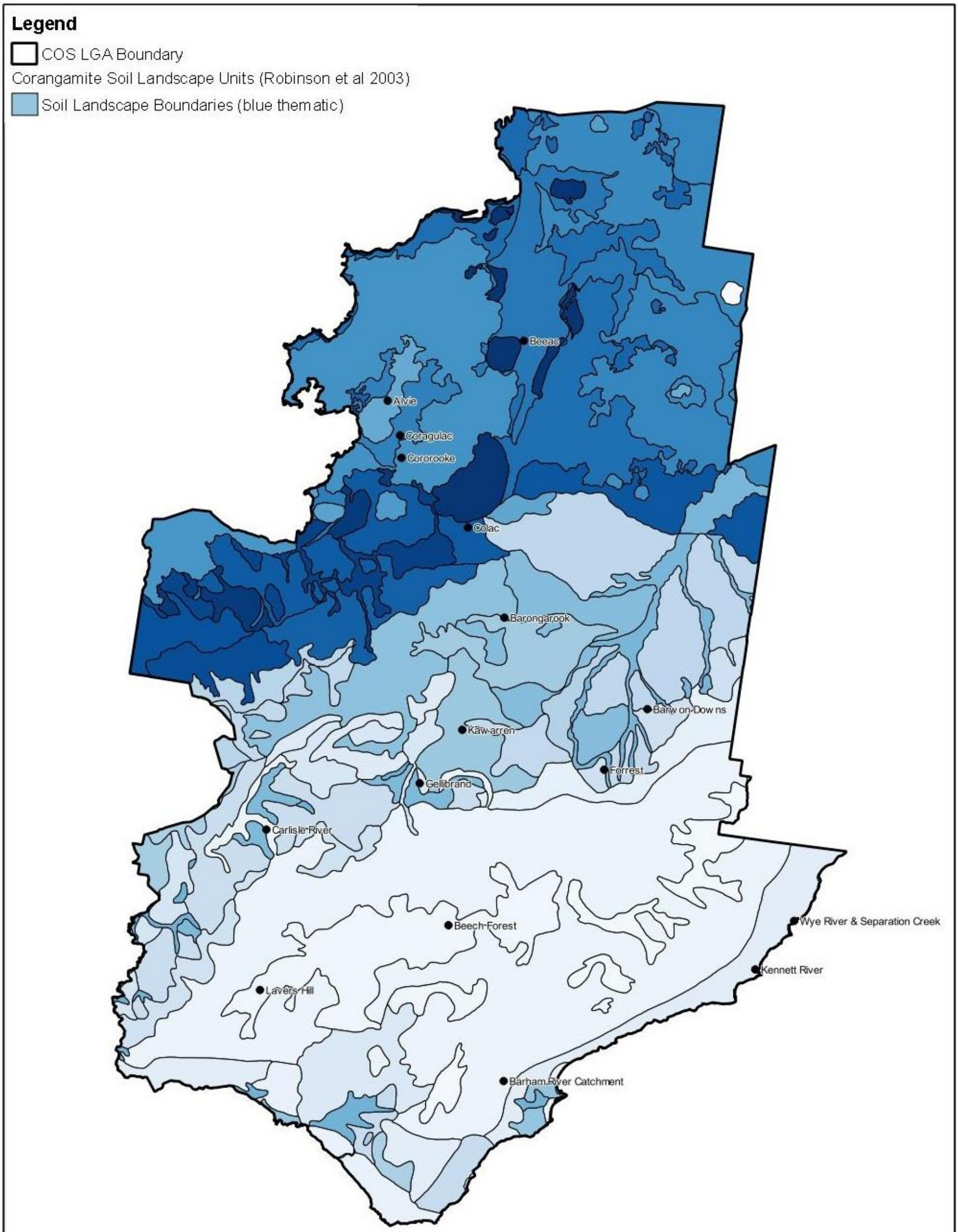


Figure 11: Soil Landscape Units - Shire

1307 Colac-Otway Shire Council DWMP Review

N

Whitehead & Associates
Environmental Consultants

0 5 10 15 20 25 30 km
(Approx Scale)

Revision	3
Drawn	JK
Approved	MS

The soil landform unit dataset was analysed to determine the key soil attributes that relate to soil suitability for DWM. There is a significant inter-relationship that exists between various soil attributes, resulting in depth, hydraulic and limitation hazards used to assess the final soil suitability with the Shire. The degree of constraint, or constraint class, was assigned to each soil landform unit within the Shire based on available data and the professional judgement, skills and experience of the project team. Reference was also to the *AS/NZS 1547:2012,* the current EPA Code of Practice, and the experience of the project team in the design and monitoring DWM systems.

Table 8 below outlines each of the hazards and the criteria used for the soil suitability constraint classifications.

The depth constraint of the soil was based on the depth of the soil profile to the limiting horizon, i.e. hardpan, groundwater or bedrock, for each soil landform unit. The depth constraint classes were determined based on the minimum depth requirements for sustainable DWM and taking into account the minimum separation requirements of 600mm (*AS/NZS 1547:2012*) from the base of the land application system to the limiting layer. This benchmark depth was based on the most constraining DWM application system, in terms of depth, absorption systems (trenches and beds). Soil absorption systems require 300 – 600mm depth from the surface for utilisation and also need to adhere to the minimum 600mm separation to the limiting layer requirements. Therefore, the minimum depth required for the sustainable installation of an absorption system is around 1m depth, based on an absorption system at 400mm depth. Greater depths of unsaturated soil provide increased treatment of effluent and reduced potential for lateral water movement.

The hydraulic constraint of the soil was determined based on limiting soil texture, structure and permeability. A DWM system should be sized according to the most limiting soil horizon to ensure that an appropriate effluent loading rate is applied. In most cases, this will be the subsoil horizon as the soils within COS predominantly consist of gradational and texture contrast soils with clay subsoils. The constraint criterion for the hydraulic hazard parameter was based on the soil category of the limiting soil horizon for each soil landform unit (as used in *AS/NZS 1547:2012)*. Indicative permeability was taken from the EPA Code of Practice (Table 9, Appendix A), but this can be superseded if in situ permeability testing data can be provided.

A limitation constraint of the soil was also considered, which was based on qualitative descriptions provided within the individual soil landform unit reports. The limitations include both physical and chemical characteristics of the soil. Soil limitation is difficult to quantify, as most limitations can be overcome by amending the soil or introducing a management practice.

The following limitations were considered with regards to DWM; nutrient retention, soil stability and physical retention. Specifically, these limitations refer to whether the soil is any of the following; dispersive, sodic, restricted drainage (waterlogging, seasonally high watertables, mottling), low fertility, low p-sorb, shrink swell (self-mulching), coarse fragments (including hardpans), very acidic (aluminium toxicity) or hardsetting.

	Consequence for DWM				
	Low		Mod		High
Dispersive					
Sodic					
Restricted Drainage					
Low Fertility					
Low P-sorb					
Shrink Swell					
Coarse Fragments					
Very Acidic					
Hardsetting					

A significance weighting was applied to each of the soil constraint parameters to reflect the influence that each parameter has on the design, construction and operation of DWM systems. The significance weighting was determined through discussion with project team members and coordination with the Stakeholder Working Group. The following significance weightings were applied:

- Depth Hazard: 1.2;
- Texture Parameter: 1.2;
- Structure Parameter: 0.9;
- Indicative Permeability Parameter: 1;
- Limitation Hazard: 0.7.

Where soil landform unit information was not available or was incomplete, the characteristic was conservatively inferred using professional judgement and available information. This was only relevant for soil landform unit 92, as the type soil profile data was unavailable.

Most importantly, some of the soil landform units associated with the targeted localities and towns/settlements were cross referenced with site and soil investigations undertaken by both Whitehead & Associates and Robert Van de Graaff & Associates on two separate occasions. Generally the observed soil characteristics were the same as the literature documented in Robinson *et al.* (2003) LRA. However, where characteristics differed, the soil landform unit for the particular region around the test site was updated with the field specific data.

Although the soil suitability constraint for a particular soil landform unit may be high, it does not necessarily mean that wastewater could not be sustainably managed on-site. It gives guidance to the loading rate and type of system(s) that could be suitable. It is important to note that site specific investigation is still necessary to confirm the regional constraint assessment and to determine the appropriate method for sustainable DWM.

For lots constrained by unfavourable soil, it might be possible to mitigate this constraint by:

- Secondary treatment with an AWTS or sand filter;
- Applying a lower (soil) loading rate; or
- Improving soil by amelioration or importation of good quality soil.

Table 9 details the results of the soil suitability constraint analysis for the Shire. The associated DWM discrete constraint map for the Shire is provided as Figure 12. The soil suitability for lots

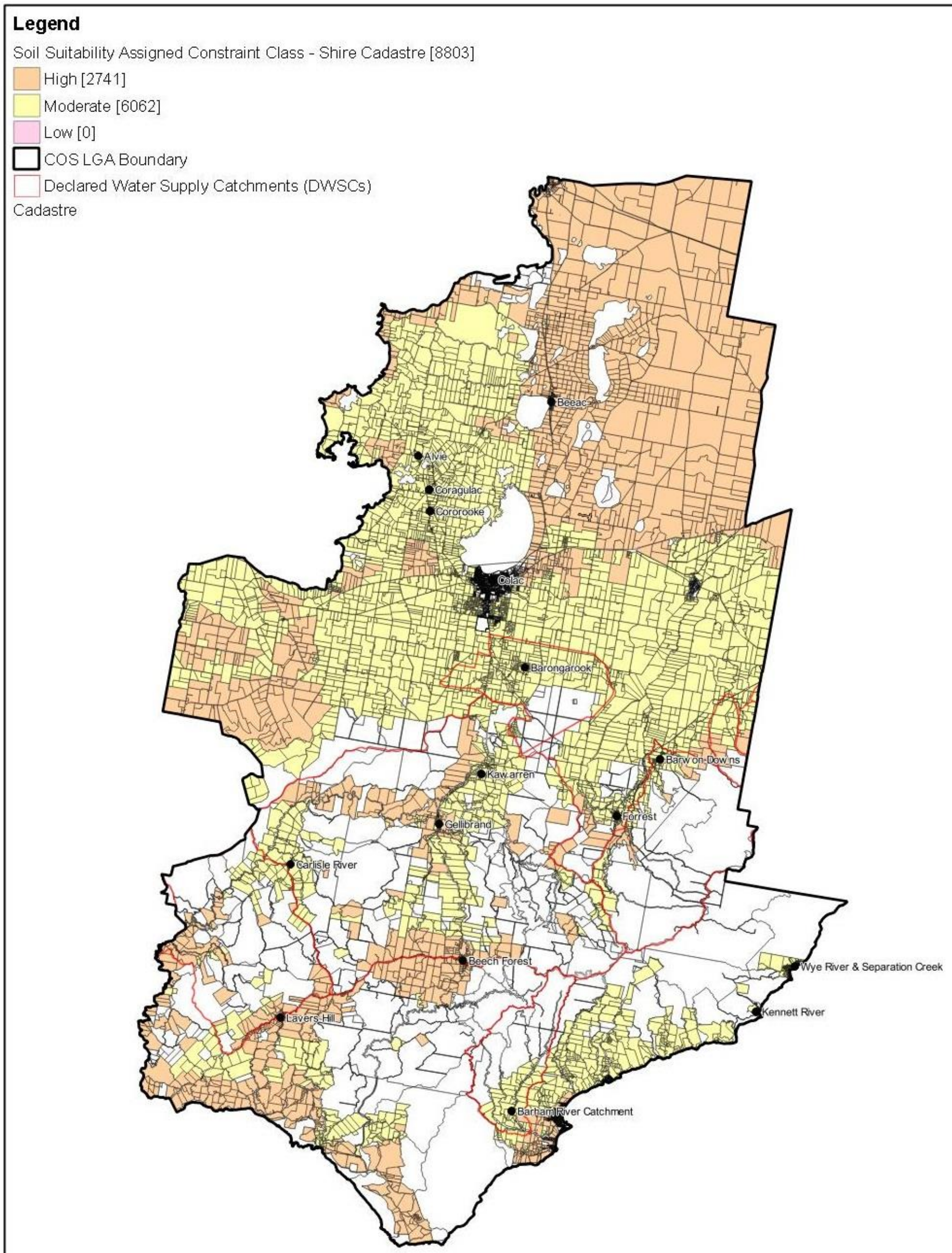
within the Shire predominantly resulted in moderate to high constraint ratings due to the presence of clay subsoils derived from the basaltic lithology as mentioned above.

Table 8: Soil Suitability Constraint Classification Criteria

Hazard Type	Parameter	Class	Description	Significance Weighting (%)
Depth Hazard	Profile Depth	Low (1)	Greater than 2 metres profile depth	Greater depths of unsaturated soil provide increased treatment of effluent (renovation) and reduced potential for lateral water movement. A significance of 1.2 (120%) is applied to the depth hazard rating for each soil to reflect the substantial influence this parameter has on the design, construction and operation of DWM systems.
		Medium (2)	Greater than 1 metre to less than 2 metres profile depth	
		High (3)	Less than 1 metre profile depth	
Hydraulic Hazard	Texture	Low (1)	Soil Category 2 & 3 (per *AS/NZS 1547:2012*). Dominant Sandy Loam (SL) to Loam (L) soils.	Used (along with structure) primarily to infer properties of soil permeability, porosity and aeration. Excessively free-draining soils (Cat 1) can be just as problematic as excessively poor-draining soils (Cat 6) for DWM. Soil 'renovation' capacity also linked to textural classification (i.e. OM content, Fe/Al content). A significance of 1.2 (120%) is applied to the texture rating for each soil to reflect the influence this parameter has on the design, construction and operation of DWM systems.
		Medium - Low (2)	Soil Category 4 (per *AS/NZS 1547:2012*). Dominant Clay Loam (CL) soils.	
		Medium - High (3)	Soil Category 5 (per *AS/NZS 1547:2012*). Dominant Light Clay (LC) soils.	
		High (4)	Soil Category 1 or 6 (per *AS/NZS 1547:2012*). Dominant Gravel (G) or Sand (S) or Medium Clay (MC) to Heavy Clay (HC) soils.	
	Structure	Low (1)	Strongly structured soils (per *AS/NZS 1547:2012*) in the dominant horizon.	Refers to the general organisation and stability of 'natural' soils. The development and distinctness of individual soil units (peds) and the level of cohesion both within peds and between adjacent peds. Soil structure can be altered by anthropogenic activity (mechanical, chemical inputs etc.). Field assessment required, making quantification subjective. Used as a primary indicator of soil stability and secondary indicator of soil permeability (along with texture). A significance of 0.9 (90%) is applied to the structure rating for each soil to reflect the variability of reporting and interpretation.
		Medium - Low (2)	Moderately structured soils (per *AS/NZS 1547:2012*) in the dominant horizon.	
		Medium - High (3)	Weakly structured soils (per *AS/NZS 1547:2012*) in the dominant horizon.	
		High (4)	Single-grained or Massive structure (apedal) soils (per *AS/NZS 1547:2012*) in the dominant horizon.	
	Indicative Permeability (K_{sat})	Low (1)	Indicative K_{sat} within the range of 1.4m/d to 3.0m/d based on Soil Category 2b & 3a (per CoP 891.3, Table 9).	Initial values inferred from soil texture / structure (per CoP 891.3, Table 9) if no site-specific data available. In-situ permeability (permeameter) testing, per approved methods (i.e. AS/NZS 1547:2012) to be used if dedicated (site-specific) values are to be applied. A significance of 1.0 (100%) is applied to the indicative permeability rating for each soil.
		Medium (2)	Indicative K_{sat} greater than 3.0m/d or within the range of 0.5m/d to 1.4m/d based on Soil Category 1 & 2a or 3b & 4a (per CoP 891.3, Table 9).	
		High (3)	Indicative K_{sat} less than 0.5m/d based on Soil Category 4b, 4c, 5a, 5b, 5c, 6a, 6b & 6c (per CoP 891.3, Table 9).	
Limitation Hazard	Nutrient Retention	Low	Soils with minor limitations; may include minor low fertility (CEC) or acidity.	A significance of 0.7 (70%) is applied to the limitation rating for each soil to reflect the limit and resolution of available information.
	Soil Stability	Medium	Non-sodic/dispersive soils; with low P-sorb, restricted drainage, shrink swell or coarse fragments; may include minor low fertility (CEC) or acidity.	
	Physical Restriction	High	Soils with dispersiveness and/or sodicity; may include minor low fertility (CEC), low P-sorb, restricted drainage, shrink swell, coarse fragments or acidity.	

Table 9: Soil Suitability Constraint Map Summary

	Total Lots	Total Number in Assigned Constraint Class		
		High	Moderate	Low
Shire (Overall)	8,136 (750)	2,533 (177)	5,603 (573)	0
Alvie Town (Locality)	157 (4)	15 (0)	142 (4)	0 (0)
Barham River (Apollo Bay) Settlement (Locality)	309 (83)	76 (63)	233 (20)	0 (0)
Barongarook Settlement (Locality)	260 (2)	0 (0)	260 (2)	0 (0)
Barwon Downs Town (Locality)	252 (8)	19 (0)	233 (8)	0 (0)
Beeac Town (Locality)	628 (14)	592 (13)	38 (1)	0 (0)
Beech Forest Town (Locality)	329 (3)	285 (3)	44 (0)	0 (0)
Carlisle River Town (Locality)	245 (1)	42 (1)	203 (0)	0 (0)
Coragulac Town (Locality)	175 (13)	0 (0)	175 (13)	0 (0)
Cororooke Town (Locality)	254 (31)	0 (1)	254 (30)	0 (0)
Forrest Town (Locality)	344 (5)	28 (0)	316 (5)	0 (0)
Gellibrand Town (Locality)	260 (5)	123 (1)	137 (4)	0 (0)
Kawarren Settlement (Locality)	212 (3)	13 (0)	199 (3)	0 (0)
Kennett River Town (Locality)	183 (0)	0 (0)	183 (0)	0 (0)
Lavers Hill Town (Locality)	189 (5)	177 (5)	12 (0)	0 (0)
Separation Creek Town (Locality)	129 (0)	0 (0)	129 (0)	0 (0)
Wye River Town (Locality)	376 (13)	0 (0)	376 (13)	0 (0)



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure 12: Soil Suitability - Shire

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 6 12 18 24 30 km

(Approx Scale)

N

Revision	4
Drawn	JK
Approved	MS

6.3 Sensitivity Overlay

A sensitivity overlay for landslip hazard and depth to groundwater has been generated for use by Council in conjunction with the final Risk Assessment map to determine if any additional constraints may impact on sustainable DWM at any given location within the Shire. These sensitivity overlays will be applied at Council's discretion upon reviewing any given lot.

6.3.1 Landslip Hazard

COS contains areas which are susceptible to landslip, including land throughout the Otway Ranges. The Otway Group, or Eumeralla Formation, is considered to be one of the most landslip prone geological units within the Shire. Landslips occur in both the rock and soil materials, even where the rock is not significantly weathered.

A number of geotechnical studies have been undertaken within COS by various public agencies, including 'Landslip Risk Management in Colac Otway Shire' and 'Landslip Risk Management Related to Wastewater Disposal' both undertaken by Dalhaus Environmental Geology Pty Ltd.

All land included in the Erosion Management Overlay (EMO1 - COS Planning Scheme) has been identified as having a sufficiently high risk of potential instability to warrant specific review of these risks prior to works as detailed in Schedule 1 to the EMO (COS Planning Scheme).

The landslip prone regions are shown in informative Figure A5, attached in Appendix A. The figure shows that the primary regions of landslip are found south of Lavers Hill, Beech Forest, Forrest and Gellibrand towns and along the coastline and hinterlands around the Apollo Bay, Kennett River, Wye River and Separation Creek towns. Council may request additional supporting documentation to be provided with regards to DWM in these regions.

6.3.2 Groundwater Depth

If the soil is saturated and the groundwater depth is shallow, then there is a greater possibility of contaminating groundwater and increasing surface water runoff. This is particularly important in selecting the type of DWM system.

The depth to groundwater has direct implications on future development opportunities and can constrain the use of a DWM system. The location and type of land application system that can be installed on an individual lot will be limited by the depth to groundwater at the site. If applied effluent moves into saturated soils, i.e. shallow groundwater located beneath a LAA, then potential contamination of the groundwater, aquifer and/or surface waters could occur. Saturated subsurface conditions are considered to be the most conducive to pathogen transport.

The current EPA Code of Practice states that a minimum depth of 1.5m must remain between the base of the land application system and the seasonal watertable. The greatest depth to groundwater from the natural ground surface would be required for trenches and beds, which are generally built to 600mm depth. Therefore, the minimum required depth to groundwater from the natural ground surface would be 2.1m. If this buffer cannot be maintained, a detailed DWM system design would be required. This calculated minimum depth to groundwater vertical setback distance is conservative; however, soil type would be the defining characteristic. For example, if the soil beneath the base of the LAA is sand, then the associated hydraulic conductivity would be high, with treated effluent reaching the groundwater table at a much quicker rate than if the soil was clay. Therefore, site specific DWM design is required in regions where the depth to groundwater may be an issue, and the appropriateness of the required vertical setback distance to groundwater will need to be assessed.

Groundwater depth within the Shire was inferred from the groundwater bore data from the WMIS Database Interface as managed by DELWP; this is the same dataset used for the proximity to groundwater bores constraint analysis. A total of 294 groundwater bores (as at 2015), located within and around the vicinity of the Shire based on the WMIS DEPI data, were used in the depth to groundwater analysis. The depth of groundwater from the natural surface was time-series monitored for each of these bores as part of the State Observation Bore Network (SOBN). The average reduced water level of the time-series data for the groundwater depth was assigned to each bore. The groundwater bores and associated depths to groundwater were then spatially mapped as point data using GIS. The point data was gridded with no vertical exaggeration (maximum cell size of 20m) to create a Digital Elevation Model (DEM). The groundwater depths are summarised along a thematic colour gradient from surface water (negative values) (deep blue) to 245m (red), with an average depth of 21.5m. Gridded groundwater depth data was derived from the DEM and combined with the cadastre data set for the centroid of each lot. This interpolates an average depth to groundwater for each lot within the Shire which is covered by the extent of the DEM.

The following criteria were used to determine the DWM constraint classification for the depth to groundwater (based on the centroid of each lot):

- Non-Compliant (high risk): lots that have an average groundwater depth less than the minimum vertical separation distance of 2.1m as stipulated by the current EPA Code of Practice; and
- Compliant (low risk): lots that have an average groundwater depth more than the minimum vertical separation distance of 2.1m as stipulated by the current EPA Code of Practice.

The resultant groundwater depth and groundwater depth compliance maps are attached as informative Figures A6 and A7, respectively, in Appendix A. The depth to groundwater compliance mapping showed that there were 4,542 compliant and 1,496 non-compliant lots within COS based on available data.

Due to the limited number of groundwater bores with water level information, there are regions within the Shire that were not able to be included in the analysis, particularly in the southern half of the Shire. There were lots throughout the Shire, primarily in the southern region, that was not covered by the DEM and were excluded from the depth to groundwater analysis due to lack of data. These are shown as white in the respective map. Due to lack of available data, the depth to groundwater compliance is to be used for informative purposes only and site specific investigations will be necessary to determine the depth of groundwater in the regions with no available data or for those lots that are non-compliant.

For lots constrained by groundwater depth (shallow groundwater), it might be possible to mitigate this constraint by:

- Secondary treatment with an AWTS or sand filter; or
- Increasing separation distance between point of land application and watertable by constructing a raised bed or sand mound.

6.3.3 Vegetation

The National Parks and State Forests within COS have also been mapped and are presented as an informative map as Figure A7 in Appendix A. The Otway Ranges within the DWSCs is dominated by protected vegetated regions, which are also extensive along the Great Ocean Road extending into the north of the Apollo Bay, Wye River and Separation Creek localities. Great

Otway National Park and Otway Forest Park form the primary classified vegetative areas within this region. The Otway Forest Park includes the mountain and foothill forest of the northern fall of the Otway Ranges, adjacent to the Great Otway National Park. The northern region of COS includes protected lakes of the Western Volcanic Plains.

6.4 Risk Assessment Summary

It is evident that variability in constraint exists between the targeted localities and towns/settlements within the Shire. Further detailed studies into the performance of existing on-site DWM systems within each of the targeted unsewered localities and towns/settlements is recommended to verify the findings of this broad-scale risk assessment, to provide a more detailed study on maximum lot development density and hence minimum lot size in proposed development areas. This will aid Council in ensuring future development will not adversely impact environmental and public health. The Sensitivity Analysis, which consolidates the individual constraints, is detailed in Section 4.1 of the Operational Plan.

7 Land Application System Sizing Tables (Water Balance)

7.1 Overview

Water balance modelling was undertaken to determine the minimum footprint areas for a broad range of effluent land application systems that could be used in unsewered properties in the Shire. The effluent land application systems that have been sized and included in the Sizing Tables include subsurface irrigation, conventional absorption trenches and beds, ETA trenches and beds, LPED irrigation systems, and wick trenches. No Sizing Tables for Mounds are given as they will require site-specific design by a suitably qualified person. Explanations for these land application systems are detailed in Appendix A of the DWMP Operational Document (2015 as amended).

All six of the *AS1547:2012* soil categories were used in the modelling, for three household sizes (based on number of bedrooms and likely maximum occupancy rate, for domestic dwellings). The results are provided in the System Sizing Tables (in the Locality Reports in Appendix B), which summarise the minimum basal (or 'wetted') area and the likely minimum total footprint area (including minimum spacing for trenches and beds) for different systems.

The Sizing Tables are suitable for designing land application systems for Low and Moderate Risk properties only. If your locality is not provided as a Locality Report in Appendix B, you can use the System Sizing Tables for the nearest locality (i.e. Colac/Elliminyt can utilise Barongarook).

Where the EPA Code of Practice states that the system type is not suitable for the type of soil, or the soil and climate characteristics of the location render the system type unsuitable, 'not applicable' (NA) is shown in the Sizing Table. 'Impractical' is noted when the system type can be used, but the resultant size of the land application area would not be practical primarily due to associated costs of construction.

7.2 Water Balance Methodology

A water balance is a means of incorporating the impact of rainfall, evapotranspiration and plant and soil moisture fluxes into the design of effluent land application systems (from trenches to irrigation systems). Water balance is a critical factor in the effective design and operation of effluent land application systems. This is particularly relevant for the higher rainfall areas in the southern half of the Shire.

A simplistic water balance is expressed by the following equation:

Precipitation + Applied Effluent = Evapotranspiration + Percolation + Runoff

On the left hand side of the equation are the water INPUTS, factors that add to the moisture within an irrigation field. On the right hand side of the equation are the water LOSSES, factors that reduce the moisture content within an irrigation field. For a land application area to be balanced hydraulically the INPUTS should be equal to or less than the LOSSES, otherwise hydraulic overloading and failure may result if the inherent moisture storage capacity of the irrigation field is subsequently exceeded.

Rainfall data can be obtained from the Bureau of Meteorology and commonly water balances are undertaken using conservative monthly rainfall data for a local weather station. Pan evaporation (Class A Pan) is less readily available, and usually is only available for selected weather stations.

Evapotranspiration is the combination of evaporation and transpiration of moisture from the soil through the open pores in the leaves of plants. Evapotranspiration rates vary with changes to soil and air moisture as well as season, but can be estimated by applying appropriate monthly crop factors to pan evaporation data.

Percolation is equivalent to the rate of deep drainage of both rainfall and applied effluent through the soil and is controlled mainly by soil properties, but also in part by slope and other factors. The runoff factor allows for the fact that not all rainfall that falls on a ground surface will actually infiltrate the irrigation field and so contribute to soil moisture. During periods of high rainfall, the soil becomes saturated and excess rainfall runs off as it cannot percolate into the soil.

If all factors in the water balance are expressed in terms of millimetres (mm) per month, then it is possible to solve the equation to determine a minimum land application area (footprint) such that the LOSSES match or exceed the INPUTS. This is usually done using pre-prepared spreadsheets to simplify the numerous calculations involved in running the balance for each month of the year.

The water balance methodology used for the Sizing Tables is the same as that described in the MAV Land Capability Assessment Framework (2014) and the specific inputs are discussed below.

7.3 Water Balance Inputs

7.3.1 Daily Wastewater Load

The daily wastewater load is the product of the design occupancy rate and the wastewater generation in L/person/day.

The current EPA Code of Practice specifies that the design occupancy rate is the number of bedrooms (including any rooms that could be used as a bedroom with a closable door, such as a study or library) plus one (number of bedrooms +1). For example, a four bedroom home is expected to accommodate up to 5 persons in the normal course of events (this does not include accommodation, businesses or holiday homes). This takes into account the future potential occupancy, not just the current occupancy (which may be much smaller).

Table 4 of the EPA Code of Practice (2016) specifies a wastewater generation rate of 180L/person/day for households with standard water fixtures. The water balance uses this figure. However, where it can be demonstrated that full-reduction fixtures have been, or will be, installed in the household and will remain in place, then a design loading rate of 150L/person/day, in accordance with *AS1547:2012* can be adopted for a site-specific DWM design. Alternatively, if tank water is the only water source onsite, then a design loading rate of 120L/person/day, can be used in accordance with *AS1547:2012*, and the results in the System Sizing Tables will not apply.

The design wastewater loads used in water balance modelling are shown in Table 10a-c below.

Table 10a: 180L/p/day - Design Wastewater Loads for Water Balance Modelling

No. Bedrooms	Design Occupancy	L/person/day	L/household/day
2	3	180	**540**
3	4	180	**720**
4	5	180	**900**
5	6	180	**1,080**

Table 11b: 150L/p/day - Design Wastewater Loads for Water Balance Modelling

No. Bedrooms	Design Occupancy	L/person/day	L/household/day
2	3	150	**450**
3	4	150	**600**
4	5	150	**750**
5	6	150	**900**

Table 12c: 120L/p/day - Design Wastewater Loads for Water Balance Modelling

No. Bedrooms	Design Occupancy	L/person/day	L/household/day
2	3	120	**360**
3	4	120	**480**
4	5	120	**600**
5	6	120	**720**

7.3.2 Climate Data

For this project, interpolated rainfall and evapotranspiration data for each unsewered locality has been obtained from SILO and BoM databases, as discussed in Section 6.2.2 above. 70th percentile rainfall and average evapotranspiration data were used to create unique water balances for each system type for each locality. The data point closest to the town/settlement was used for the water balance, and in some cases more than one town/settlement shares the same climate data point due to proximity to that data point.

7.3.3 Runoff Factor

Conservative annual runoff factors of 10% (90% infiltration of rainfall) have been adopted for soil absorption systems (e.g. trench, bed etc.) and 20% (80% infiltration) for drip and spray irrigation systems in the Shire, which is likely to be an underestimate for the higher rainfall areas on and around the Otways.

7.3.4 Soil Type and Design Loading Rate or Design Irrigation Rate (DLR or DIR)

The DLRs and DIRs for the commonly used EPA-accepted methods of land application of effluent (as listed in Appendix A, Table 9, of the EPA Code of Practice, 2013) were used as the basis of water balance modelling and the sizing of the land application areas for all systems. All listed systems except for mounds were modelled, as mounds require a site-specific design which accounts for site factors (including, but not limited to ground slope). For simplicity, every soil

category (and subcategories depending on soil structure), have been modelled, regardless of whether they are observed in the locality. It is noted that most towns will only have two or three soil types, and that the system sizing's provided for the other soil types are irrelevant for that location (unless a significant amount of topsoil is imported for the construction of the land application system, which is not common).

The DLR or DIR should be selected for the most limiting soil layer (usually the heavier-textured subsoil horizons). Where data was absent from the current EPA Code of Practice, average values were selected from *AS1547:2012* (Table 5.2). For instance, the current EPA Code of Practice does not specify DLRs for absorption or evapotranspiration (ETA) beds for gravels, sands or weakly structured sandy loams, but acknowledges that these systems may be appropriate if the soil does not have a high perched or seasonal groundwater table.

7.4 Implications for High Rainfall Areas

The water balance is **highly** sensitive to the Design Loading Rate (DLR) or Design Irrigation Rate (DIR) selected. The DLR and DIR are considered to be conservative or 'safe' deep drainage percolation rates for land application systems that are sustainable for the long term. However, deep drainage percolation in DWM land application areas is not widely understood and the high variability of soil dynamics across regions means that a 'one size fits all' approach may not be the most appropriate method for designing a land application system for a particular site.

If the selected DLR or DIR, taken from the EPA Code of Practice, 2016 (Appendix A: Table 9), is low due to heavy-textured soils and the site is in a high rainfall region, then the required minimum land application area is proportionately large. This can pose difficulties for design and installation, particularly for systems that use gravity dosing (which is far less effective for large systems compared to pumped dosing). LAAs that were deemed as not likely to be practical are highlighted in the Sizing Tables.

Some locations within the Shire feature areas of particularly high rainfall and low winter evapotranspiration, which presents a case whereby the water balance, is unresolvable and therefore cannot produce consequential data. For these areas, Lavers Hill, Beech Forest, and the Barham River catchment (known as 'Paradise'), the water balance method as described above cannot be used to predict the minimum required area for effluent land application, and a site-specific, detailed system design is required. As a result of the water balance, the majority of properties in these localities are likely to be rated as High or Very High Risk, and therefore the Sizing Tables are not applicable. There may be lots in high rainfall areas that also have an unresolvable water balance in addition to the above mentioned localities.

The Bureau of Meteorology (BoM) website shows five rainfall stations on the Otway Ridge; Lavers Hill, Weeaproinah, Barramunga, Beech Forest and Wyelangta, with the latter two still actively recording rainfall. 70th percentile monthly rainfall from the active station that is closest to the Otway Ridge location being assessed should be used in any water balance; e.g. for Lavers Hill, the 70th percentile monthly rainfall from the Wyelangta BoM rainfall station should be used. The 70th percentile monthly rainfall from the Wyelangta and Beech Forest BoM rainfall stations is tabulated in Appendix C.

Furthermore, the water balance and prescribed DLRs and DIRs do not take into consideration the possibility that the soil and/or bedrock in some high rainfall areas may have a natural permeability that is higher than that assumed from its textural category. In such instances, the DLR or DIR could be sustainably increased, thereby allowing for a smaller system footprint. A site-specific water balance would require detailed soil testing (including constant-head permeameter testing)

to clearly demonstrate that the soil can sustainably accommodate a higher effluent loading, year-round. This approach is suitable for properties that are rated as Low, Moderate or High Risk.

In these high rainfall areas, site-specific design to select and size an appropriate DWM system and effluent disposal method is required to ensure that DWM is sustainable with no off-lot discharge. Innovative designs may be required and overarching measures to assist in managing the wastewater in these regions may include minimising wastewater generation, increasing reuse and increasing the land application footprint. It should be noted that there may be cases in which an appropriate solution cannot be devised or in which costs are prohibitive.

Council engaged W&A to undertake a detailed design for a recommended alternative LAA design for the high rainfall areas. The following standard drawings and sizing tables can be used for the high rainfall areas.

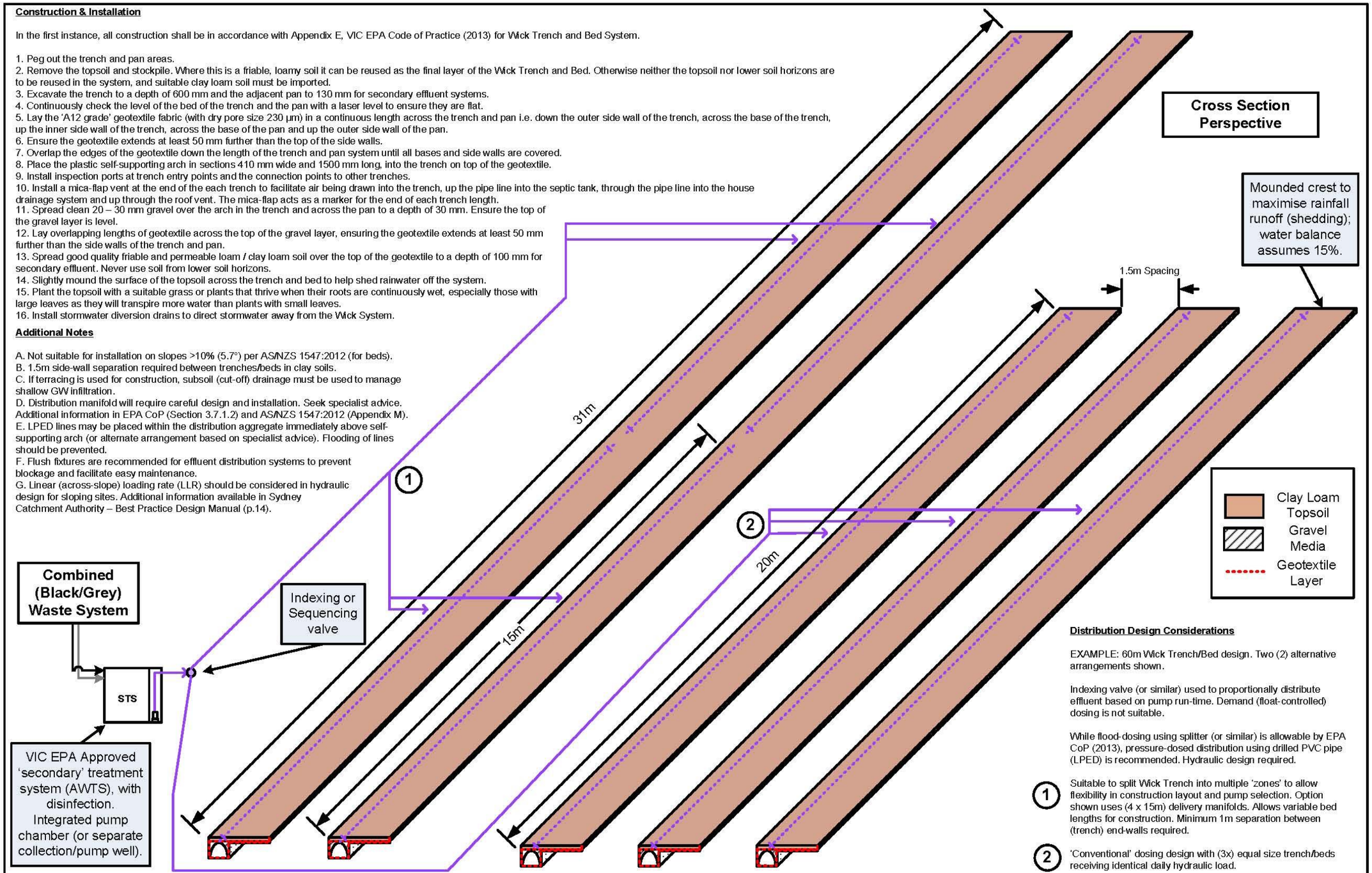
Construction & Installation

In the first instance, all construction shall be in accordance with Appendix E, VIC EPA Code of Practice (2013) for Wick Trench and Bed System.

1. Peg out the trench and pan areas.
2. Remove the topsoil and stockpile. Where this is a friable, loamy soil it can be reused as the final layer of the Wick Trench and Bed. Otherwise neither the topsoil nor lower soil horizons are to be reused in the system, and suitable clay loam soil must be imported.
3. Excavate the trench to a depth of 600 mm and the adjacent pan to 130 mm for secondary effluent systems.
4. Continuously check the level of the bed of the trench and the pan with a laser level to ensure they are flat.
5. Lay the 'A12 grade' geotextile fabric (with dry pore size 230 µm) in a continuous length across the trench and pan i.e. down the outer side wall of the trench, across the base of the trench, up the inner side wall of the trench, across the base of the pan and up the outer side wall of the pan.
6. Ensure the geotextile extends at least 50 mm further than the top of the side walls.
7. Overlap the edges of the geotextile down the length of the trench and pan system until all bases and side walls are covered.
8. Place the plastic self-supporting arch in sections 410 mm wide and 1500 mm long, into the trench on top of the geotextile.
9. Install inspection ports at trench entry points and the connection points to other trenches.
10. Install a mica-flap vent at the end of the each trench to facilitate air being drawn into the trench, up the pipe line into the septic tank, through the pipe line into the house drainage system and up through the roof vent. The mica-flap acts as a marker for the end of each trench length.
11. Spread clean 20 – 30 mm gravel over the arch in the trench and across the pan to a depth of 30 mm. Ensure the top of the gravel layer is level.
12. Lay overlapping lengths of geotextile across the top of the gravel layer, ensuring the geotextile extends at least 50 mm further than the side walls of the trench and pan.
13. Spread good quality friable and permeable loam / clay loam soil over the top of the geotextile to a depth of 100 mm for secondary effluent. Never use soil from lower soil horizons.
14. Slightly mound the surface of the topsoil across the trench and bed to help shed rainwater off the system.
15. Plant the topsoil with a suitable grass or plants that thrive when their roots are continuously wet, especially those with large leaves as they will transpire more water than plants with small leaves.
16. Install stormwater diversion drains to direct stormwater away from the Wick System.

Additional Notes

A. Not suitable for installation on slopes >10% (5.7°) per AS/NZS 1547:2012 (for beds).
B. 1.5m side-wall separation required between trenches/beds in clay soils.
C. If terracing is used for construction, subsoil (cut-off) drainage must be used to manage shallow GW infiltration.
D. Distribution manifold will require careful design and installation. Seek specialist advice. Additional information in EPA CoP (Section 3.7.1.2) and AS/NZS 1547:2012 (Appendix M).
E. LPED lines may be placed within the distribution aggregate immediately above self-supporting arch (or alternate arrangement based on specialist advice). Flooding of lines should be prevented.
F. Flush fixtures are recommended for effluent distribution systems to prevent blockage and facilitate easy maintenance.
G. Linear (across-slope) loading rate (LLR) should be considered in hydraulic design for sloping sites. Additional information available in Sydney Catchment Authority – Best Practice Design Manual (p.14).



Distribution Design Considerations

EXAMPLE: 60m Wick Trench/Bed design. Two (2) alternative arrangements shown.

Indexing valve (or similar) used to proportionally distribute effluent based on pump run-time. Demand (float-controlled) dosing is not suitable.

While flood-dosing using splitter (or similar) is allowable by EPA CoP (2013), pressure-dosed distribution using drilled PVC pipe (LPED) is recommended. Hydraulic design required.

1. Suitable to split Wick Trench into multiple 'zones' to allow flexibility in construction layout and pump selection. Option shown uses (4 x 15m) delivery manifolds. Allows variable bed lengths for construction. Minimum 1m separation between (trench) end-walls required.
2. 'Conventional' dosing design with (3x) equal size trench/beds receiving identical daily hydraulic load.

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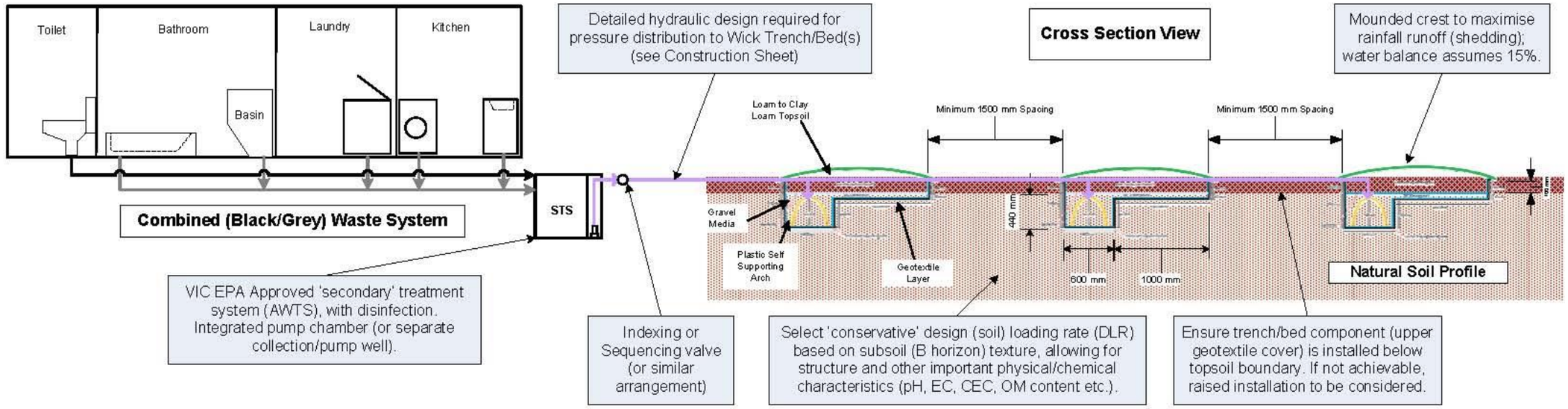
RECOMMENDED LAND APPLICATION DESIGN FOR HIGH-RAINFALL AREAS
CONSTRUCTION – SECONDARY TREATMENT WITH WICK TRENCH/BED

Project: 1307
Colac Otway Shire DWMP
Drawn: BC/MS
Dimensions: As shown



Beech Forest/Ferguson/Weeaproinah - Wick Trench Option (8mm/day)

Number of Bedrooms	Load (L/Day)	Required Length (m)	Design Basal Area (m^2)	Maximum Storage Depth (mm)	Maximum (In-soil) storage Volume (m^3)	Effluent Application Area Footprint (m^2) - including interbed spacing
3	720	280	237	277	65,500	880
4	900	356	301	260	78,300	1,140
5	1,080	425	360	264	94,900	1,400

Lavers Hill/Wyelangta - Wick Trench Option (8mm/day)

Number of Bedrooms	Load (L/Day)	Required Length (m)	Design Basal Area (m^2)	Maximum Storage Depth (mm)	Maximum (In-soil) storage Volume (m^3)	Effluent Application Area Footprint (m^2) - including interbed spacing
3	720	343	290	273	78,900	1,140
4	900	425	360	277	99,650	1,400
5	1,080	520	440	265	116,350	1,660

Beech Forest/Ferguson/Weeaproinah - Wick Trench Option (10mm/day)

Number of Bedrooms	Load (L/Day)	Required Trench Length (m)	Design Basal Area (m^2)	Maximum Storage Depth (mm)	Maximum (In-soil) storage Volume (m^3)	Effluent Application Area Footprint (m^2) - including interbed spacing
3	720	168	142	288	40,850	555
4	900	213	180	264	47,450	685
5	1,080	255	216	264	56,950	815

Lavers Hill/Wyelangta - Wick Trench Option (10mm/day)

Number of Bedrooms	Load (L/Day)	Required Trench Length (m)	Design Basal Area (m^2)	Maximum Storage Depth (mm)	Maximum (In-soil) storage Volume (m^3)	Effluent Application Area Footprint (m^2) - including interbed spacing
3	720	190	161	270	43,350	620
4	900	237	201	271	54,400	750
5	1,080	285	241	272	65,500	945

Beech Forest/Ferguson/Weeaproinah - Wick Trench Option (12mm/day)

Number of Bedrooms	Load (L/Day)	Required Trench Length (m)	Design Basal Area (m^2)	Maximum Storage Depth (mm)	Maximum (In-soil) storage Volume (m^3)	Effluent Application Area Footprint (m^2) - including interbed spacing
3	720	121	102	284	28,950	425
4	900	151	128	275	35,100	490
5	1,080	182	154	268	41,300	620

Lavers Hill/Wyelangta - Wick Trench Option (12mm/day)

Number of Bedrooms	Load (L/Day)	Required Trench Length (m)	Design Basal Area (m^2)	Maximum Storage Depth (mm)	Maximum (In-soil) storage Volume (m^3)	Effluent Application Area Footprint (m^2) - including interbed spacing
3	720	131	111	274	30,350	425
4	900	164	139	270	37,550	555
5	1,080	197	167	268	44,750	620

Beech Forest/Ferguson/Weeaproinah - Wick Trench Option (20mm/day)

Number of Bedrooms	Load (L/Day)	Required Trench Length (m)	Design Basal Area (m^2)	Maximum Storage Depth (mm)	Maximum (In-soil) storage Volume (m^3)	Effluent Application Area Footprint (m^2) - including interbed spacing
3	720	57	48	264	12,650	165
4	900	71	60	264	15,850	230
5	1,080	85	72	264	19,000	295

Lavers Hill/Wyelangta - Wick Trench Option (20mm/day)

Number of Bedrooms	Load (L/Day)	Required Trench Length (m)	Design Basal Area (m^2)	Maximum Storage Depth (mm)	Maximum (In-soil) storage Volume (m^3)	Effluent Application Area Footprint (m^2) - including interbed spacing
3	720	59	50	250	12,500	165
4	900	73	62	281	17,500	230
5	1,080	89	75	250	18,750	295

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RECOMMENDED LAND APPLICATION DESIGN FOR HIGH-RAINFALL AREAS
DESIGN – SECONDARY TREATMENT WITH WICK TRENCH/BED

Project: 1307
Colac Otway Shire DWMP
Drawn: BC/MS
Dimensions: As shown

7.5 Footprint Area of Land Application Systems

The size of a land application system depends not only on the volume of the effluent to be applied, the quality of the soil and on local rainfall, but also on how the system is laid out and on the spacing of components (e.g. trenches) and the width of mandatory setbacks.

In a subsurface irrigation system, the drip-lines are often closely spaced and the land may be considered to have an even loading. Therefore, the total land application area is the required area as specified by the water balance (plus any setbacks which must be maintained). Irrigation systems can be designed to best fit the most suitable area, provided that the pump is capable of delivering effluent evenly throughout the entire system.

For absorption and ETA trenches and beds, wick trenches and Low Pressure Effluent Distribution (LPED) systems, a minimum spacing between trenches or beds must be observed to prevent overloading of the soil between them. The current EPA Code of Practice or *AS1547:2012* specifies minimum spacing's, which have been used to estimate a typical footprint area of the system, on the assumption that the longest acceptable trench or bed length has been used. These values are provided in the individual model spreadsheets for each system type. It is highlighted that the 'typical footprint' is indicative only, and is likely to represent the minimum footprint for a well-laid out system. The final area must be determined by the system designer/installer as part of the final DWM design (for all risk category lots).

8 Sub-catchment Analysis

The Minister for Water's (2012) Guidelines for planning permit applications in potable water supply catchments specify that, to avoid the blanket application of a 1 in 40 hectare dwelling density in DWSCs, a DWMP must include consideration of the broader cumulative impact of DWM systems within a catchment. Aggregated 'cumulative' risk is area dependant, therefore it is important to delineate manageable areas for investigation and analysis. The DWSCs were therefore divided into smaller 'sub-catchments' so that the cumulative risk could be identified and to assist in prioritising further assessment and management resources. Sub-catchments are delineated based on areas of concern; whether that refers to offtake points, water quality sampling points or towns/settlements. The aim is to identify areas of concern that may pose a potential impact on water quality.

The sub-catchments were delineated using the TauDEM Sub-catchment Delineation tool in QGIS™. The Digital Elevation Model (DEM) developed in Section 6.2.5 and Water Corporation identified offtake and discharge points were used to inform the delineation of the sub-catchment boundaries. There are 9 identified Barwon Water offtakes, 5 identified Wannon Water offtakes and 10 identified discharge points. The Barwon Downs Wellfield Intake offtake points (seven in total) that refer to groundwater and multiple North Otway Wannon Water offtake points that are located in the same locality are not included in the sub-catchment analysis. For the purposes of this analysis, a sub-catchment is an area of terrain with one single outflow point. The residual regions were subdivided into a number of larger sub-catchments based on their discharge points.

Sub-catchment analysis can be applied at a variable scale. In addition to delineating the sub-catchments based on offtake and discharge points, smaller sub-catchments were delineated based on the town/settlement boundaries for the targeted unsewered towns/settlements located within the DWSC. The aim is to prioritise both the towns/settlements and sub-catchments within the DWSCs and to determine the relative contribution of risk of the town/settlement development within the larger sub-catchment.

Figure 13 shows the delineated sub-catchments and towns/settlements within the DWSC and the relative offtake and discharge points. The sub-catchment analysis resulted in the delineation of 24 individual sub-catchments, with 13 of these sub-catchments delineated based on offtake points. There were seven town/settlement sub-catchments identified. It is important to ensure that a high level of environmental health is maintained within these 13 sub-catchments in order to ensure that the drinking water supply is protected.

Section 4.4 of the Operational Plan details the prioritisation of both sub-catchments and towns/settlements based on cumulative Sensitivity Ratings. Figure 14 outlines the Sensitivity Rating mapping for the DWSCs.

Legend

- DWSCs
- Barwon Water Offtakes
- Wannon Water Offtakes
- Discharge Points
- Stream Reach

Subcatchments

- Arkins Creek Weirs
- Barham River Pump Station 1
- Barham River Pump Station 2
- Boundary Creek
- Callahans Creek
- East Barwon Diversion Gates
- Gellibrand Pump Station
- Leahy Creek
- North Otway Raw WPS
- Olangolah
- to Barham River West Branch
- to Barongarook Creek
- to Barwon River West Branch
- to Callahan Creek North Branch
- to Carlisle River
- to Chappell Creek and Gellibrand River
- to Deans Creek
- to Dewings Creek (Wurdi Boluc Inlet Channel)
- to Gellibrand River (near Sheepyard Creek)
- to Gellibrand River and Charleys Creek
- to King Creek
- to Love Creek
- To Matthews Creek (to the north)
- West Gellibrand River

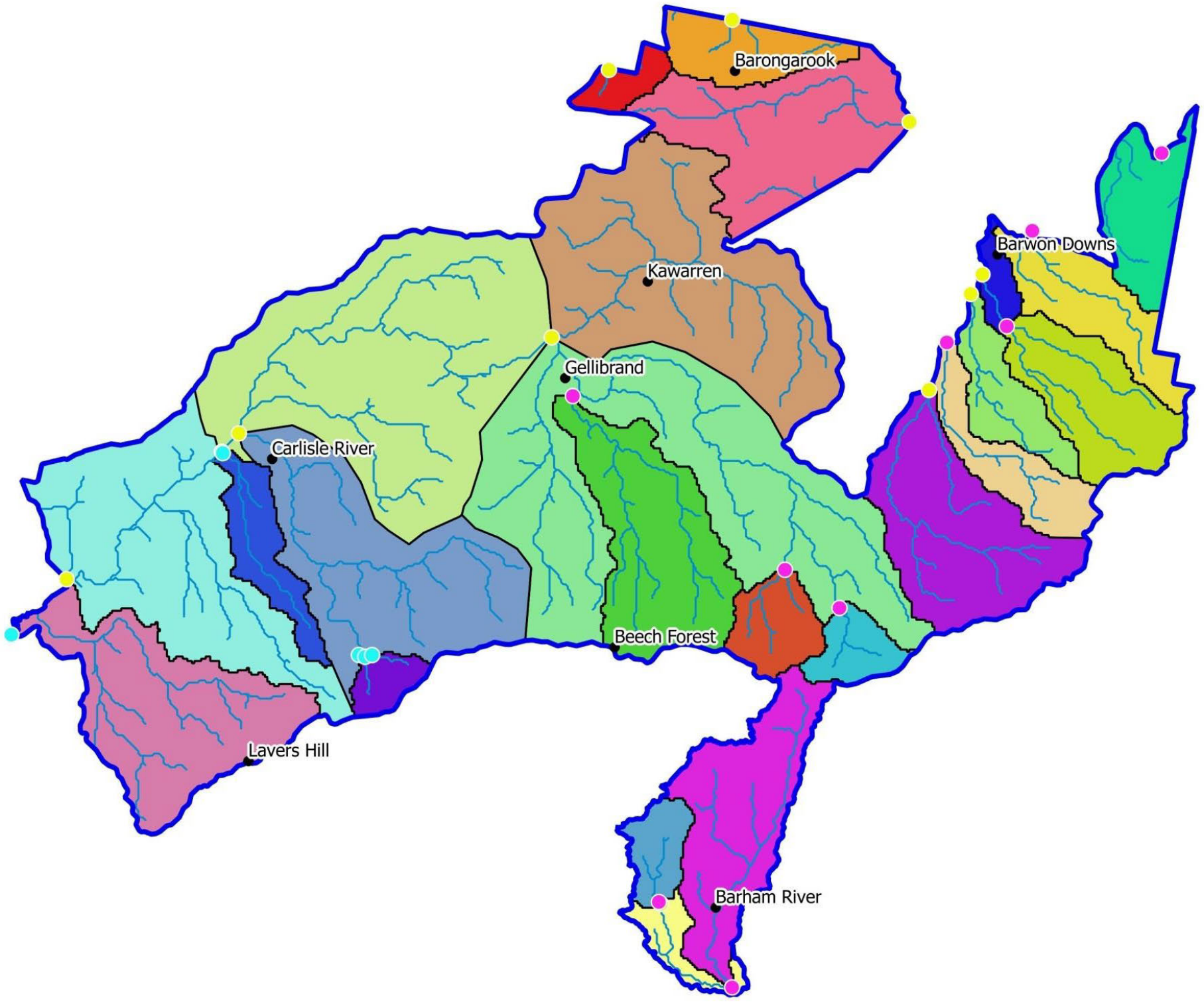

Figure 13: Subcatchments within DWSC

1307 Colac Otway Shire DWMP Revision

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(Approx Scale)

Revision	3
Drawn	JK
Approved	MS

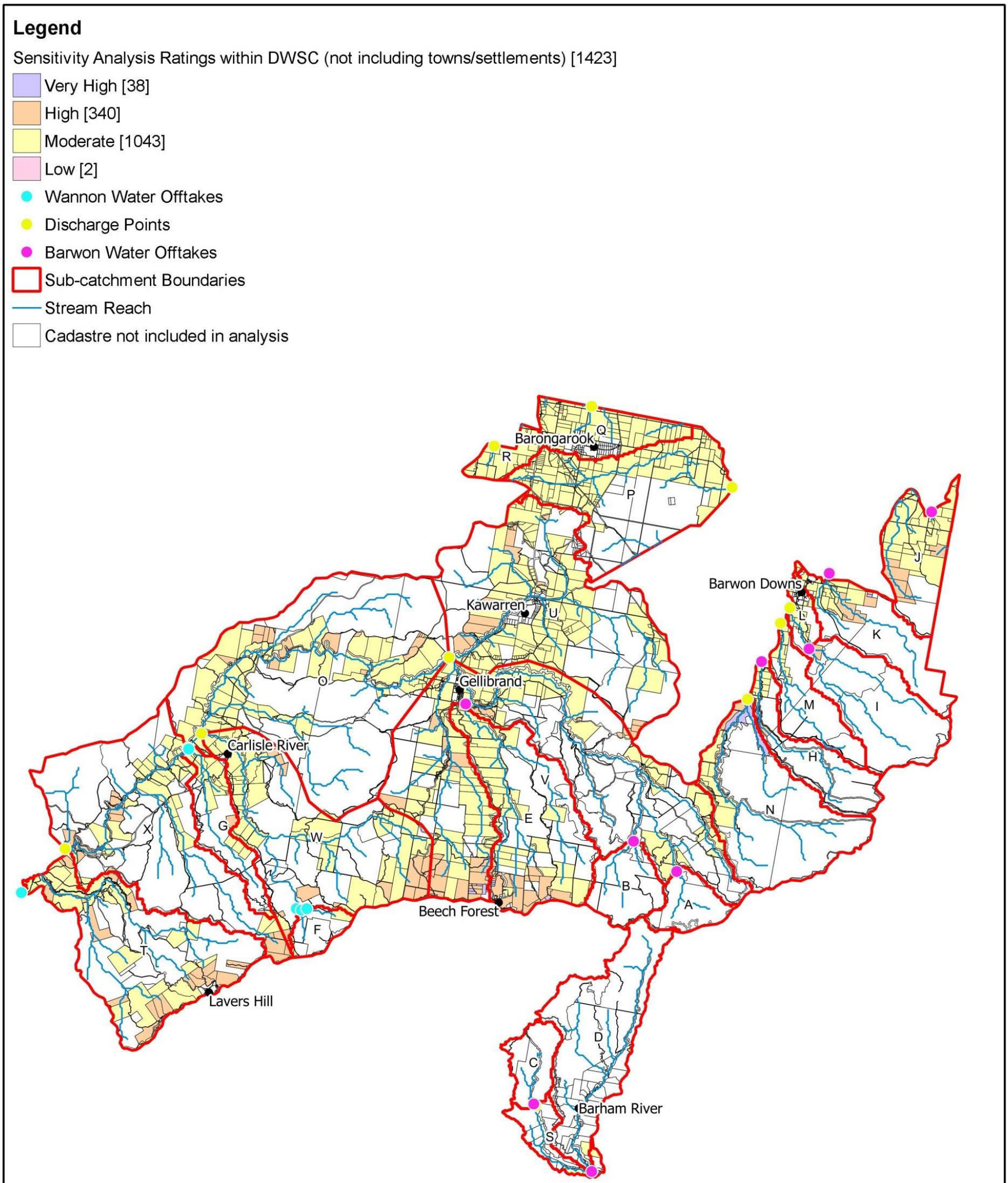

Figure 14: Sub-catchments & Associated Sensitivity Analysis within DWSC

1307 Colac Otway Shire DWMP Revision

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0 5 10 15 20 25 km

(Approx Scale)

Revision	3
Drawn	JK
Approved	MS

9 Glossary of Terms

Term	Definition
Aerobic treatment	Biological treatment processes that occur in the presence of oxygen (i.e. aerobic bacteria digest wastewater contaminants). Aerobic bacteria are organisms that require oxygen to survive and grow.
Anaerobic treatment	Biological treatment processes that occur in the absence of oxygen.
Blackwater	Wastewater grossly contaminated with faeces (i.e. from a toilet).
Desludging	Removal of the semi solid waste from a tank.
Effluent	Water discharged from a treatment plant.
Evapotranspiration	Transfer of water from the soil to the atmosphere through evaporation and plant transpiration. Calculated using the FAO Penman-Monteith method to derive (ET_0).
Organic Matter	Material that comes from the tissues of organisms (plants, animals, or microorganisms) that are currently or were once living.
Greywater	Wastewater from showers, baths, sinks, washing machines, dish washers.
Hardpan	A hardened, compacted and/or cemented horizon.
Locality	The broader locality surrounding a town (place name within mapped boundaries).
Non-Potable	Water not suitable for human consumption.
Parcel	The smallest unit of land able to be transferred within Victoria's cadastral system, usually having one proprietor or owner (land.vic.gov.au). For the purposes of this DWMP, parcel and lot are given to have the same meaning.
Peds	An aggregate of soil particles.
Permeability	The ability of the soil to allow water to pass through.
P-sorb	Phosphorus adsorption capacity of soil.
Property	Land under common occupation (land.vic.gov.au). May include multiple parcels.
Sensitivity	The 'likely' consequence of off-site (DWM) impacts based on the cumulative effect of individual lot constraints (soil suitability, slope, useable lot area, climate and location) and variables affecting the specific land capability and associated limitations of the lot to sustainably manage wastewater in compliance with SEPP objectives.
Settlement	An area of residential development within the Rural Living Zone (Barongarook and Kawarren) or Rural Conservation Zone (Barham River).
Sewage	Solid and liquid wastewater conveyed through sewers.
Sewerage	A system of sewers.
Town	The town servicing a locality, which is predominantly zoned Township Zone. It contains both residential and commercial development.

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Appendix A

Informative Maps

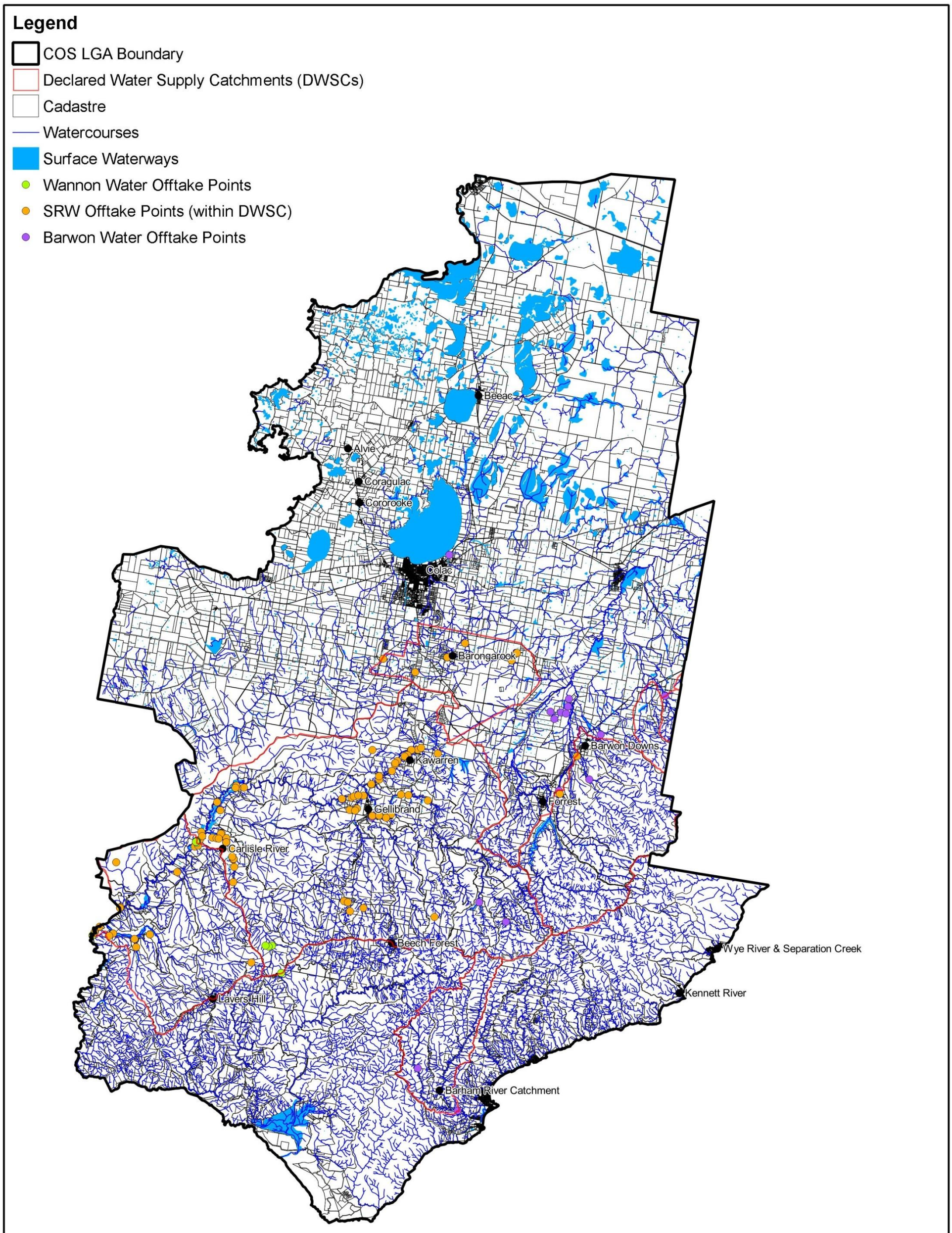

Figure A1: Surface Waters & Associated Buffers - Shire

Colac Otway Shire DWMP Review

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(Approx Scale)

Revision	5
Drawn	JK
Approved	MS

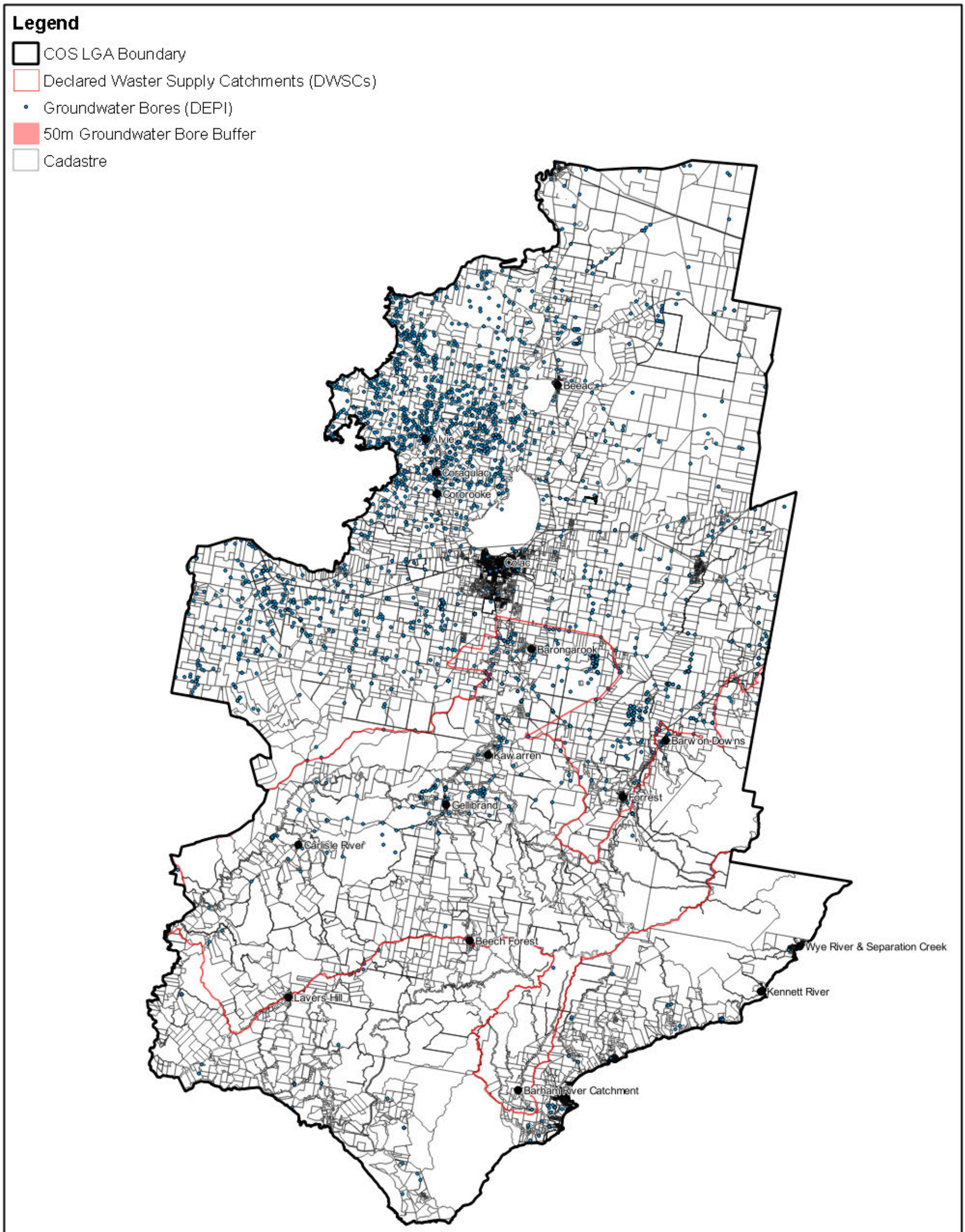

Figure A2: Groundwater Bores & Associated Buffers - Shire

Colac Otway Shire DWMP Review

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(Approx Scale)

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Revision	4
Drawn	JK
Approved	MS

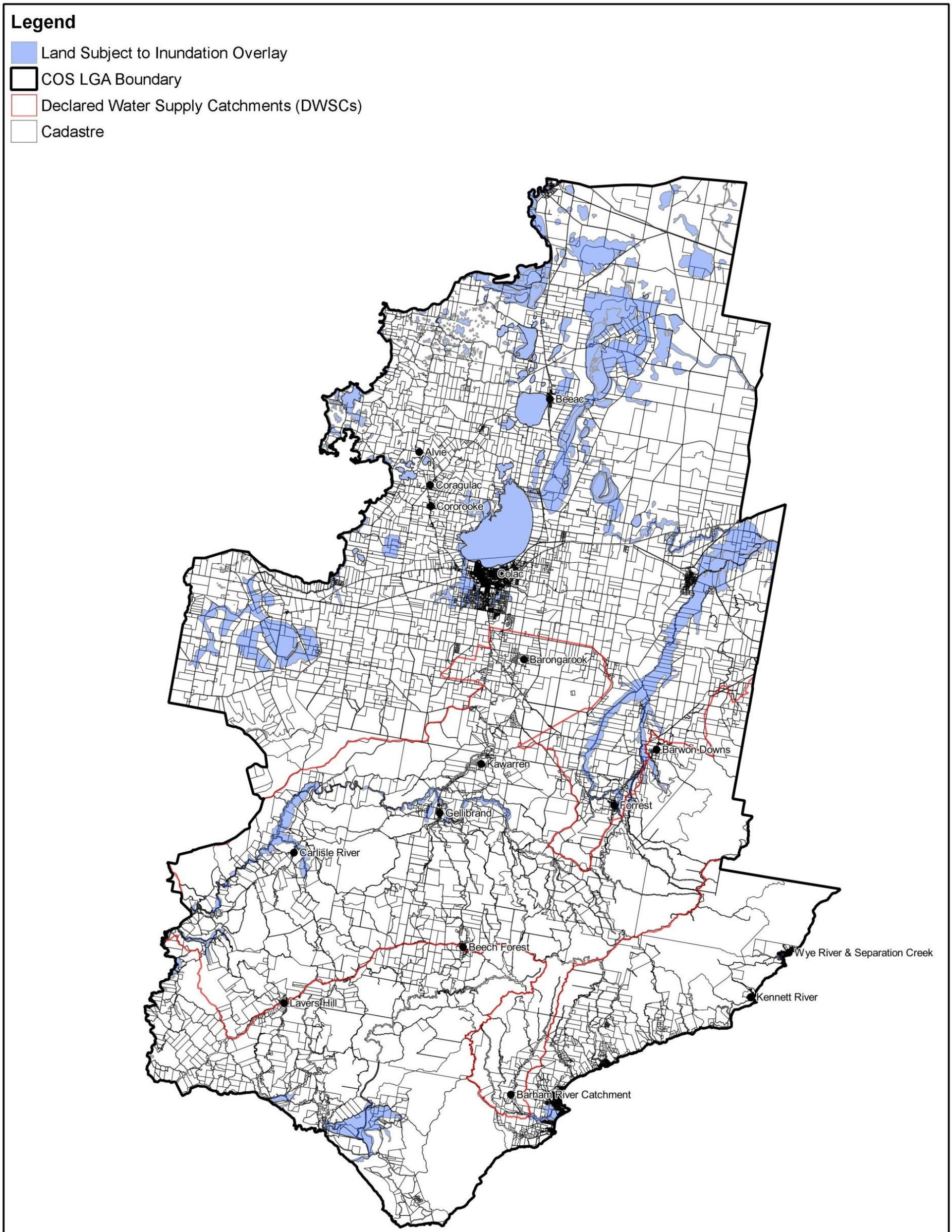


Figure A3: Land Subject to Inundation - Shire

Colac Otway Shire DWMP Review

N

Whitehead & Associates Environmental Consultants

0 6 12 18 24 30 km

(Approx Scale)

Revision	2
Drawn	JK
Approved	MS

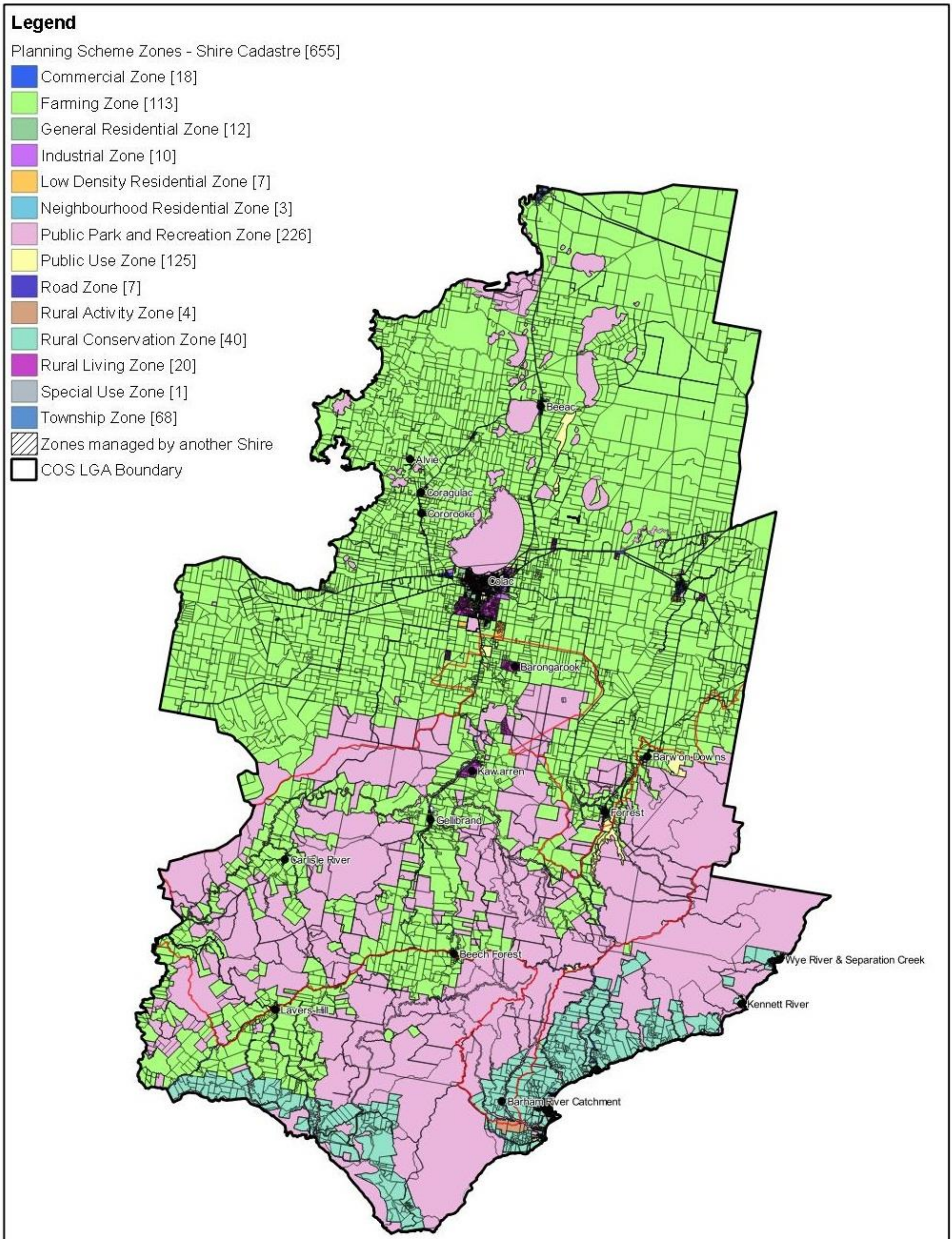


Figure A4: Planning Scheme Zones - Shire

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 6 12 18 24 30 km

(Approx Scale)

N

Revision	3
Drawn	JK
Approved	MS

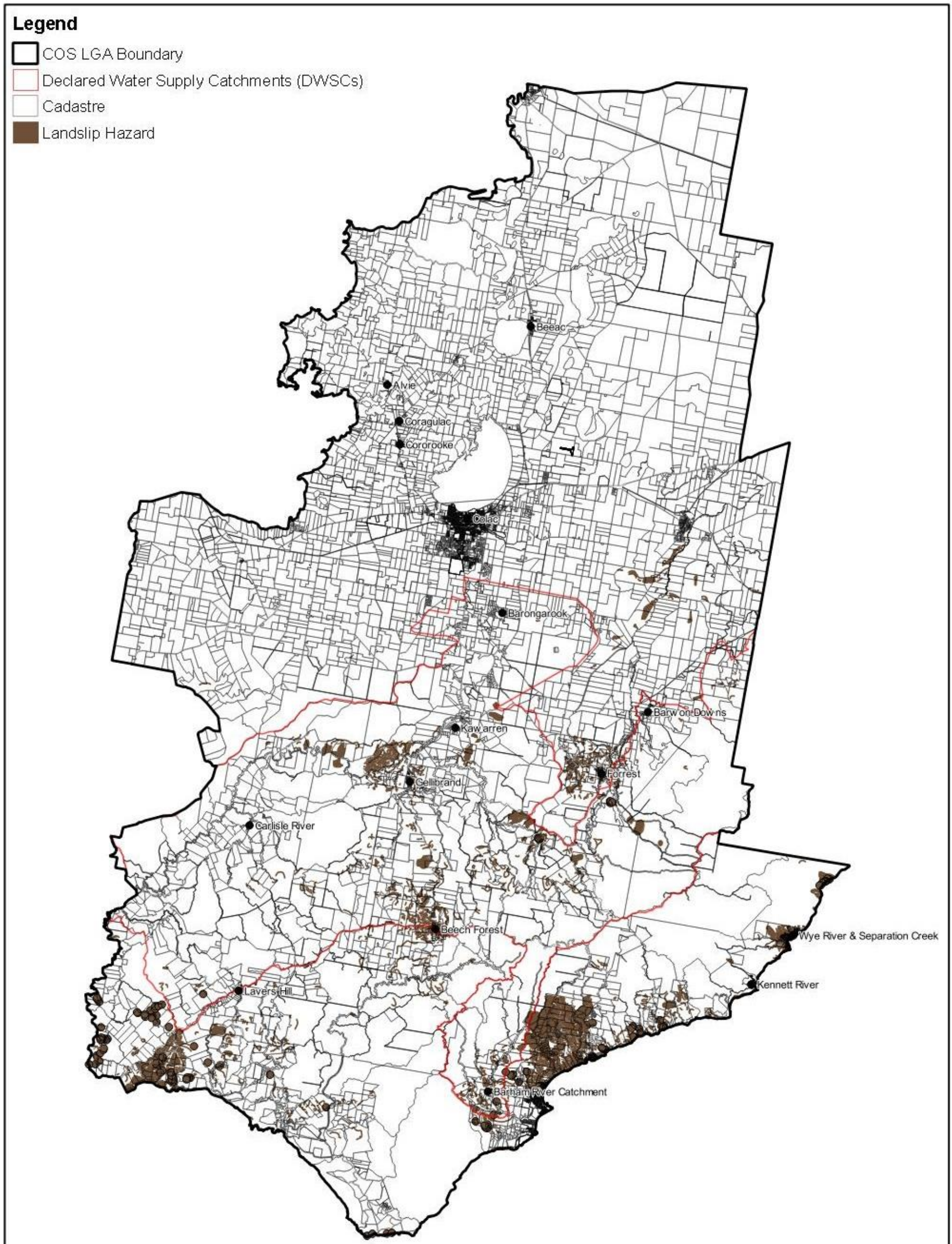


Figure A5: Sensitivity Overlay - Landslide Hazard - Shire

Colac Otway Shire DWMP Review

N

Whitehead & Associates
Environmental Consultants

0 6 12 18 24 30 km
(Approx Scale)

Revision	3
Drawn	JK
Approved	MS

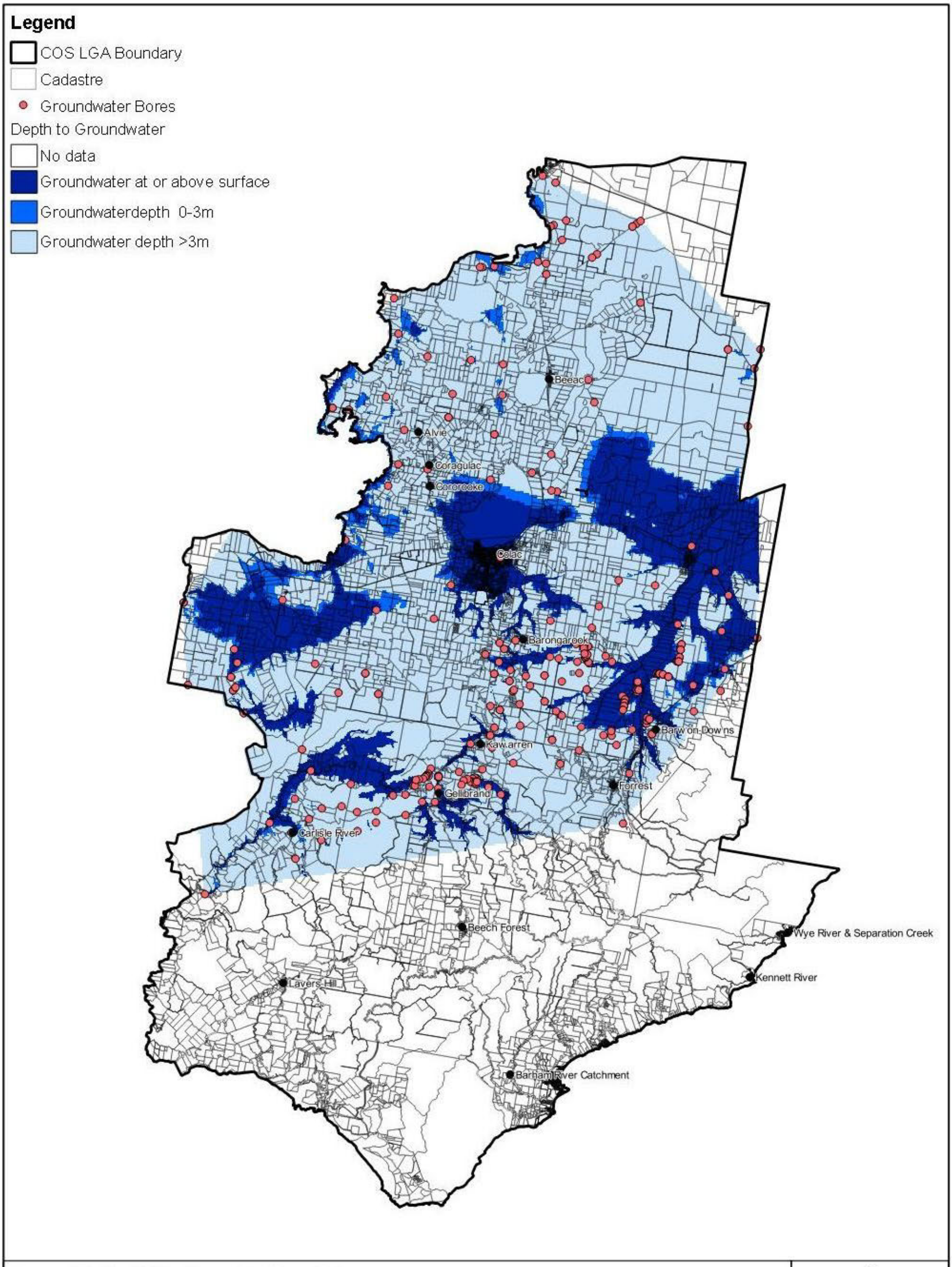


Figure A6: Depth to Groundwater - Shire

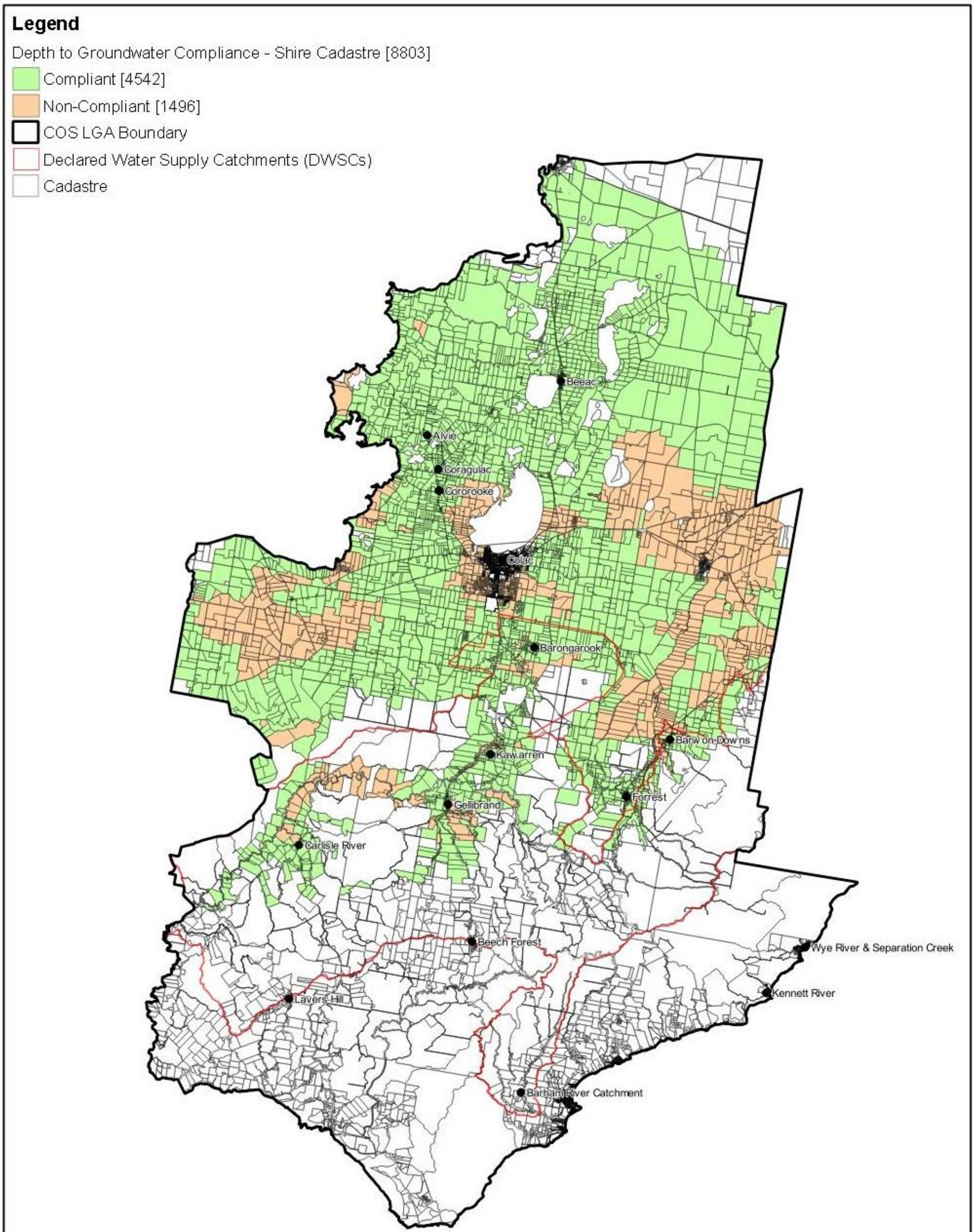
Colac Otway Shire DWMP Review

N

Whitehead & Associates
Environmental Consultants

0 6 12 18 24 30 km
(Approx Scale)

Revision	3
Drawn	JK
Approved	MS


Legend
Depth to Groundwater Compliance - Shire Cadastre [8803]
Compliant [4542]
Non-Compliant [1496]
COS LGA Boundary
Declared Water Supply Catchments (DWSCs)
Cadastre
Beeac
Alvie
Coragulac
Cororooke
Colac
Barongarook
Barwon Downs
Kawarren
Forrest
Gellibrand
Carlisle River
Beech Forest
Wye River & Separation Creek
Lavers Hill
Kennett River
Barham River Catchment
Figure A7: Depth to Groundwater Compliance - Shire
Colac Otway Shire DWMP Review
N
Whitehead & Associates
Environmental Consultants
0 6 12 18 24 30 km
(Approx Scale)
Revision 3
Drawn JK
Approved MS

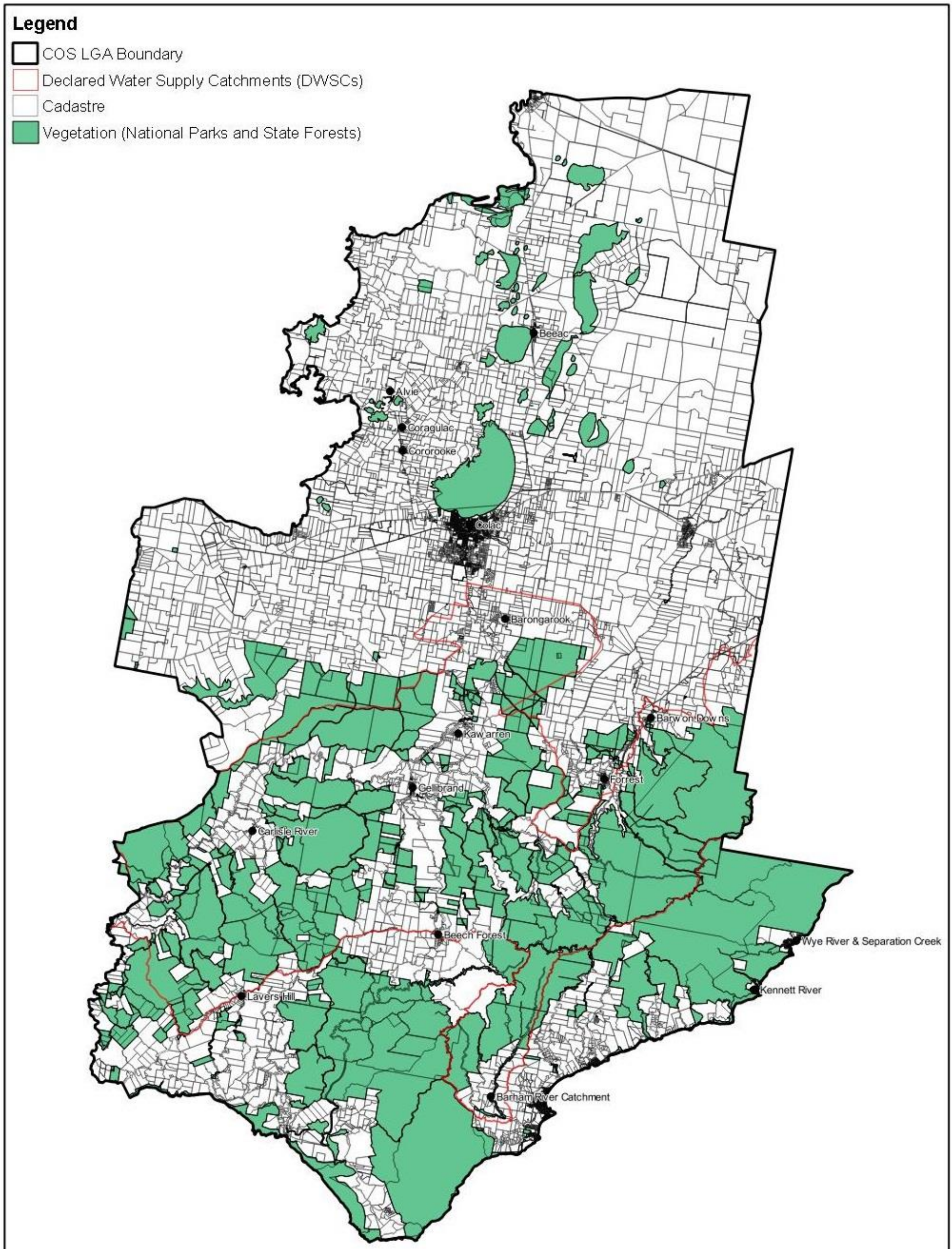


Figure A8: Sensitivity Overlay - Vegetation - Shire

Colac Otway Shire DWMP Review

N

Whitehead & Associates
Environmental Consultants

0 6 12 18 24 30 km
(Approx Scale)

Revision	3
Drawn	JK
Approved	MS

Appendix B

Locality Reports

If your locality is not provided as a Locality Report in Appendix B, you can use the System Sizing Tables for the nearest locality (i.e. Colac/Elliminyt can utilise Barongarook).

Note: words have the following meanings in the DWMP (refer to glossary for further definition):

'Town' means the developed area/town which services the wider locality. 'Towns', which contain both residential and commercial development, are predominantly zoned Township zone.

'Settlement' refers to residential areas in Barham River, Barongarook and Kawarren, which are in the Rural Living Zone and Rural Conservation Zone.

'Locality' means the wider geographical area, inclusive of the town/settlement.

The white cadastre regions shown on the locality and town/settlement Sensitivity Rating maps refers to regions excluded from the study. Refer to Section 5 for more detail.

Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

A. Alvie Locality Report

1a. Introduction

Alvie is a rural locality located approximately 12km northwest of Colac on the western side of Lake Corangamite within the Western Volcanic Plain landscape and Red Rock region. Alvie lies at the foot of the Red Rock Scenic Reserve, an old scoria formation that formed due to violent volcanic eruptions, which is a popular tourist attraction.

The locality has a population of approximately 132 residents (ABS Census, 2016). There are approximately 161 and 33 unsewered lots located within the Alvie locality and town respectively. There were 4 new lots with DWM systems within the locality from June 2015-2021. There are 30 DWM system permits that have been inspected to date by COS (including PTI and CTU). The current DWM permits and their associated treatment system and LAA method within the Alvie locality are summarised as follows:

- 3 AWTS (1 subsurface irrigation, 2 unknown);
- 20 septic tanks (6 trenches and 14 unknown);
- 2 worm farm (1 subsurface irrigation, 1 unknown); and
- 5 unknown (2 trenches and 3 unknown).

No site investigations were conducted within the Alvie locality as part of the 2014 field assessments; however, soil investigations were conducted to confirm the soil type.

2a. Background Documentation

Refer to the following documents for additional detail specifically regarding the locality:

- Red Rock Region Community Infrastructure Plan (September, 2013);
- COS Planning Scheme; and
- Rural Living Strategy (2011)

3a. Summary of Constraints to DWM

Characteristic	Description
Climate Zone	Zone 2.
Surface waterways & catchments	Alvie contains a number of lakes, predominantly in the region to the south of the locality, that have formed within the Western Volcanic Plains; including Lake Coragulac (southeast near town), Lake Wernwrap, Lake Purdiguluc and Lake Gnalinegurk.
Groundwater	Proximity to groundwater bores: significant throughout the locality with a high density of groundwater bores.
Land subject to inundation	To the south of the town around the lakes.
Useable lot area	High: 12 (22)

Characteristic	Description
Town (Locality)	Moderate: 11 (22) Low: 10 (105) Compliant: 0 (12)
Minimum lot size compliance with Planning Scheme Zoning	The town is predominantly zoned as Township, with some Public Use Zone. Land in the wider locality area is predominantly in the Farming Zone, with land associated with the lakes in the Public Conservation and Resource Zone. Compliancy is variable throughout the locality, with the majority of the town compliant. Compliant: 28 (40) Non-compliant: 5 (121)
Slope **Town (Locality)**	High: 1 (17) (higher towards Lake Coragulac) Moderate: 7 (15) Low: 25 (129)
Geology	Northwest region – unnamed stony rises of Newer Volcanic Group; Town – unnamed phreatomagmatic deposits (tuff rings) of Newer Volcanic Group; Eastern and southern regions – unnamed scoria deposits (scoria cones and agglutinated spatter rims) of Newer Volcanic Group; and Some unnamed non-marine swamp, lake and estuarine deposits.
Soil suitability **Town (Locality)**	High: 0 (15) Moderate: 33 (146) Low: 0 (0) The town consists of soil landscape unit ‘101’ (moderate rating) which forms in the undulating low hills of the Western Volcanic Plains and consists of friable mottled black texture contrast soil and neutral black gradational soils to depths less than 1.5m. The soils consist of moderately structured clay loam over strongly structured medium clay to heavy clay. Limitations include restricted drainage. The western and surrounding regions of the locality consists of soil landscape unit ‘114’ (moderate rating) which forms in the undulating basalt plains and stony rises and consists of gradational and friable mottled textured contrast soils to depths of less than 1.5m. The soils consist of strongly structured clay loam over strongly structured medium clay. There are some landform depressions to the north of the town.

Characteristic	Description
Sensitivity Overlay	Depth to Groundwater Compliance: all compliant. Landslip: Nil. Vegetation: Red Rock Scenic Reserve and lakes to the south (Coragulac, Werowrap, Corangamite, and Gnalinegurk).
Sensitivity Analysis Rating **Town (Locality)**	Very High: 0 (0) High: 3 (8) Moderate: 22 (73) Low: 8 (76)

4a. Sensitivity Analysis (Maps)

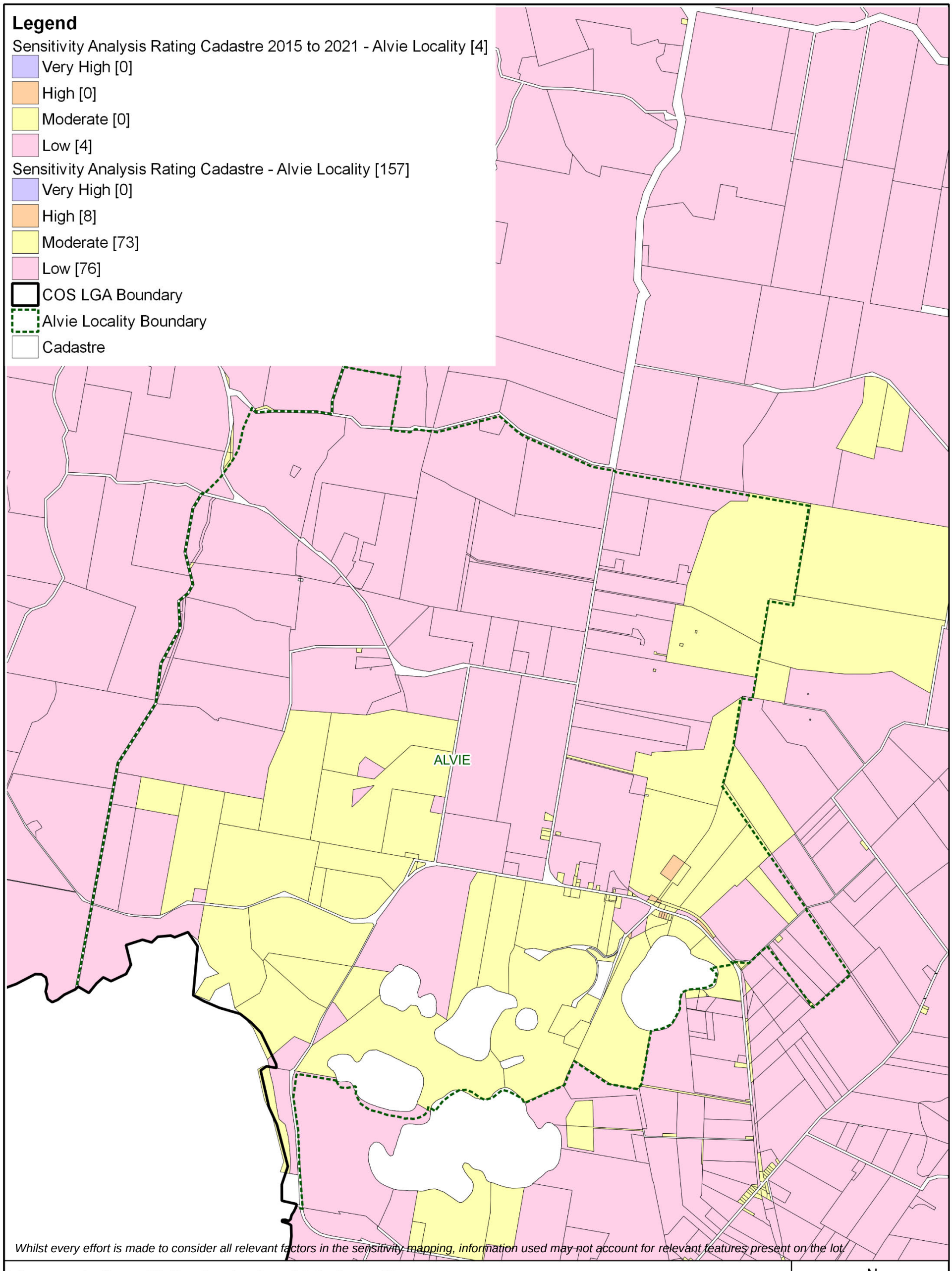


Figure a1: Sensitivity Analysis - Alvie Locality

Colac Otway Shire DWMP Review

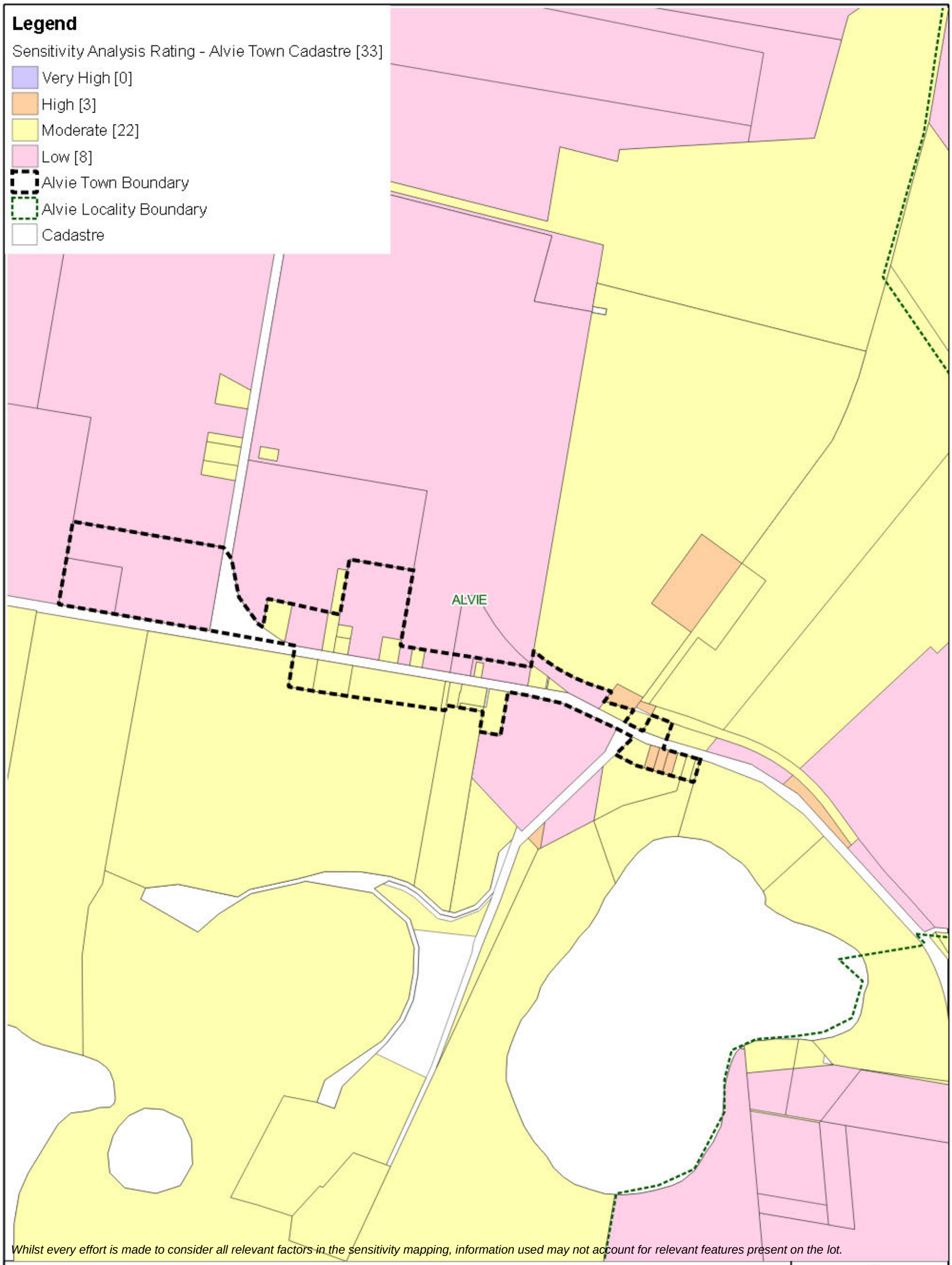
Whitehead & Associates Environmental Consultants

0 500 1,000 1,500 2,000 2,500 m

(Approx Scale)

N

Revision	6
Drawn	JK
Approved	MS



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure a2: Sensitivity Analysis - Alvie Town

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 200 400 600 800 1000 m

(Approx Scale)

N

Revision	3
Drawn	JK
Approved	MS

5a. System Selection

Due to the dominance of heavy-textured soils in the Alvie area, conventional absorption trenches and beds are not likely to be feasible and are discouraged. Appendix A of the EPA Code of Practice (2013) prohibits LPED systems on Category 5 and 6 soils (medium to heavy clays). The System Sizing Tables (below) indicate which systems are likely to be the most appropriate for the locality.

6a. System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. Monthly 70th percentile rainfall and average evapotranspiration data for Alvie was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

The Design Loading Rates (DLRs) and Design Irrigation Rates (DIRs) were taken from the EPA Code of Practice. Where the Code of Practice has precluded use of a particular type of system on a certain soil type, it is shown as 'Not Applicable' for that soil type in the Sizing Tables. Where the evapotranspiration deficit requires unrealistically large land application areas for a particular system on a certain soil type, it is also shown as 'Not Applicable' for that soil type in the Sizing Tables. Detailed, site-specific LCAs and system designs would be required to further investigate the feasibility of systems deemed 'Not Applicable' in the sizing tables. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained lots.

Sizing Tables for the Alvie locality are provided below.

7a. General Conclusion

The lots within Alvie have been predominantly assigned a Moderate or Low Sensitivity Rating to sustainable DWM. Predominantly, both Standard and Council LCAs will be required, with the use of System Sizing tables deemed appropriate. The constraints within Alvie are quite low in comparison to other localities, with particular attention directed towards ensuring that the quality of the groundwater resources is maintained and the correct decommissioning of groundwater bores occurs where necessary.

Alvie and Beeac

Drip and Spray Irrigation Systems* - Secondary Treated Effluent only								
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**	
	DIR (mm)	**5**	**5**	**4**	**3.5**	**3**	**2**	
Development Type	**Daily (L/day)**	**Total min. irrigation area required for zero wet weather effluent storage (m^2) not including spacing and setbacks**						
5 + bedroom residence	1,080	268		356	426	530	1,039	
4 bedroom residence	900	223		297	355	442	866	
1-3 bedroom residence	720	127		237	284	353	693	
Note: * irrigation system sizes are based on the assumption that the land application area is less than 10% slope. Reductions in DIR apply for slopes above 10% according to Table M2 of AS1547:2012								

Conventional Absorption Trenches and Beds - Primary or Secondary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Weak Loams & High/Mod Clay Loams (3 & 4)**	**Weak Clay Loams (4)**	**Massive Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**Not supported (Alternative Land Application System Required)**							
Development Type	**Daily (L/day)**								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								

Evapotranspiration-Absorption Trenches and Beds - Primary or Secondary Treated Effluent (Category 1 to 5) and Secondary Treated Effluent only (Category 6)									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3a)**	**Weak/Massive Loams (3b)**	**High/Mod Clay Loams (4a)**	**Weak Clay Loams (4b) & Strong Light Clays (5a)**	**Massive Clay Loams (4c) and Mod & Weak Light Clays (5b, 5c)**	**Medium to Heavy Clays (6) - Secondary Effluent Only**
	DLR (mm)	**20***	**20***	**15**	**10**	**12**	**8**	**5**	**5**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted' area required for zero wet weather effluent storage (m^2) not including spacing and setbacks**							
5 + bedroom residence	1,080	58		78	123	100	128	281	
4 bedroom residence	900	48		65	102	83	132	234	
1-3 bedroom residence	720	39		52	82	67	106	188	
Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012									

LPED Irrigation Systems - Primary or Secondary Treated Effluent								
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**	
	DIR (mm)	**N/A (Alternative Land Application System Required)**	**4**	**3.5**	**3**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**	
Development Type	**Daily (L/day)**		**Total min. basal or 'wetted' area required (m^2)†**					
5 + bedroom residence	1,080		379	460	584			
4 bedroom residence	900		316	383	487			
1-3 bedroom residence	720		253	307	390			
† required for zero wet weather storage (m^2) not including spacing & setbacks								

Wick Trenches and Beds - Secondary Treated Effluent Only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2) Loams (3) & High/Mod Clay Loams (4a,b)**	**Weak Clay Loams (4)**	**Massive Clay Loams (4)**	**Strong Light Clays (5a)**	**Moderate Light Clays (5b)**	**Weak Light Clays (5c)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**25**	**30**	**20**	**10**	**12**	**8**	**8**	**5**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted' area required for zero wet weather effluent storage (m^2) not including spacing and setbacks**							
5 + bedroom residence	1,080	46	38	58	123	100	128		281
4 bedroom residence	900	38	32	48	102	83	132		234
1-3 bedroom residence	720	31	25	39	82	67	106		188

B. Barham River Catchment (Apollo Bay) Locality Report

1b. Introduction

Barham River (also known informally as 'Paradise') is a rural settlement located in the hinterlands of the Apollo Bay locality on the south-eastern coast of COS. On maps, it is officially within the broader Apollo Bay locality, but it is distinguished by low density, unsewered residential properties primarily extending along Barham River Road and other minor roads. Many properties are rural-residential (including hobby farms). The landform consists of dissected low hills and alluvial terraces abutting rivers and streams at the base of the Otway Ranges. The entire Barham River ('Paradise') Catchment settlement is located within the Barham River DWSC as indicated by the surface water informative map A1, Appendix A.

Because it does not fit within specific Census locality boundaries, it is difficult to estimate the residential population of the Barham River Catchment settlement. The broader Apollo Bay locality (which includes the Barham River Catchment settlement) has a population of approximately 1,598 residents (ABS Census, 2016) which reaches up to 15,000 in the peak holiday season.

The settlement of Apollo Bay is sewered, with approximately 392 and 78 unsewered lots located within the Apollo Bay locality and Barham River Catchment settlement, respectively. There are 83 new lots with DWM systems within the locality from June 2015-2021. There are 161 DWM system permits that have been inspected by COS to date within the Barham River Catchment settlement/ Apollo Bay locality (including PTI and CTU). The current DWM permits and their associated treatment system and LAA method are summarised as follows:

- 62 AWTS (7 subsurface irrigation, 16 drip irrigation, 8 irrigation, 3 trenches and 28 unknown);
- 1 secondary treatment system (1 unknown);
- 2 composting toilets (1 drip irrigation);
- 63 septic tanks (27 trenches and 36 unknown);
- 3 worm farms (2 trenches and 1 unknown);
- 1 sand filter (1 unknown); and
- 30 unknown (11 trenches, 1 reln drain, 1 subsurface irrigation, and 17 unknown).

2b. Background Documentation

Refer to the following documents for additional detail specifically regarding the locality:

- Apollo Bay Structure Plan (April 2007);
- Barham River Confluence Land Management Plan (February 2012);
- COS Planning Scheme; and
- Rural Living Strategy (2011)

3b. Site Assessment Results

The following table summarises the results from the representative audits conducted by Consultant staff in September 2014.

Characteristic	Description
Land use	The Barham River Catchment settlement comprises a range of land uses, including rural living, small farms, and tourism.
Occupancy rates	2 (as per Apollo Bay Gazetted Locality, ABS Census, 2011).
Typical soils	Sandy clays and clay loams over clay or weathered shallow bedrock as determined during field investigations.
AS/NZS 1547:2012 soil categories	4 (Clay Loams), 5 (Light and Sandy Clays) and 6 (Medium to Heavy Clays).
Existing Systems	**Separate Blackwater and Greywater** Of the three systems inspected during field investigations, one (33%) was assumed to comprise separate blackwater treatment in a septic tank, with direct greywater diversion within the lot boundary. The septic tank was not accessed, as it could not be found. Time since last pump out was not determined. It was assumed that septic effluent is discharged to conventional absorption trenches; however, the LAA was not identified. **Combined Blackwater and Greywater** Two systems (67%) inspected have a combined wastewater treatment system, or were assumed to have based on layout of pipework and age of dwelling. The time since last pump-out was generally unknown (partly due to owner not being home to ascertain). Septic effluent discharged to one or more conventional absorption trenches (or was assumed to if trenches could not be identified). The trench dimensions were generally unclear, and it is likely that they were undersized for the number of bedrooms. The majority of trenches or/and available LAAs were located on land of less than 8% slope and appeared to be parallel with contours.

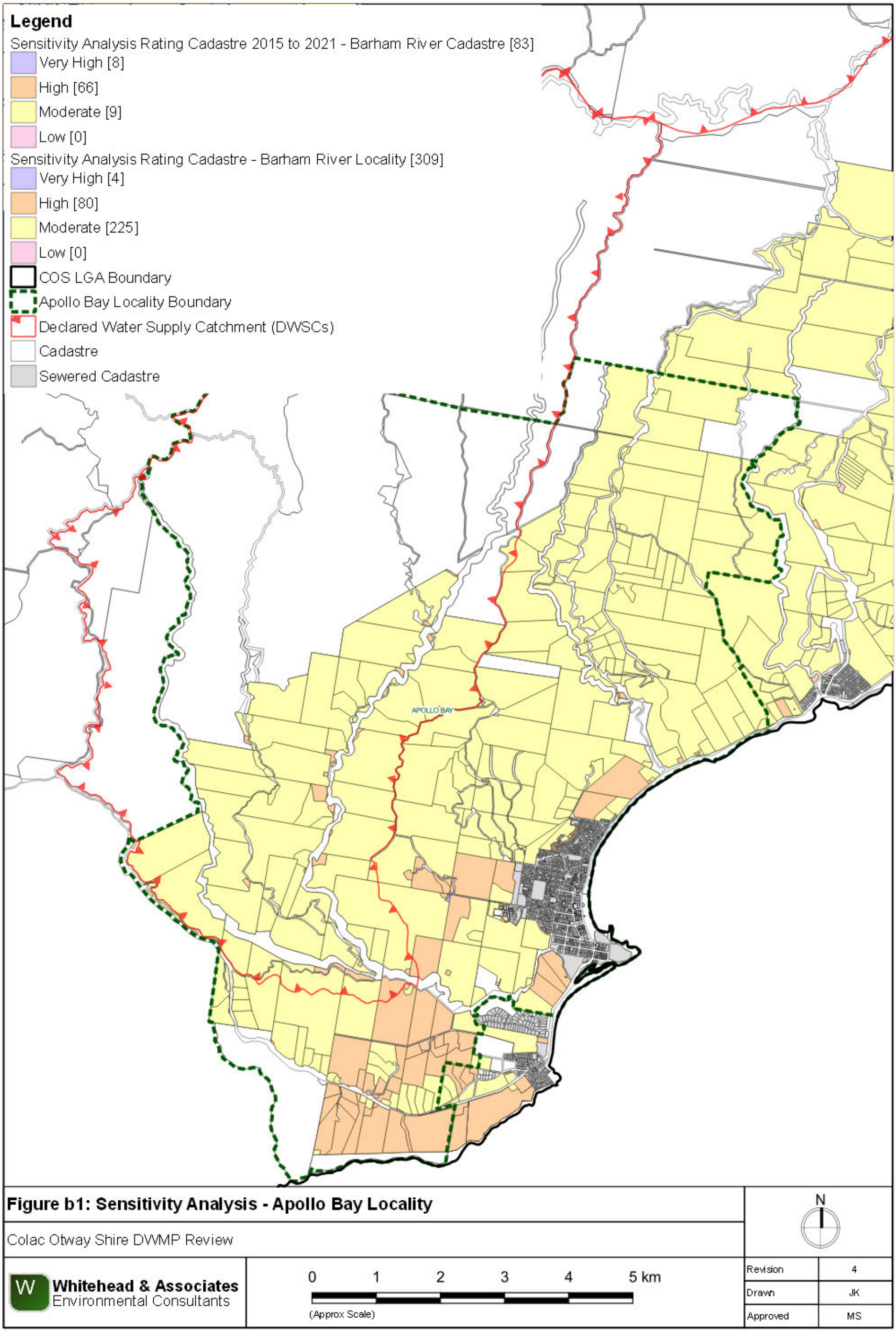
4b. Summary of Constraints to DWM

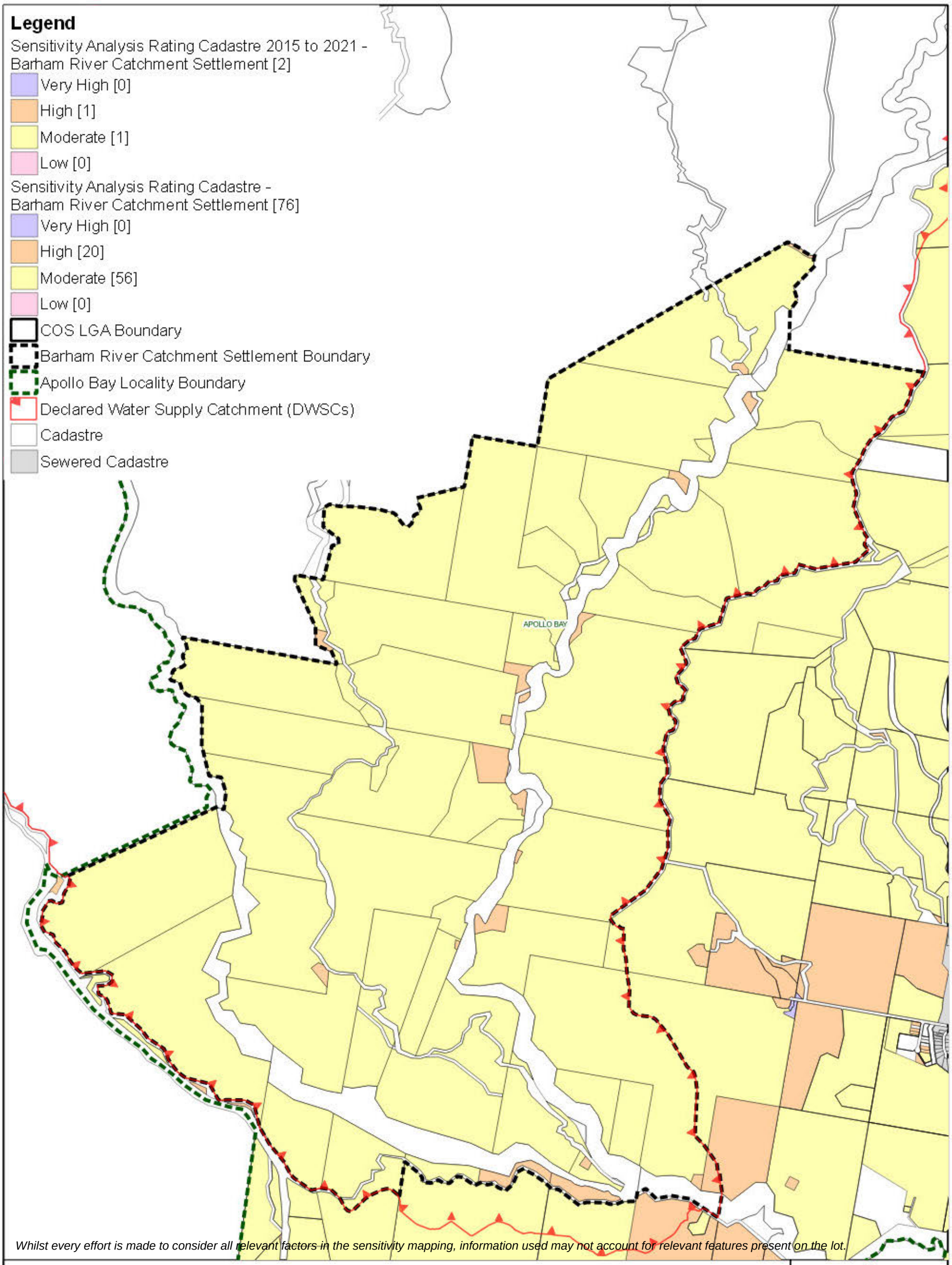
Characteristic	Description
Climate Zone	Zone 3.
Surface waterways & catchments	Approximately half of the broader Apollo Bay locality is within a DWSC. The entirety of the Barham River (‘Paradise’) Catchment settlement is located in the Barham River DWSC, which is the drinking water supply for connected properties in Apollo Bay. Barham River (east and west branches) is the major watercourse and has tributaries throughout the catchment.

Characteristic	Description
	Barham River confluences with the Southern Ocean between the settlements of Marengo and Apollo Bay.
Groundwater	Proximity to groundwater bores: primarily around semi-rural lots on the outskirts (west and northwest) of Apollo Bay settlement. No depth to groundwater data.
Land subject to inundation	Along the lower coastal creek reaches, particularly at the Barham River confluence with the Southern Ocean.
Useable lot area **Settlement (Locality)**	High: 16 (106) Moderate: 7 (22) Low: 54 (258) Compliant: 1 (6)
Minimum lot size compliance with Planning Scheme Zoning	The Barham River ('Paradise') Catchment settlement is primarily zoned Rural Conservation Zone and is located to the west and northwest of the Apollo Bay town, in the foot slopes of the Otway Ranges. Compliancy is variable throughout the broader Apollo Bay locality, with a greater density of non-compliant lots located to the south, west and north of the Apollo Bay settlement. Compliant: 21 (128) Non-compliant: 57 (264)
Slope **Settlement (Locality)**	High: 73 (285) (particularly around the Otway Ranges foot slopes) Moderate: 3 (41) Low: 2 (40)
Geology	Sedimentary Eumeralla Formation (early Cretaceous), fluvial braided stream deposits, unnamed Quaternary sedimentary (non-marine) colluvium and gully alluvium, and alluvial floodplain deposits. It differs along the coastline near the town of Apollo Bay.
Soil suitability **Settlement (Locality)**	High: 1 (139) Moderate: 77 (253) Low: 0 (0) Northern region/hinterland region consists of soil landscape unit '61' (moderate rating) which forms in the deeply dissected hills of the Otway Ranges and consists of brown gradational soils to 1.2m depth. The soils consist of moderately structured silty loam over clay loam. Limitations include restricted drainage and very acidic soil.

Characteristic	Description
	The western region of the Apollo Bay locality and extending northeast along the coastline towards Skenes Creek consists of soil landscape unit '64' (moderate rating) which forms in the similar landscape as detailed in '61'. It consists of brown texture contrast soils to 0.9m depth. The soils consist of weakly structured clay sand over strongly structured clay loam. The northern half of the Apollo Bay locality consists of soil landscape unit '62' (high rating) which forms in the alluvium, alluvial terraces, floodplains and coastal plains of the Sedimentary Western Plains and elevated longitudinal coastal dunes at Cape Otway and consists of red-yellow calcareous sand soils to 1.9m depth. The soils consist of apedal loamy sand over weakly structured sandy clay. Limitations include low fertility and coarse fragments. The southern half of the Apollo Bay locality consists of soil landscape unit '91' (high rating) which forms in the deeply dissected and uplifted plains with coastal cliffs and consists of grey sand soils with hardpans to more than 2m depth. The soils consist of weakly structured loamy sand over apedal sand. Limitations include low fertility and coarse fragments. There is a small region in the southwest of the locality that consists of medium clay deep grey gradational soils.
Sensitivity Overlay	No depth to groundwater data Landslip: extensive within the eastern (coastal) section of locality, significant in the foot slopes of the Otway Ranges. Vegetation: Great Otway National Park in the northwest.
Sensitivity Analysis Rating **Settlement (Locality)**	Very High: 0 (12) High: 21 (146) Moderate: 57 (234) Low: 0 (0)

5b. Sensitivity Analysis (Maps)


Legend
Sensitivity Analysis Rating Cadastre 2015 to 2021 - Barham River Cadastre [83]
Very High [8]
High [66]
Moderate [9]
Low [0]
Sensitivity Analysis Rating Cadastre - Barham River Locality [309]
Very High [4]
High [80]
Moderate [225]
Low [0]
COS LGA Boundary
Apollo Bay Locality Boundary
Declared Water Supply Catchment (DWSCs)
Cadastre
Sewered Cadastre
APOLLO BAY
Figure b1: Sensitivity Analysis - Apollo Bay Locality
Colac Otway Shire DWMP Review
Whitehead & Associates
Environmental Consultants
0 1 2 3 4 5 km
(Approx Scale)
N
Revision 4
Drawn JK
Approved MS


Legend
Sensitivity Analysis Rating Cadastre 2015 to 2021 - Barham River Catchment Settlement [2]
Very High [0]
High [1]
Moderate [1]
Low [0]
Sensitivity Analysis Rating Cadastre - Barham River Catchment Settlement [76]
Very High [0]
High [20]
Moderate [56]
Low [0]
COS LGA Boundary
Barham River Catchment Settlement Boundary
Apollo Bay Locality Boundary
Declared Water Supply Catchment (DWSCs)
Cadastre
Sewered Cadastre
APOLLO BAY
Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.
Figure b2: Sensitivity Analysis - Barham River Catchment Settlement
Colac Otway Shire DWMP Review
Whitehead & Associates Environmental Consultants
0 500 1,000 1,500 2,000 2,500 m
(Approx Scale)
N
Revision 5
Drawn JK
Approved MS

6b. System Selection

Due to the dominance of heavy-textured soils in the Barham River Catchment settlement, conventional absorption trenches and beds are not likely to be feasible and are discouraged. Appendix A of the EPA Code of Practice (2013) prohibits LPED systems on Category 5 and 6 soils (medium to heavy clays).

The wet climate of the Barham River Catchment settlement makes it a higher risk for DWM and site-specific, detailed design will be required for unsewered lots in this area. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained lots.

EPA Code of Practice (2013) (Section 2.2.2) identifies secondary treatment standard (or better) followed by subsurface pressure-compensating irrigation as current best-practice in Victoria for substantially reducing the risk associated with unsewered development. Further, the Code describes a "Wick trench/bed" land application option that may be incorporated with secondary treatment for consideration on sites constrained by climate or lot 'useable area', particularly within the DWSCs. Any variation from this best-practice approach must be provided with detailed supporting information to demonstrate suitability.

The Sizing Tables (discussed below) are not applicable for the Barham River Catchment settlement.

7b. System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA (2014). 70th percentile monthly rainfall exceeds average monthly evapotranspiration in eight months of the year in the Barham River area. As a result, there is a month-to-month surplus of hydraulic inputs and subsequently the monthly water balance does not resolve itself and cannot produce meaningful results for land application area sizing.

Site-specific detailed design is required for the Barham River Catchment settlement.

8b. General Conclusion

The majority of the lots within the locality have been assigned a Moderate or High Sensitivity Rating to sustainable DWM. Predominantly, both Standard and Detailed LCAs will be required, with site-specific design a necessity due to the higher rainfall associated with this region. System Sizing Tables were not generated and a monthly water balance will need to be generated for system sizing for the Standard LCA. Particular attention needs to be directed towards ensuring that setbacks from surface waterways are maintained and that the systems selected are appropriate for steeper slopes with correct construction.

C. Barongarook Locality Report

1c. Introduction

Barongarook is located in the centre of COS approximately 9km south of Colac. The landform consists of dissected low hills and alluvial terraces abutting a stream on the northern foothills of the Otway Ranges. Notably, the entire settlement and surrounding locality is located within a DWSC, predominantly Barwon Downs Wellfield Intake DWSC and Gellibrand River DWSC in the southwest, as indicated by the surface water informative map, Appendix A.

Barongarook has two main settlement areas; a large one to the north and a smaller rural living settlement to the south. Barongarook locality has a population of approximately 434 residents (ABS Census, 2016). There are approximately 262 and 101 unsewered lots located within the Barongarook locality and settlements, respectively. There are 2 new lots with DWM systems within the locality from June 2015-2021. There are 130 DWM system permits that have been inspected to date by COS (including PTI and CTU). The current DWM permits and their associated treatment system and LAA method within the Barongarook locality are summarised as follows:

- 21 AWTS (5 subsurface irrigation, 4 drip irrigation, 1 irrigation and 10 unknown);
- 2 sand filters (1 subsurface irrigation and 1 drip irrigation);
- 1 secondary treatment system (1 unknown);
- 66 septic tanks (11 trenches, 1 subsurface irrigation and 54 unknown); and
- 40 unknown (12 trenches, 3 subsurface irrigation, 3 irrigation, and 22 unknown).

No field investigations were conducted in the Barongarook locality as part of the 2014 field assessments; however, soil investigations were conducted to confirm the soil type.

2c. Background Documentation

Refer to the following documents for additional detail regarding the locality:

- Barongarook Covenant Reserve Land Management Plan (February, 2012);
- COS Planning Scheme; and
- Rural Living Strategy (2011).

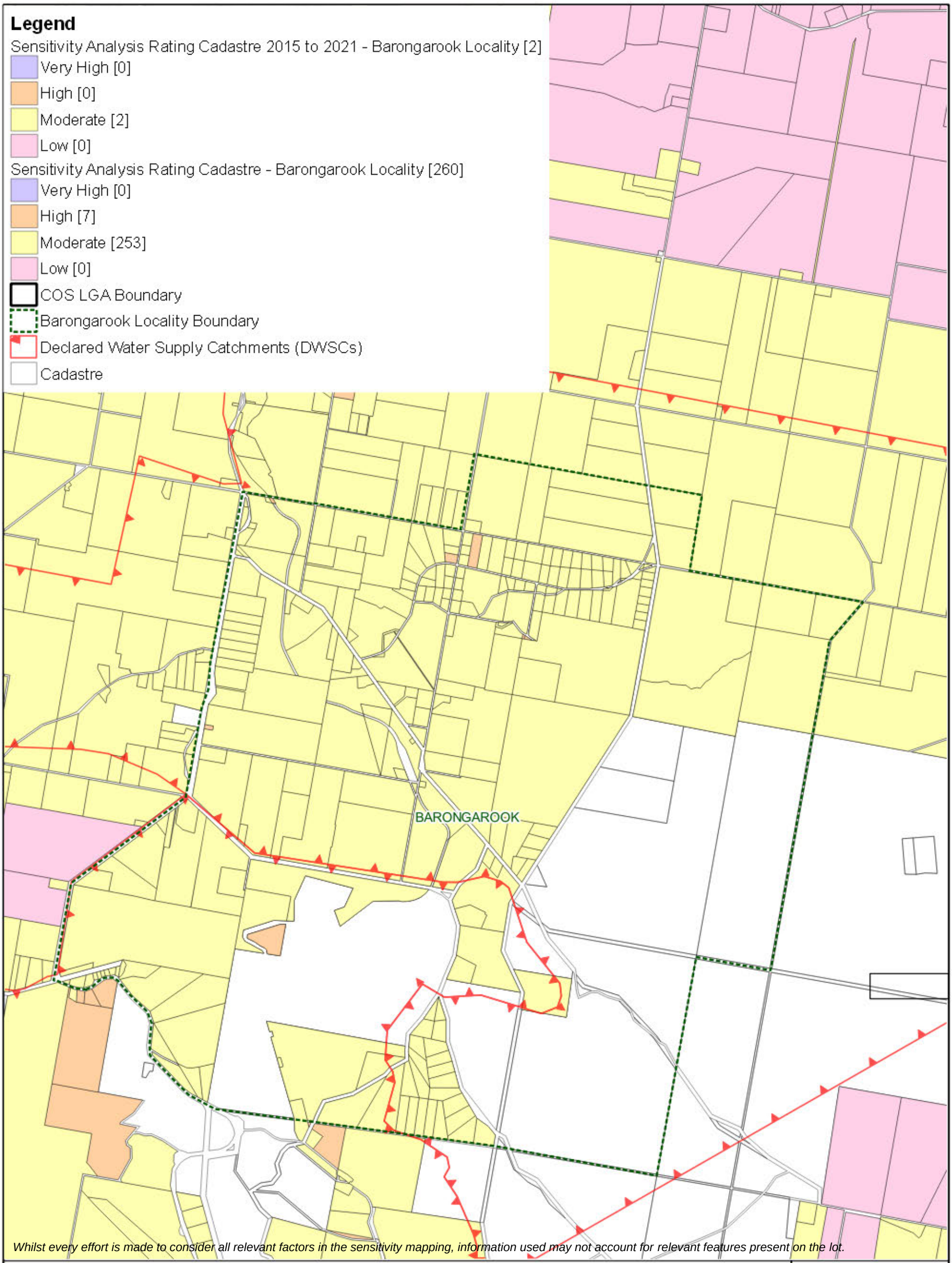
3c. Summary of Constraints to DWM

Characteristic	Description
Climate Zone	Zone 3.
Surface waterways & catchments	The locality is located entirely within the Barwon Downs Wellfield Intake (Geelong) DWSC and Gellibrand River DWSC in the south. Boundary Creek is located to the south of the settlement, traversing southwest-northeast. Ten Mile Creek and Dividing Creek are also located to the south of the settlement. Tributaries of the Barongarook Creek West Branch flow into the surrounding region from the north into the settlement.

Characteristic	Description
Groundwater	Proximity to groundwater bores: distributed throughout.
Land subject to inundation	Nil
Useable lot area **Settlement (Locality)**	High: 18 (26) Moderate: 6 (16) Low: 77 (213) Compliant: 0 (7)
Minimum lot size compliance with Planning Scheme Zoning	The locality is predominately in the Farming Zone with some Public Conservation and Resource Zone to the southeast. The settlements (one in the south and the other in the north) are zoned Rural Living. Lots are predominantly non-compliant, including both settlement areas. Compliant: 0 (12) Non-compliant: 101 (250)
Slope **Settlement (Locality)**	High: 1 (16) Moderate: 16 (48) Low: 84 (198)
Geology	Dilwyn Formation of the Wangeripp Group (Eocene age) which consists of shallow marine, coastal barrier and back beach lagoonal deposits. Intertwined with Demons Bluff formation of the Niranda Group which consists of shallow marine and minor lagoonal deposits, with some alluvial and fluvial deposits associated with the Eumeralla Formation.
Soil suitability **Settlement (Locality)**	High: 0 (0) Moderate: 101 (262) Low: 0 (0) Variable soil landscapes (four). The majority of the locality and southern region of the northern settlement area consists of soil landscape unit ‘88’ which forms along the rolling plains in the western part of the Barwon catchment and northern parts of the Gellibrand catchment and consists of grey sand soils to more than 2m depth. The soils consist of apedal sandy loam to sand over weakly structured sandy clay. Limitations include low fertility and coarse fragments. The northwest region of the locality consists of soil landscape unit ‘92’ (moderate rating) which forms in the undulating plain in the north part of the Gellibrand River Catchment and consist of mottled yellow and red

Characteristic	Description
	gradational soil to more than 2m depth. The soils consist of moderately structured sandy loam over light clay. Limitations include low fertility and low p-sorb. Around Bushbys Road in the northwest consists of soil landscape unit '93' (moderate rating) which forms in the gently undulating plain in the western parts of Barwon Catchment and consist of mottled gradational soil to more than 2m depth. The soils consist of weakly structured loam over moderately structured medium clay. Limitations include low fertility, p-sorb and coarse fragments. The southwest region of the locality consists of soil landscape unit '90' which forms on the rolling hills in the northern upper reaches of the Gellibrand catchment and consists of mottled gradational soil to more than 2m depth. The soil consists of apedal fine sandy loam over weakly structured silty clay loam. Limitations include low p-sorb, low fertility and restricted drainage.
Sensitivity Overlay	Depth to Groundwater Compliance: variable compliancy; predominantly compliant, except for the middle of the locality and a few lots in the northern settlement. Landslip: minimal. Vegetation: Otway Forest Park and Great Otway National Park to the south to southeast.
Sensitivity Analysis Rating **Settlement (Locality)**	Very High: 0 (0) High: 2 (7) Moderate: 99 (255) Low: 0 (0)

4c. Sensitivity Analysis (Maps)



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure c1: Sensitivity Analysis - Bargonarook Locality

Colac Otway Shire DWMP Review

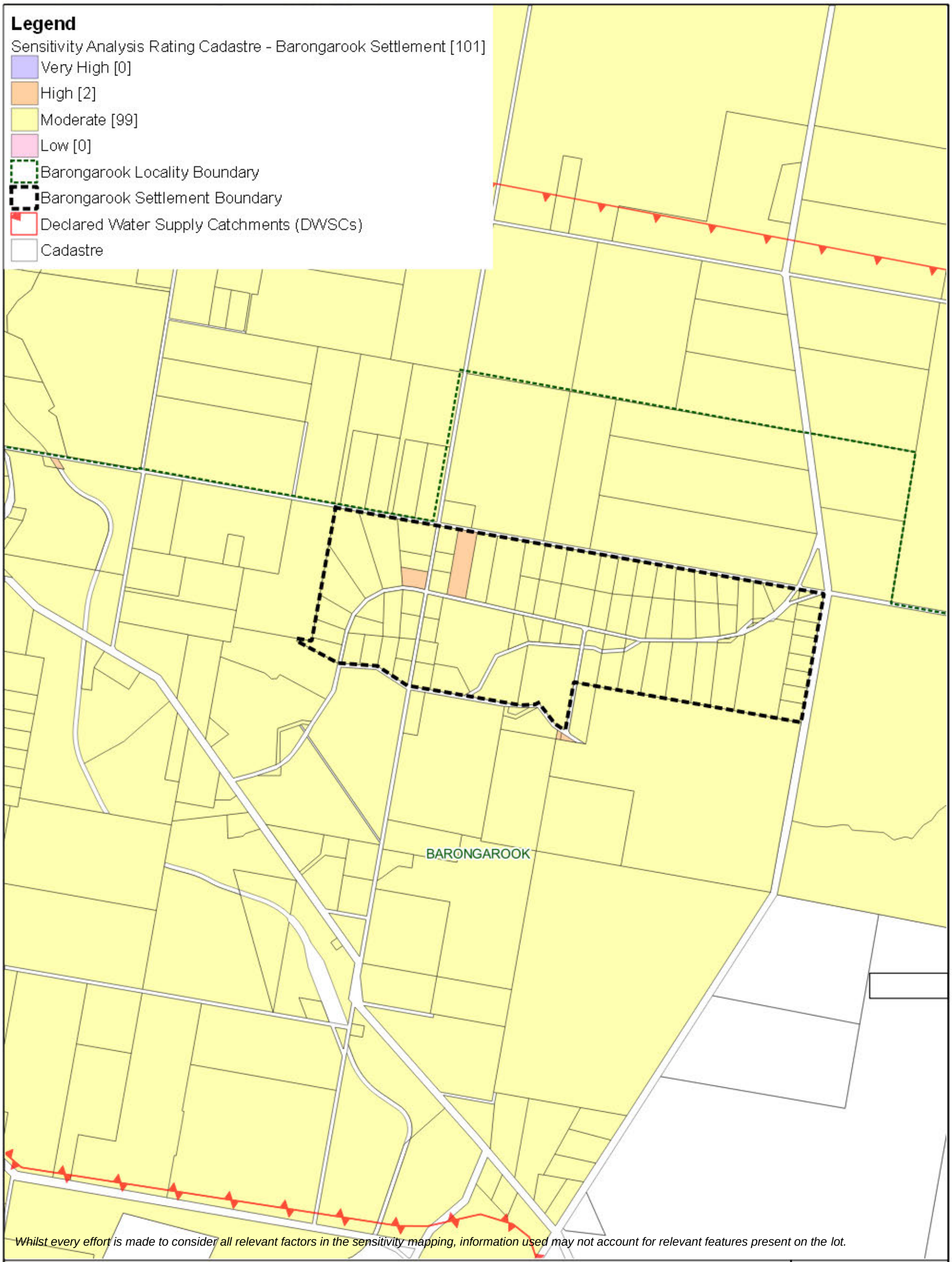
Whitehead & Associates Environmental Consultants

0 1 2 3 4 5 km

(Approx Scale)

N

Revision	4
Drawn	JK
Approved	MS


Legend
Sensitivity Analysis Rating Cadastre - Barongarook Settlement [101]
Very High [0]
High [2]
Moderate [99]
Low [0]
Barongarook Locality Boundary
Barongarook Settlement Boundary
Declared Water Supply Catchments (DWSCs)
Cadastre
BARONGAROOK
Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.
Figure c2: Sensitivity Analysis - Barongarook Settlement
Colac Otway Shire DWMP Review
Whitehead & Associates
Environmental Consultants
0 0.5 1 1.5 2 2.5 km
(Approx Scale)
N
Revision 4
Drawn JK
Approved MS

5c. System Selection

Due to the dominance of heavy-textured soils in the Barongarook locality, conventional absorption trenches and beds are not likely to be feasible and are discouraged. Appendix A of the EPA Code of Practice (2013) prohibits LPED systems on Category 5 and 6 soils (medium to heavy clays).

EPA Code of Practice (2013) (Section 2.2.2) identifies secondary treatment standard (or better) followed by subsurface pressure-compensating irrigation as current best-practice in Victoria for substantially reducing the risk associated with unsewered development. Further, the Code describes a "Wick trench/bed" land application option that may be incorporated with secondary treatment for consideration on sites constrained by climate or lot 'useable area', particularly within the DWSCs. Any variation from this best-practice approach must be provided with detailed supporting information to demonstrate suitability.

The System Sizing Tables (below) indicate which systems are likely to be the most appropriate for the locality.

6c. System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. Monthly 70th percentile rainfall and average evapotranspiration data for Barongarook was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

The Design Loading Rates (DLRs) and Design Irrigation Rates (DIRs) were taken from the current EPA Code of Practice. Where the Code of Practice has precluded use of a particular type of system on a certain soil type, it is shown as 'Not Applicable' for that soil type in the Sizing Tables. Where the evapotranspiration deficit requires unrealistically large land application areas for a particular system on a certain soil type, it is also shown as 'Not Applicable' for that soil type in the Sizing Tables. Detailed, site-specific LCAs and system designs would be required to further investigate the feasibility of systems deemed 'Not Applicable' in the sizing tables. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained lots.

Sizing Tables for Barongarook are provided below.

7c. General Conclusion

The lots within the locality have predominantly been assigned a Moderate Sensitivity to sustainable DWM, with some lots assigned a Low or High Sensitivity Rating. Predominantly, the Standard LCA will be required, with use of the System Sizing tables deemed appropriate. The Low Sensitivity Rating lots within a DWSC are required to complete a Standard LCA as per the current EPA Code of Practice's requirements. Particular attention needs to be directed towards assessing cumulative impact of DWM systems on the environment to ensure that the DWSCs are protected and that groundwater resources are preserved.

Barongarook

Drip and Spray Irrigation Systems* - Secondary Treated Effluent only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**		
	DIR (mm)	**5**	**5**	**4**	**3.5**	**3**	**2**		
Development Type	**Daily (L/day)**	**Total min. irrigation area required for zero wet weather effluent storage (m^2)†**					**N/A (Alternative Land Application System Required)**		
5 + bedroom residence	1,080	386		600	831	1,350			
4 bedroom residence	900	322		500	693	1,125			
1-3 bedroom residence	720	258		400	554	900			
Note: * irrigation system sizes are based on the assumption that the land application area is less than 10% slope. Reductions in DIR apply for slopes above 10% according to Table M2 of AS1547:2012									
† not including spacing and setbacks									

Conventional Absorption Trenches and Beds - Primary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Weak Loams & High/Mod Clay Loams (3 & 4)**	**Weak Clay Loams (4)**	**Light Clays (5)**	**Massive Clay Loams (4)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**Not supported (Alternative Land Application System Required)**							
Development Type	**Daily (L/day)**								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								

Evapotranspiration-Absorption Trenches and Beds - Primary Treated Effluent (Category 1 to 5) and Secondary Treated Effluent only (Category 6)									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3a)**	**Weak/Massive Loams (3b)**	**High/Mod Clay Loams (4a)**	**Weak Clay Loams (4b) & Strong Light Clays (5a)**	**Massive Clay Loams (4c) and Mod & Weak Light Clays (5b, 5c)**	**Medium to Heavy Clays (6) - Secondary Effluent Only**
	DLR (mm)	**20***	**20***	**15**	**10**	**12**	**8**	**5**	**5**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing & setbacks**							
5 + bedroom residence	1,080	62		87	145	115	199	441	
4 bedroom residence	900	52		73	121	96	166	368	
1-3 bedroom residence	720	42		58	97	77	133	294	
Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012									

LPED Irrigation Systems - Primary or Secondary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**		
	DIR (mm)	**N/A (Alternative Land Application System Required)**	**4**	**3.5**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**		
Development Type	**Daily (L/day)**		**Total min. basal or 'wetted area' (m^2)†**						
5 + bedroom residence	1,080		744	1,135					
4 bedroom residence	900		620	946					
1-3 bedroom residence	720		496	757					
† required for zero wet weather storage (m^2) not including spacing & setbacks									

Wick Trenches and Beds - Secondary Treated Effluent Only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2) Loams (3) & High/Mod Clay Loams (4a,b)**	**Weak Clay Loams (4)**	**Massive Clay Loams (4)**	**Strong Light Clays (5a)**	**Moderate Light Clays (5b)**	**Weak Light Clays (5c)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**25**	**30**	**20**	**10**	**12**	**8**	**8**	**5**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing & setbacks**							
5 + bedroom residence	1,080	49	40	62	145	115	199		441
4 bedroom residence	900	41	33	52	121	96	166		368
1-3 bedroom residence	720	33	27	42	97	77	133		294

D. Barwon Downs Locality Report

1d. Introduction

The Barwon Downs locality is located on the northern slopes of the Otway Ranges, with the town located on the northern foothills. The landform consists of dissected hills abutting rivers and streams, and alluvial terraces with relatively flat topography. The majority (approximately 80%) of the region is located within a DWSC, with the town located within the Upper Barwon DWSC. The region to the northeast of the town also falls within the Gosling Creek DWSC.

The locality has a population of approximately 131 residents (ABS Census, 2016). There are approximately 260 and 85 unsewered lots located within the Barwon Downs locality and town, respectively. There are 8 new lots with DWM systems within the locality from June 2015-2021. There are 72 DWM system permits that have been inspected to date by COS (including PTI and CTU). The current DWM permits and their associated treatment system and LAA method within the Barwon Downs region are summarised as follows:

- 11 AWTS (4 subsurface irrigation, 1 trench and 6 unknown);
- 1 composting toilet (1 unknown);
- 3 secondary treatment system (3 unknown);
- 10 sand filters (10 subsurface irrigation);
- 33 septic tank (6 trenches and 27 unknown);
- 5 worm farms (3 trenches and 2 unknown); and
- 9 unknown (3 trenches and 6 unknown).

2d. Background Documentation

Refer to the following documents for additional detail regarding the locality:

- Barwon Downs Township Master Plan Report (June, 2006);
- COS Planning Scheme; and
- Rural Living Strategy (2011).

3d. Site Assessment Results

The following table summarises the results from the representative audits conducted by Consultant staff in September 2014.

Characteristic	Description
Land use	Barwon Downs comprises a range of land uses, including dairy, forestry, rural living and tourism.
Occupancy rates	2.3 (Barwon Downs State Suburb, ABS Census, 2011).
Typical soils	Yellow mottled duplex soil with very deep (60 cm) silt loam grading to silty clay loam surface and subsurface over strongly mottled clay

Characteristic	Description
	subsoil; between 25-60 cm the subsurface was saturated (25 July 2014). Drainage is generally poor and permeability is generally low.
AS/NZS 1547:2012 soil categories	5 (Light Clays) and 6 (Medium to Heavy Clays)
Existing Systems	**Separate Blackwater and Greywater** Of the eight systems inspected during field investigations, seven systems (88%) comprised separate blackwater treatment in a septic tank or composting toilet, with direct greywater diversion to an adjacent paddock, street drain, trench or AWTS. Where discharged to paddocks or neighbouring vacant lots, greywater was typically ponded near the diversion outlet pipe, and often in areas trampled by livestock (cattle and sheep). The blackwater septic tanks were typically 40+ years old and the time since last pump-out was unknown for the majority (due to owners not being home to ascertain). Septic effluent discharged to one or more conventional absorption trenches (or was assumed to if trenches could not be identified). The trench dimensions were generally unclear, and it is likely that most trenches were undersized for the number of bedrooms. The majority of trenches or/and available LAAs were located on land of less than 4% slope and appeared to be parallel with contours. One greywater diversion system was pumped with a home-made pump-well, with moveable sprinklers around fruit trees. The AWTS had not been serviced since installation approximately 4 years ago and the sprinkler heads periodically become blocked. Setback distances from boundaries were inadequate for this system. **Combined Blackwater and Greywater** One of the eight systems (13%) inspected was assumed to have a combined wastewater treatment system, based on layout of pipework and age of dwelling. Septic effluent discharged to a series of conventional absorption trenches which appeared to be working well and were adequately sized.

4d. Summary of Constraints to DWM

Characteristic	Description
Climate Zone	Majority within Zone 3.
Surface waterways & catchments	The locality consists of an extensive drainage network. It is located within the DWSCs of Upper Barwon, Gosling Creek and a small part of Matthew Creek in the northeast. The locality is predominantly located within a DWSC, except for approximately 1km north of the most northern extent of the town. The major waterways include: Denn Creek

Characteristic	Description
	to the east of the town, Callahan Creek North and South Branches and Barwon River East Branch to the west and south of the town, Dewing Creek, Seymour Creek, Kind Creek, and Mackie Creek.
Groundwater	Proximity to groundwater bores: primarily located around the town and north-western region of the locality.
Land subject to inundation	Along Barwon River East Branch and Callahan Creek.
Useable lot area **Town (Locality)**	High: 43 (77) Moderate: 23 (28) Low: 19 (148) Compliant: 0 (7)
Minimum lot size compliance with Planning Scheme Zoning	The locality is predominantly zoned Farming Zone to the north and Public Conservation and Resource Zone to the south. The town is zoned as Township Zone. Compliancy is variable throughout the locality, with the town predominantly compliant. Compliant: 80 (110) Non-compliant: 5 (150)
Slope **Town (Locality)**	High: 0 (49) (in southern region) Moderate: 1 (22) Low: 84 (189)
Geology	Eumeralla Formation of the Otway Group is predominant in the east, intertwined with the Dilwyn Formation of the Wangeripp Group (Eocene age) which consists of shallow marine, coastal barrier and back beach lagoonal deposits. Intertwined with Demons Bluff formation of the Niranda Group which consists of shallow marine and minor lagoonal deposits, with some unnamed alluvium flood plain deposits along waterways. The northwest corner is underlain by Gellibrand Marl from the Heytesbury Group continental shelf deposit.
Soil suitability	High: 0 (19) Moderate: 85 (241) Low: 0 (0) Variable soil throughout the locality (7 different units); however, it is noted that the locality is spatially expansive.

Characteristic	Description
	The town consists of soil landscape units '78' and '73' which form on the undulating plain inland of Otway Range and steep rolling hills on the northern periphery of the Otway Range and consists of texture contrast soils with ironstone to 2m depth. The soils consist of weakly structured sandy loam over strongly structured medium to heavy clay. Limitations include low fertility, low p-sorb, sodic, dispersive, restricted drainage and coarse fragments. The central west region consists of soil landscape unit '76' which form on the undulating plains and consist of grey sand soils to more than 2m depth. The soils consist of weakly structured loamy sand over apedal sand. Limitations include low fertility. The northeast to southwest transversing region consists of soil landscape unit '63' which forms on deeply dissected hills of the Otway Ranges and consists of brown texture contrast soils to 0.9m depth. The soils consist of weakly structured loam over strongly structured heavy clay. Limitations include sodicity and very acidic. The southern region consists of soil landscape unit '61' which also form on the deeply dissected hills of the Otway Ranges and consist of brown gradational soils to 1.2m depth. The soils consist of moderately structured silty loam over clay loam. Limitations include acidity and restricted drainage. The regions adjacent to the river consist of soil landscape unit '95' which forms on the alluvial floodplain of the Barwon River and its tributaries with numerous cut-off meanders. The soil consists of a moderately structured fine sandy clay loam over medium clay to more than 2m depth. Limitations include restricted drainage and dispersive.
Sensitivity Overlay	Depth to Groundwater Compliance: predominantly compliant, except to the north and west of the town along Barwon River East Branch. Landslip: some to the south Vegetation: Great Otway National, Otway Forest Park, and Barwon Downs bushland reserve.
Sensitivity Analysis Rating **Town (Locality)**	Very High: 0 (1) High: 24 (57) Moderate: 61 (201) Low: 0 (1)

5d. Sensitivity Analysis (Maps)

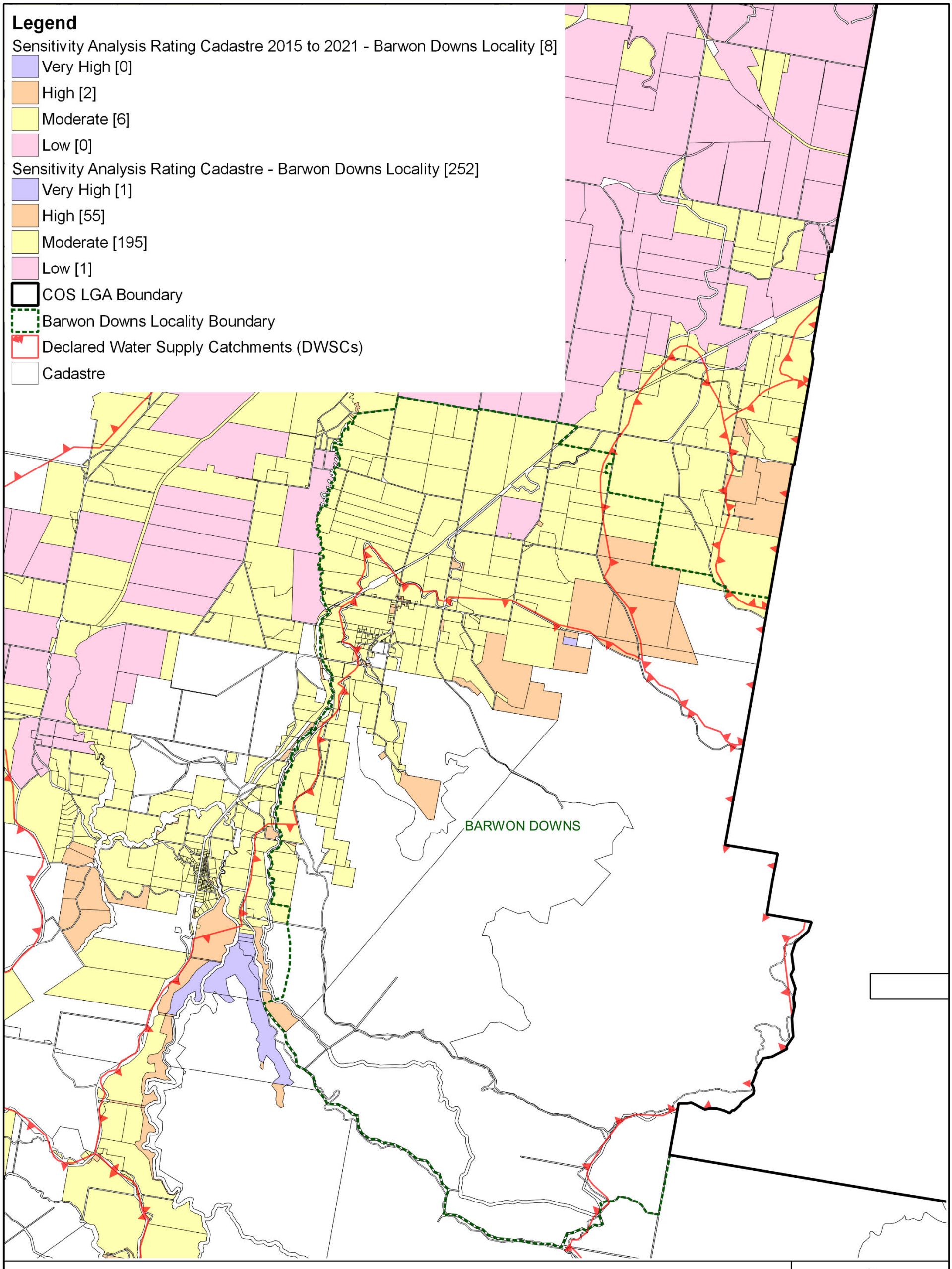


Figure d1: Sensitivity Analysis - Barwon Downs Locality

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

Revision	4
Drawn	JK
Approved	MS

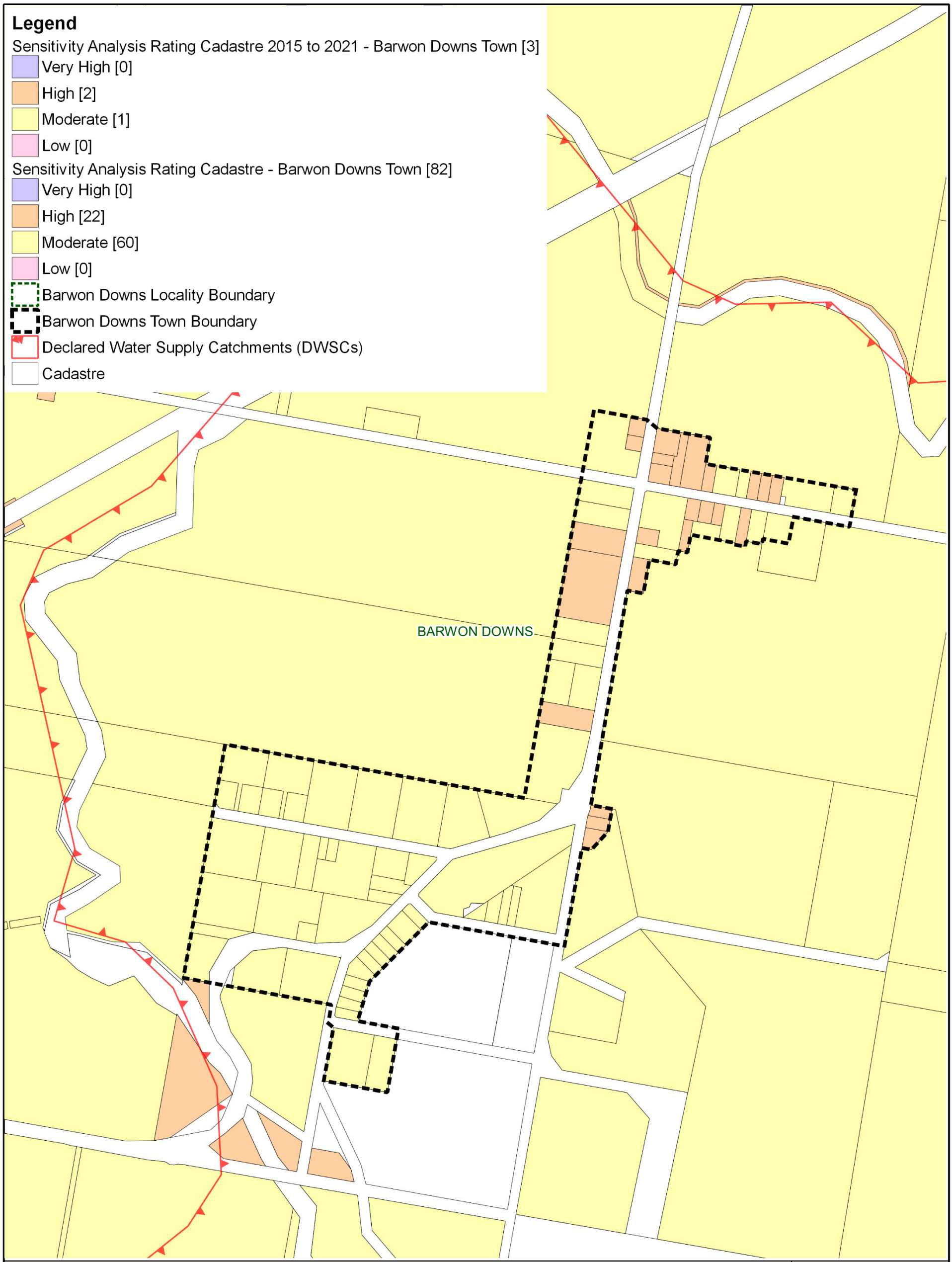


Figure d2: Sensitivity Assessment - Barwon Downs Town

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 150 300 450 600 750 m

(Approx Scale)

N

Revision	4
Drawn	JK
Approved	MS

6d. System Selection

Due to the dominance of heavy-textured soils in the Barwon Downs locality, conventional absorption trenches and beds are not likely to be feasible and are discouraged. Appendix A of the EPA Code of Practice (2013) prohibits LPED systems on Category 5 and 6 soils (medium to heavy clays). Current best-practice is for effluent to be treated to a secondary standard or better, particularly within the DWSCs. Any variations to this must be provided with detailed evidence and explanations to demonstrate its suitability.

The System Sizing Tables (below) indicate which systems are likely to be the most appropriate for the locality.

7d. System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. Monthly 70th percentile rainfall and average evapotranspiration data for Barwon Downs was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

The Design Loading Rates (DLRs) and Design Irrigation Rates (DIRs) were taken from the current EPA Code of Practice. Where the Code of Practice has precluded use of a particular type of system on a certain soil type, it is shown as 'Not Applicable' for that soil type in the Sizing Tables. Where the evapotranspiration deficit requires unrealistically large land application areas for a particular system on a certain soil type, it is also shown as 'Not Applicable' for that soil type in the Sizing Tables. Detailed, site-specific LCAs and system designs would be required to further investigate the feasibility of systems deemed 'Not Applicable' in the sizing tables. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained lots.

Sizing Tables for the Barwon Downs locality are provided below.

8d. General Conclusion

The lots within Barwon Downs, including the entire town, have predominantly been assigned a Moderate Sensitivity Rating to sustainable DWM. Predominantly, Standard LCAs will be required, with the use of System Sizing Tables deemed appropriate. The Low Sensitivity Rating lots within a DWSC are required to complete a Standard LCA as per the current EPA Code of Practice's requirements. Particular attention needs to be directed towards ensuring that the soil stability and appropriate setbacks to surface waterways and groundwater bores are maintained.

Barwon Downs

Drip and Spray Irrigation Systems* - Secondary Treated Effluent only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**		
	DIR (mm)	**5**	**5**	**4**	**3.5**	**3**	**2**		
Development Type	**Daily (L/day)**	**Total min. irrigation area required for zero wet weather effluent storage (m^2) not including spacing or setbacks**							
5 + bedroom residence	1,080	419		684	1,000	1,863	2,556		
4 bedroom residence	900	349		570	834	1,552	2,130		
1-3 bedroom residence	720	280		456	667	1,242	1,704		
Note: * irrigation system sizes are based on the assumption that the land application area is less than 10% slope. Reductions in DIR apply for slopes above 10% according to Table M2 of AS1547:2012									

Conventional Absorption Trenches and Beds - Primary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Weak Loams & High/Mod Clay Loams (3 & 4)**	**Weak Clay Loams (4)**	**Light Clays (5)**	**Massive Clay Loams (4)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**Not supported (Alternative Land Application System Required)**							
Development Type	**Daily (L/day)**								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								

Evapotranspiration-Absorption Trenches and Beds - Primary Treated Effluent (Category 1 to 5) and Secondary Treated Effluent only (Category 6)									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3a)**	**Weak/Massive Loams (3b)**	**High/Mod Clay Loams (4a)**	**Weak Clay Loams (4b) & Strong Light Clays (5a)**	**Massive Clay Loams (4c) and Mod & Weak Light Clays (5b, 5c)**	**Medium to Heavy Clays (6) - Secondary Effluent Only**
	DLR (mm)	**20***	**20***	**15**	**10**	**12**	**8**	**5**	**5**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing or setbacks**							
5 + bedroom residence	1,080	63		89	150	118	208	488	
4 bedroom residence	900	53		74	125	98	173	407	
1-3 bedroom residence	720	42		59	100	79	139	326	
Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012									

LPED Irrigation Systems - Primary or Secondary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**		
	DIR (mm)	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**		
Development Type	**Daily (L/day)**								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								
† required for zero wet weather storage (m^2) not including spacing or setbacks									

Wick Trenches and Beds - Secondary Treated Effluent Only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2) Loams (3) & High/Mod Clay Loams (4a,b)**	**Weak Clay Loams (4)**	**Massive Clay Loams (4)**	**Strong Light Clays (5a)**	**Moderate Light Clays (5b)**	**Weak Light Clays (5c)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**25**	**30**	**20**	**10**	**12**	**8**	**8**	**N/A (Alternative Land Application System Required)**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted area' required for zero wet weather storage (m2) not including spacing or setbacks**							
5 + bedroom residence	1,080	49	40	63	150	118	208		
4 bedroom residence	900	41	34	53	125	98	173		
1-3 bedroom residence	720	33	27	42	100	79	139		

E. Beeac Locality Report

1e. Introduction

Beeac is a rural town located on the northern side of Lake Beeac, approximately 19km north of Colac. The landform features undulating agricultural land on the Western Volcanic Plains.

The locality has an estimated permanent population of approximately 370 residents (ABS Census, 2016). There are approximately 642 and 256 unsewered lots located within the Beeac locality and town, respectively. There are 14 new lots with DWM systems within the locality from June 2015-2021.There are 99 DWM system permits that have been inspected to date by COS (including PTI and CTU). The current DWM permits and their associated treatment system and LAA method within the Beeac locality are summarised as follows:

- 25 AWTS (3 subsurface, 1 trench, 5 drip irrigation, 16 unknown);
- 3 sand filters (1 subsurface irrigation and 2 unknown);
- 47 septic tanks (11 trenches, 1 irrigation and 35 unknown); and
- 24 unknown (6 trenches, 1 subsurface irrigation, and 17 unknown).

No field investigations were conducted within Beeac locality as part of the 2014 field assessments; however, soil investigations were conducted to confirm the soil type. There have been noted issues with the earthen stormwater drains; particularly with regards to odour and amenity with standing water which could also contain wastewater in the form of greywater or combined wastewater. These earthen stormwater drains flow into Lake Beeac.

2e. Background Documentation

Refer to the following documents for additional detail regarding the locality:

- Urban Design Framework Plans for Beeac (2006/2007);
- Lake Beeac Catchment Plan (1998);
- Beeac Cemetery and Grasslands Land Management Plan (February, 2012);
- Colac Otway Domestic Wastewater Management Plan (2007);
- COS Planning Scheme; and
- Rural Living Strategy (2011).

3e. Summary of Constraints to DWM

Characteristic	Description
Climate Zone	Zone 2.
Surface waterways & catchments	The locality has an extensive coverage of lakes, with Lake Beeac forming the largest waterbody to the southwest of the town. Other waterbodies include: Lake Cunadare to the northwest, Thomas Lake, Cemetery Lake, Butchers Lake, Calvert Lough and constructed drainage network to the east of the town.

Characteristic	Description
Groundwater	Proximity to groundwater bores: primarily located within the western half of the locality. Groundwater is seasonally high at some sites but depth hasn't been ascertained.
Land subject to inundation	Extensive, particularly to the east of the town and around Lake Beeac.
Useable Lot Area **Town (Locality)**	High: 187 (242) Moderate: 60 (83) Low: 9 (303) Compliant: 0 (14)
Minimum lot size compliance with Planning Scheme Zoning	The locality is predominantly zoned Farming Zone, with some land around the lakes in the Public Conservation and Resource Zone. The town is zoned as Township Zone. Compliancy is variable throughout the locality; the Farming Zoned lots are generally non-compliant to the east of the town and the town is compliant. Compliant: 249 (268) Non-compliant: 7 (374)
Slope **Town (Locality)**	High: 0 (0) Moderate: 0 (0) Low: 256 (642)
Geology	Beeac is underlain by unnamed stony rises and hummocky lava flows of Newer Volcanic Group and unnamed non-marine sediments comprising swamp, lake deposits of clay, silt, sand and humic soil that is moderately sorted and unconsolidated. Northeast section has hills with gentle crests and flat plains located on lunette, lake and beach deposits of clay, quartz sand, coxiella shells and minor swamp deposits.
Soil suitability **Town (Locality)**	Soil has moderate to poor drainage and consists predominantly of shallow silty loam or sandy grey silt topsoil, followed by moist dark grey to brown silty clay, over moist grey or grey/yellow clay. Soil permeability 0.08-0.06m/day High: 256 (605) Moderate: 0 (37) Low: 0 (0)

Characteristic	Description
	The town and majority of the locality consists of soil landscape unit '148' which forms on the gently undulating plains with low rises and lunettes, swamps and lakes and consists of texture contrast soils to less than 2m depth. The soil consists of strongly structured medium clay over heavy clay. Limitations include restricted drainage, dispersive, very acidic, coarse fragments and sodic. Surrounding soil landscape '148' and to the east consists of soil landscape unit '153' which forms on gently undulating plains with swamps, lunettes and lakes and consists of textured contrast soils to less than 2m depth. The soils consist of strongly structured fine sandy clay loam over light to heavy clay. Limitations include restricted drainage, dispersive, very acidic, sodic and coarse fragments. The land to the west of the town consists of soil landscape unit '114' which forms on undulating basalt plains and stony rises. The soil consists of strongly structured clay loam to medium clay to less than 1.5m depth. Limitations include restricted drainage and coarse fragments.
Sensitivity Overlay	Depth to Groundwater Compliance: all compliant. Landslip: Nil. Vegetation: Lake Beeac to the south/southwest of town is an internationally important habitat for waterbirds, Lough Calvert Drainage Scheme (central), Lake Cundare, Cockatoo and Cemetery to the north of Lake Beeac.
Sensitivity Analysis Rating **Town (Locality)**	Very High: 0 (0) High: 187 (241) Moderate: 69 (355) Low: 0 (46)

4e. Sensitivity Analysis (Maps)

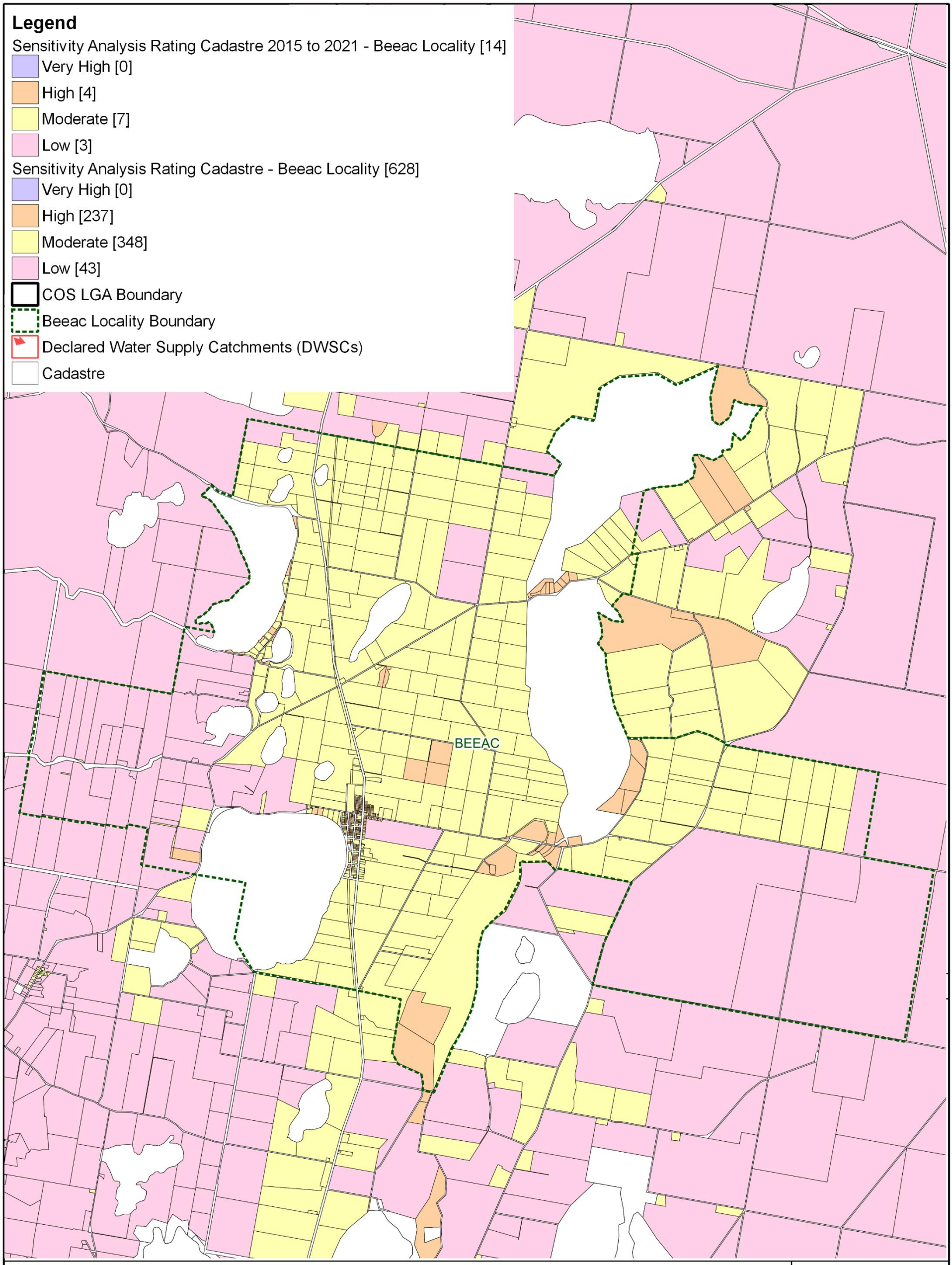


Figure e1: Sensitivity Analysis - Beeac Locality

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

Revision	4
Drawn	JK
Approved	MS

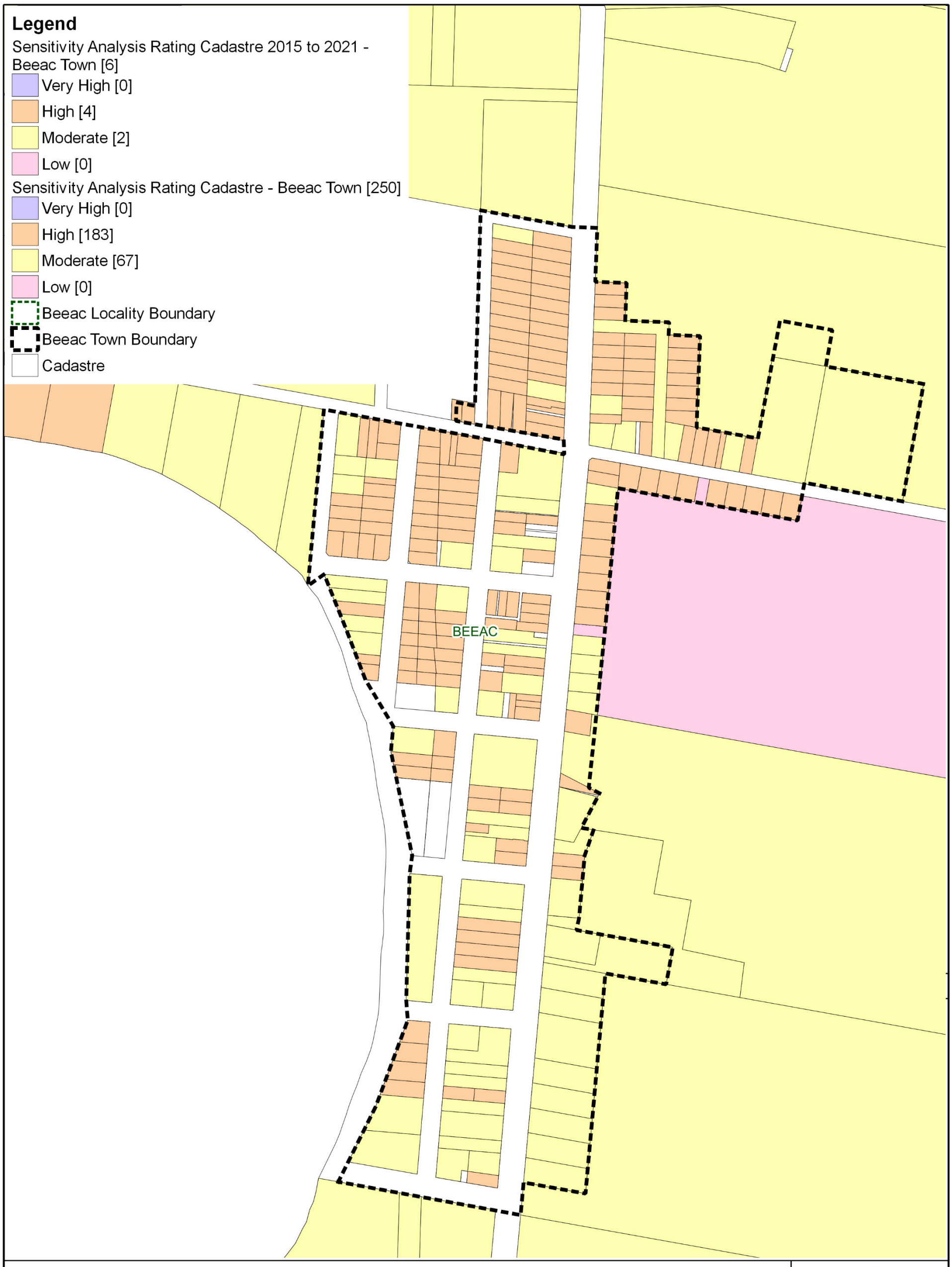


Figure e2: Sensitivity Analysis - Beeac Town

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 150 300 450 600 750 m

(Approx Scale)

N

Revision	4
Drawn	JK
Approved	MS

5e. System Selection

Due to the dominance of heavy-textured soils in the Beeac locality, conventional absorption trenches and beds are not likely to be feasible and are discouraged. Appendix A of the EPA Code of Practice (2013) prohibits LPED systems on Category 5 and 6 soils (medium to heavy clays). The System Sizing Tables (below) indicate which systems are likely to be the most appropriate for the locality.

6e. System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. The water balances used monthly 70th percentile rainfall and average evapotranspiration data for Alvie, as it was compared with that of Beeac and found to be very similar, with very little size differences in water balance results. The climate data for Alvie was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

The Design Loading Rates (DLRs) and Design Irrigation Rates (DIRs) were taken from the current EPA Code of Practice. Where the Code of Practice has precluded use of a particular type of system on a certain soil type, it is shown as 'Not Applicable' for that soil type in the Sizing Tables. Where the evapotranspiration deficit requires unrealistically large land application areas for a particular system on a certain soil type, it is also shown as 'Not Applicable' for that soil type in the Sizing Tables. Detailed, site-specific LCAs and system designs would be required to further investigate the feasibility of systems deemed 'Not Applicable' in the sizing tables. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained lots.

Sizing Tables for the Beeac locality are provided below.

7e. General Conclusion

The Sensitivity Rating with regards to sustainable DWM varied throughout the Beeac locality. Council, Standard and Detailed LCAs will be required, with the use of the Sizing Tables deemed appropriate except for the Detailed LCA which requires site-specific design. Particular attention needs to be directed towards ensuring that systems are sized based on the most limiting soil horizon, that the amenity of the Lakes is maintained, that the minimum depth from the base of the land application area and the watertable are maintained, and that DWM system components and land application areas are constructed above the COS Planning Schemes land subject to inundation overlay.

Alvie and Beeac

Drip and Spray Irrigation Systems* - Secondary Treated Effluent only

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3)	Clay Loams (4)	Light Clays (5)	Medium to Heavy Clays (6)		
	DIR (mm)	5	5	4	3.5	3	2		
Development Type	Daily (L/day)	Total min. irrigation area required for zero wet weather effluent storage (m^2) not including spacing and setbacks							
5 + bedroom residence	1,080	268		356	426	530	1,039		
4 bedroom residence	900	223		297	355	442	866		
1-3 bedroom residence	720	127		237	284	353	693		

Note: * irrigation system sizes are based on the assumption that the land application area is less than 10% slope. Reductions in DIR apply for slopes above 10% according to Table M2 of AS1547:2012

Conventional Absorption Trenches and Beds - Primary or Secondary Treated Effluent

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3)	Weak Loams & High/Mod Clay Loams (3 & 4)	Weak Clay Loams (4)	Massive Clay Loams (4)	Light Clays (5)	Medium to Heavy Clays (6)
	DLR (mm)	Not supported (Alternative Land Application System Required)							
Development Type	Daily (L/day)								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								

Evapotranspiration-Absorption Trenches and Beds - Primary or Secondary Treated Effluent (Category 1 to 5) and Secondary Treated Effluent only (Category 6)

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3a)	Weak/Massive Loams (3b)	High/Mod Clay Loams (4a)	Weak Clay Loams (4b) & Strong Light Clays (5a)	Massive Clay Loams (4c) and Mod & Weak Light Clays (5b, 5c)	Medium to Heavy Clays (6) - Secondary Effluent Only
	DLR (mm)	20*	20*	15	10	12	8	5	5
Development Type	Daily (L/day)	Total min. basal or 'wetted' area required for zero wet weather effluent storage (m^2) not including spacing and setbacks							
5 + bedroom residence	1,080	58		78	123	100	128	281	
4 bedroom residence	900	48		65	102	83	132	234	
1-3 bedroom residence	720	39		52	82	67	106	188	

Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012

LPED Irrigation Systems - Primary or Secondary Treated Effluent

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3)	Clay Loams (4)	Light Clays (5)	Medium to Heavy Clays (6)		
	DIR (mm)	N/A (Alternative Land Application System Required)	4	3.5	3	N/A (Alternative Land Application System Required)	N/A (Alternative Land Application System Required)		
Development Type	Daily (L/day)		Total min. basal or 'wetted' area required (m^2)†						
5 + bedroom residence	1,080		379	460	584				
4 bedroom residence	900		316	383	487				
1-3 bedroom residence	720		253	307	390				

† required for zero wet weather storage (m^2) not including spacing & setbacks

Wick Trenches and Beds - Secondary Treated Effluent Only

	Soil Category	Gravels & Sands (1)	Sandy Loams (2) Loams (3) & High/Mod Clay Loams (4a,b)	Weak Clay Loams (4)	Massive Clay Loams (4)	Strong Light Clays (5a)	Moderate Light Clays (5b)	Weak Light Clays (5c)	Medium to Heavy Clays (6)
	DLR (mm)	25	30	20	10	12	8	8	5
Development Type	Daily (L/day)	Total min. basal or 'wetted' area required for zero wet weather effluent storage (m^2) not including spacing and setbacks							
5 + bedroom residence	1,080	46	38	58	123	100	128		281
4 bedroom residence	900	38	32	48	102	83	132		234
1-3 bedroom residence	720	31	25	39	82	67	106		188

F. Beech Forest Locality Report

1f. Introduction

Beech Forest is located approximately 43km south of Colac on the northern edge of the Otway Ranges. The landform consists of rolling hills and crests of the Otway Ranges. Approximately half of the locality is located within a DWSC; with the northern region located within Gellibrand River DWSC and the southeast region located within Barham River DWSC. The main road through the town runs along a ridgeline that forms the DWSC boundary as indicated by the surface water informative map A1, Appendix A.

The locality has an estimated permanent population of approximately 82 residents (ABS Census, 2016). There are approximately 332 and 142 unsewered lots located within the Beech Forest locality and town, respectively. There are 3 new lots with DWM systems within the locality from June 2015-2021. There are 41 DWM system permits that have been inspected to date by COS (including PTI and CTU). The current DWM permits and their associated treatment system and LAA method within the Beech Forest locality are summarised as follows:

- 14 AWTS (1 irrigation, 3 drip irrigation, 2 trenches, and 8 unknown);
- 1 sand filter (1 drip irrigation);
- 12 septic tanks (4 trenches, 8 unknown);
- 1 worm farm (1 trench); and
- 13 unknown (6 trenches, 1 subsurface irrigation and 6 unknown).

2f. Background Documentation

Refer to the following documents for additional detail regarding the locality:

- Beech Forest Township Master Plan Report (May, 2004);
- COS Planning Scheme; and
- Rural Living Strategy (2011).

3f. Site Assessment Results

The following table summarises the results from the representative audits conducted by Consultant staff in September 2014.

Characteristic	Description
Land use	Beech Forest comprises a range of land uses, including dairy, forestry, rural living and tourism.
Occupancy rates	2.3 (Beech Forest State Suburb, ABS Census, 2011).
Typical soils	Gradational profile of dark grey brown sandy clay loam grading to dark brown silty clay loam between 10-25cm, grading to dark brown to dark reddish brown sandy clay loam with excellent structure and fairly common small rock fragments. Drainage and permeability are variable depending on slope and position.

Characteristic	Description
AS/NZS 1547:2012 soil categories	4 (Clay Loams) and 5 (Light Clays)
Existing Systems	**Separate Blackwater and Greywater** Of the six systems inspected during field investigations, just one (17%) comprised separate blackwater treatment in a septic tank, with direct greywater diversion to the ground surface within the lot boundary. The blackwater septic tank was 40+ years old and had been pumped out more than 15 years ago. Septic effluent discharged to one conventional absorption trench of approximately 3m length, on land of less than 4% slope and parallel with contours. There was no evidence of blackwater effluent surcharging to the surface. Soils were typically soft or boggy, mainly due to recent high rainfall. **Combined Blackwater and Greywater** Five of the six systems (83%) inspected had combined wastewater treatment systems or were assumed to have combined systems, based on layout of pipework and/or age of dwelling. One of these five systems is an Aerated Wastewater Treatment System (AWTS), for a commercial property. It is likely that the proportion of combined systems in Beech Forest is likely to be less than this; however, this should be confirmed by ongoing inspections by Council. Septic tank effluent discharged to one or more conventional absorption trenches, or was assumed to when the LAA could not be identified. Generally, trenches were undersized for the number of bedrooms or there was inadequate suitable space for an appropriately sized LAA. The AWTS effluent discharged to a subsurface irrigation system of approximately 480m^2.

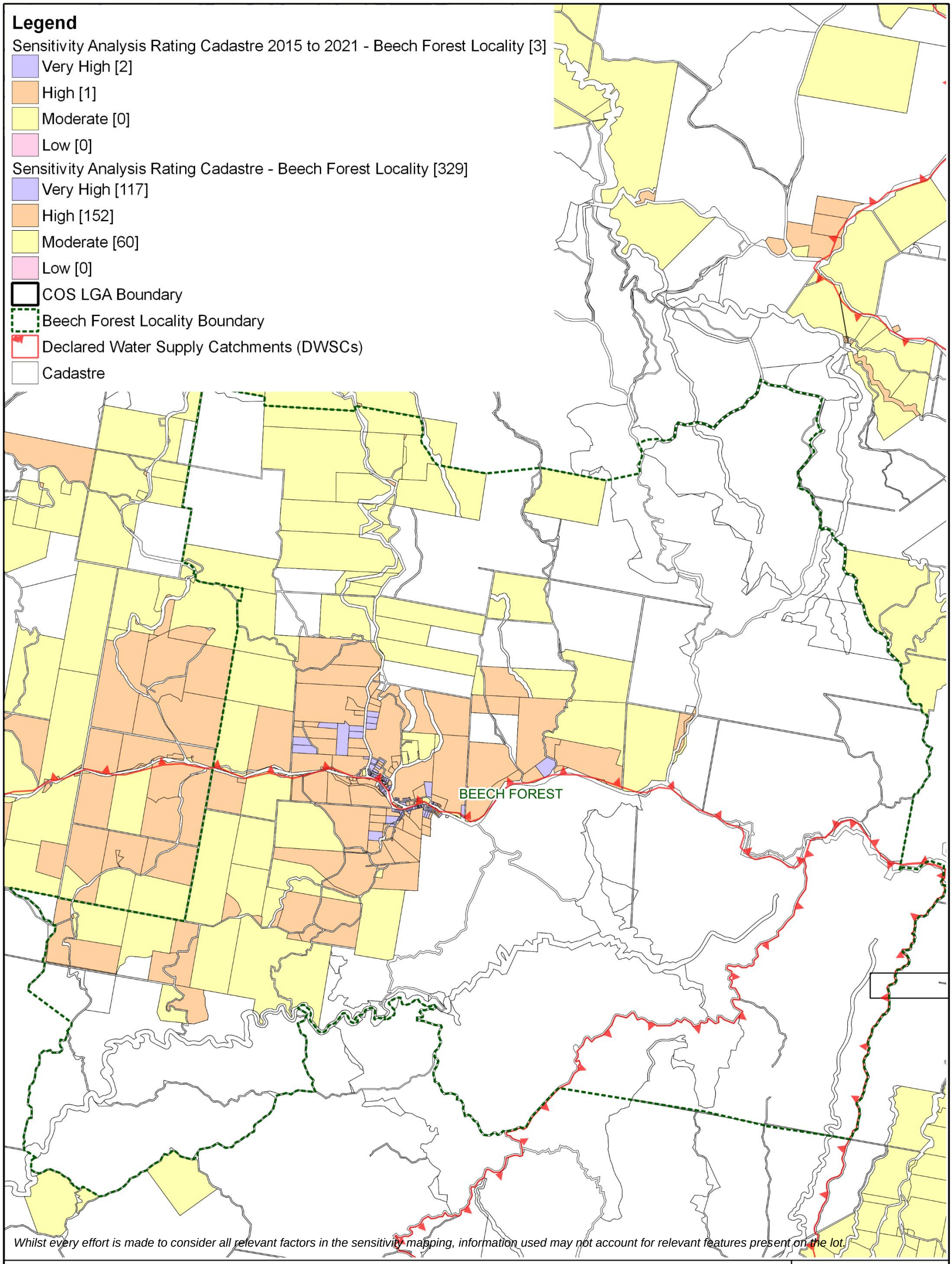
4f. Summary of Constraints to DWM

Characteristic	Description
Climate Zone	The town is included within Zone 4 and part of the surrounding locality is located within Zone 3.
Surface waterways & catchments	The northern half and the south-eastern corner of the locality are located within the Gellibrand River DWSC and Barham River DWSC, respectively. The DWSC boundary runs along the ridgeline, which forms the major road running through the middle of the town. The drainage network is extensive, with West Gellibrand Dam located in the northeast of the locality along the Gellibrand River. Waterways located within the DWSC are: Asplin Creek, Larder Creek East and West Branches, Little Larder Creek, McDonald Creek,

Characteristic	Description
	Charleys Creek, Barham River East Branch, Falls Creek, and Seaview Creek. Waterways located outside of the DWSC are: Aire River, Little Aire Creek, Youngs Creek, Corgram Creek, Farrell Creek, Beech Creek, and Deppeler Creek.
Groundwater	Proximity to groundwater bores: minimal (only 3).
Land subject to inundation	Nil.
Useable Lot Area **Town (Locality)**	High: 91 (114) Moderate: 39 (62) Low: 12 (140) Compliant: 0 (16)
Minimum lot size compliance with Planning Scheme Zoning	The locality is predominantly zoned Farming Zone to the west and Public Conservation and Resource Zone to the east. The town is zoned as Township Zone. Compliancy is variable throughout the locality, with the smaller town lots generally compliant and the larger rural lots non-compliant. Compliant: 138 (175) Non-compliant: 4 (157)
Slope **Town (Locality)**	High: 92 (216) Moderate: 25 (62) Low: 25 (54)
Geology	Underlain by Eumeralla Formation of Otway Group which consist of fluvial and braided stream sedimentary deposits.
Soil suitability **Town (Locality)**	High: 142 (288) Moderate: 0 (44) Low: 0 (0) The central region of the locality, including the town, consists of soil landscape unit ‘60’ which form on rolling hills along the top of the Otway Ranges. The soil consists of brown friable gradational soils with weakly structured clay loam over light clay to 0.9m depth. Limitations include restricted drainage. The remainder of the locality consists of soil landscape unit ‘61’ which forms on the deeply dissected hills of the Otway Ranges and consists of brown gradational soils to 1.2m depth. The soils consist of

Characteristic	Description
	moderately structured silty loam over clay loam. Limitations include acidity and restricted drainage.
Sensitivity Overlay	No depth to groundwater data. Landslip: extensive around locality Vegetation: both sides of ridgeline.
Sensitivity Analysis Rating **Town (Locality)**	Very High: 97 (119) High: 42 (153) Moderate: 3 (60) Low: 0 (0)

5f. Sensitivity Analysis (Maps)



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure f1: Sensitivity Analysis - Beech Forest Locality

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 1.5 3 4.5 6 7.5 km

(Approx Scale)

N

Revision	4
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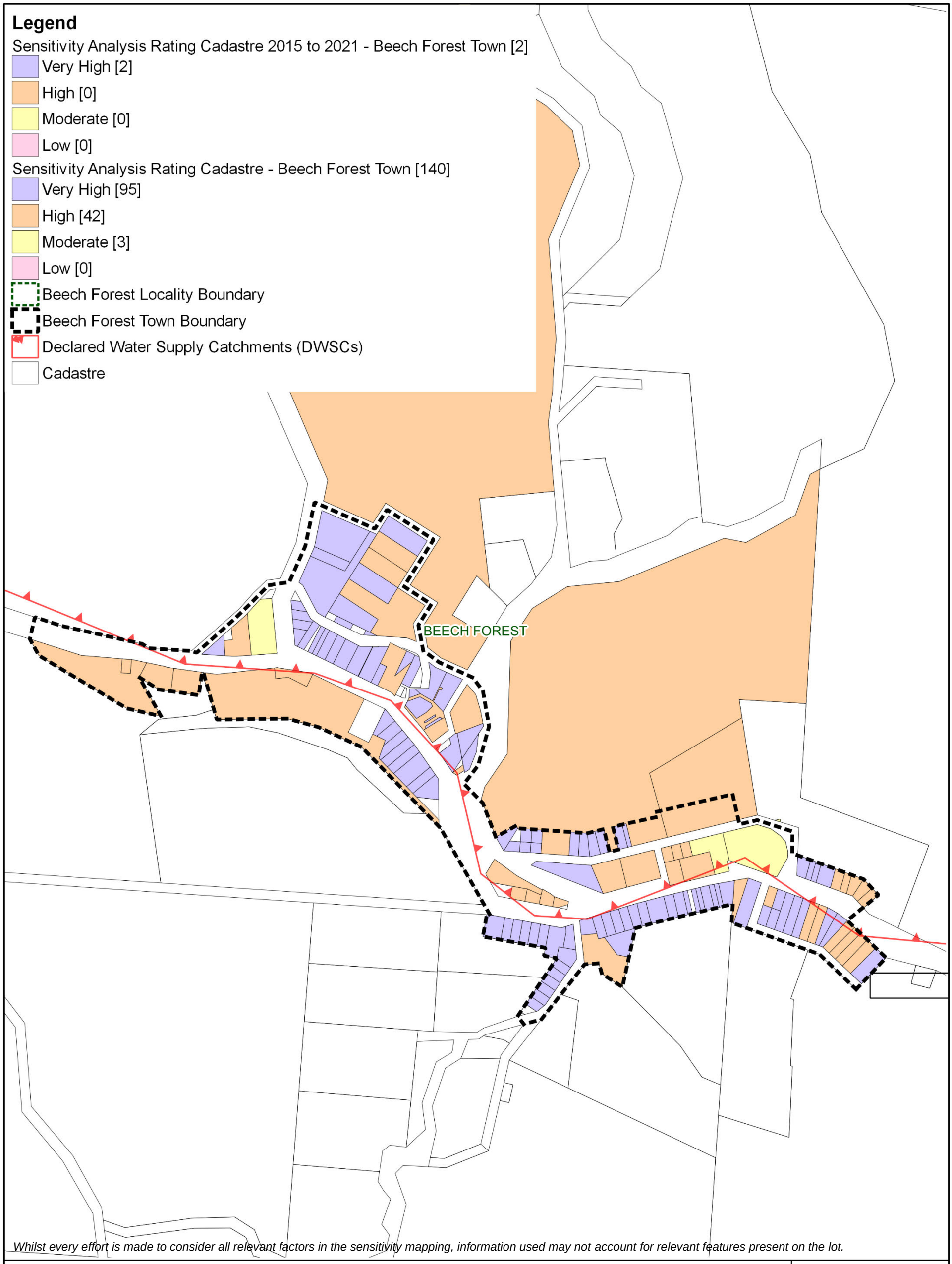


Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure f2: Sensitivity Analysis - Beech Forest Town

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 200 400 600 800 1,000 m

(Approx Scale)

N

Revision	4
Drawn	JK
Approved	MS

6f. System Selection

Due to the shallow soils and localised steep slopes in the Beech Forest locality, conventional absorption trenches and beds are not likely to be feasible and are discouraged.

The wet climate of the Beech Forest area makes it a high risk for DWM and site-specific, detailed land capability assessment and design will be required for unsewered lots in this area. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained lots.

EPA Code of Practice (2013) (Section 2.2.2) identifies secondary treatment standard (or better) followed by subsurface pressure-compensating irrigation as current best-practice in Victoria for substantially reducing the risk associated with unsewered development. Further, the Code describes a "Wick trench/bed" land application option that may be incorporated with secondary treatment for consideration on sites constrained by climate or lot 'useable area', particularly within the DWSCs. Any variation from this best-practice approach must be provided with detailed supporting information to demonstrate suitability.

System Sizing Tables (below) indicate which systems are likely to be the most appropriate for the locality.

7f. System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. Monthly 70th percentile rainfall was sourced from the Beech Forest BoM station (090006) and average evapotranspiration data for Beech Forest was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

Design Loading Rates (DLRs) and Design Irrigation Rates (DIRs) were taken from the EPA Code of Practice. Where the Code has precluded use of a particular type of system on a certain soil type, it is shown as 'Not Applicable' for that soil type in the Sizing Tables. Where the evapotranspiration deficit requires unrealistically large land application areas for a particular system on a certain soil type, it is also shown as 'Not Applicable' (N/A) for that soil type in the Sizing Tables. Detailed, site-specific LCAs and system designs would be required to justify the feasibility of these systems.

Sizing Tables for the Beech Forest locality are provided below.

8f. General Conclusion

The majority of lots within the locality have been assigned a Very High or High Sensitivity Rating to sustainable DWM. Predominantly, Detailed and Comprehensive LCAs will be required; however, all levels of LCA will require site-specific design due to the higher rainfall associated with this region (Climate Zone 4), as per Figure 3 of the DWMP Technical Document. Particular attention needs to be directed towards ensuring that DWM systems are sized based on the limiting soil horizon and that the systems selected are appropriate for steeper slopes with correct construction. The locality is also extensively considered to be prone to landslip; a geotechnical report by a suitably qualified person will need to be conducted to address this constraint.

Beech Forest (including Ferguson and Weeaproinah)

Drip and Spray Irrigation Systems* - Secondary Treated Effluent only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**		
	DIR (mm)	**Not supported (Alternative Land Application System or Extensive/Modified Design Required)**							
Development Type	**Daily (L/day)**								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								
Notes: * irrigation system sizes are based on the assumption that the land application area is less than 10% slope. Reductions in DIR apply for slopes above 10% according to Table M2 of AS1547:2012									
† not including spacing or setbacks									

Conventional Absorption Trenches and Beds - Primary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Weak Loams & High/Mod Clay Loams (3 & 4)**	**Weak Clay Loams (4)**	**Light Clays (5)**	**Massive Clay Loams (4)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**Not supported (Alternative Land Application System Required)**							
Development Type	**Daily (L/day)**								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								

Evapotranspiration-Absorption Trenches and Beds† - Primary Treated Effluent (Category 3a to 5a) only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3a)**	**Weak/Massive Loams (3b)**	**High/Mod Clay Loams (4a)**	**Weak Clay Loams (4b) & Strong Light Clays (5a)**	**Massive Clay Loams (4c) and Mod & Weak Light Clays (5b, 5c)**	**Medium to Heavy Clays (6) - Secondary Effluent Only**
	DLR (mm)	**20***	**20***	**15**	**10**	**12**	**8**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted area' required for water balance (m^2) not including spacing & setbacks**							
5 + bedroom residence	1,080	**Not Supported (not considered best-practice)**		131	332	206	862**		
4 bedroom residence	900			110	277	172	719**		
1-3 bedroom residence	720			88	222	138	575**		
Notes: * Gravels, Sands and Sandy loams are generally unsuitable for ETA trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012. ** Will require specialist advice regarding engineering and construction detail for installation.									
† will require detailed hydraulic design for effluent distribution system.									

LPED Irrigation Systems - Primary or Secondary Treated Effluent								
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**	
	DIR (mm)	**Not supported (Alternative Land Application System Required)**						
Development Type	**Daily (L/day)**							
5 + bedroom residence	1,080							
4 bedroom residence	900							
1-3 bedroom residence	720							

Wick Trench† - Secondary Treated Effluent Only - as per Section 7.4 design for High Rainfall Areas									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2) Loams (3) & High/Mod Clay Loams (4a,b)**	**Weak Clay Loams (4)**	**Massive Clay Loams (4)**	**Strong Light Clays (5a)**	**Moderate Light Clays (5b)**	**Weak Light Clays (5c)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**25**	**30**	**20**	**10**	**12**	**8**	**8**	**N/A (Alternative Land Application System Required)**
Development Type	**Daily (L/day)**	**Total effluent application area footprint (m^2), including interbed spacing**							
5 + bedroom residence	1,080	**Not Supported (not considered best-practice)**		295	815	620	1,400**		
4 bedroom residence	900			230	685	490	1,140**		
1-3 bedroom residence	720			165	555	425	880**		
Notes: ** Will require specialist advice regarding engineering and construction detail for installation.									
† will require detailed hydraulic design for effluent distribution system.									

G. Carlisle River Locality Report

1g. Introduction

Carlisle River is, spatially, the largest locality and is located approximately 30km southwest of Colac. The landform consists of dissected hills abutting rivers and streams and alluvial terraces with relatively flat topography in the dissected uplands of the Otway Ranges. Notably, the majority of the locality is located within a DWSC.

The locality has an estimated permanent population of approximately 135 residents (ABS Census, 2016). There are approximately 246 and 25 unsewered lots located within Carlisle River locality and town, respectively. There is one (1) new lot with DWM systems within the locality from June 2015-2021. There are 27 DWM system permits that have been inspected to date by COS (including PTI and CTU). The current DWM permits and their associated treatment system and LAA method within the Carlisle River locality are summarised as follows:

- 1 AWTS (1 unknown);
- 18 septic tanks (18 unknown); and
- 8 unknown (3 trenches, 5 unknown).

2g. Background Documentation

Refer to the following documents for additional detail regarding the locality:

- Carlisle River Township Master Plan Report (February, 2004);
- COS Planning Scheme; and
- Rural Living Strategy (2011).

3g. Site Assessment Results

The following table summarises the results from the representative audits conducted by Consultant staff in September 2014.

Characteristic	Description
Land use	Comprises a range of land uses, including dairy, forestry, rural living and tourism.
Occupancy rates	2.3 (Part of Beech Forest State Suburb, ABS Census, 2011).
Typical soils	Duplex soil. Black silt loam with excellent structure to 40cm, very wet below 25cm, abruptly overlies strongly mottled yellow brown and grey light to medium stiff clay to 70+cm. Can include lenses of dark yellow brown and strong brown mottled coffee rock between 40-50cm. Drainage and permeability are variable depending on slope and position.
AS/NZS 1547:2012 soil categories	4 (Clay Loams), 5 (Light Clays) and 6 (Medium to Heavy Clays).

Characteristic	Description
Existing Systems	**Separate Blackwater and Greywater** Of the three systems inspected during field investigations, one (33%) comprised separate blackwater treatment in a septic tank, with direct greywater diversion to an adjacent paddock. The septic tank was not accessible, as it was covered by a concrete slab. It had been pumped out within the last two years. Septic effluent discharged to four conventional absorption trenches of 10m each, on slopes of less than 2%. Drainage was poor. **Combined Blackwater and Greywater** Two systems (67%) inspected have a combined wastewater treatment system, or were assumed to have based on layout of pipework and age of dwelling. The time since last pump-out was generally unknown (partly due to owner not being home to ascertain). Septic effluent discharged to one or more conventional absorption trenches (or was assumed to if trenches could not be identified). The trench dimensions were generally unclear, and it is likely that they were undersized for the number of bedrooms. The majority of trenches or/and available LAAs were located on land of less than 2% slope and appeared to be parallel with contours.

4g. Summary of Constraints to DWM

Characteristic	Description
Climate Zone	Predominantly within Zone 3.
Surface waterways & catchments	Located entirely within DWSCs, i.e. Gellibrand River and Gellibrand River (South Otway). Two major rivers transverse the locality; Gellibrand River north to south in the western region of the locality and Carlisle River to the north of the town. Other waterways include: Rusty Creek, Sandy Creek, Crinoline Creek, Leahy Creek, Arkins Creek, Boggy Creek, and Charley Creek.
Groundwater	Proximity to groundwater bores: located within the town and along the Gellibrand River and Carlisle River.
Land subject to inundation	Along northern and western boundaries associated with Gellibrand River and lower reaches of the Carlisle River confluence point.
Useable lot area **Town (Locality)**	High: 9 (40) Moderate: 6 (16) Low: 10 (167) Compliant: 0 (23)

Characteristic	Description
Minimum lot size compliance with Planning Scheme Zoning	The locality is predominantly zoned Farming Zone and Public Conservation and Resource Zone. The town is zoned Township Zone. Compliancy is variable throughout the locality, with all of the lots within the town compliant. Compliant: 25 (98) Non-compliant: 0 (148)
Slope **Town (Locality)**	High: 0 (120) Moderate: 0 (32) Low: 25 (94)
Geology	Predominately underlain by the Wiridjil Gravel Member of the Pebble Point Formation, which is comprised of fluvial and braided stream deposits. Moomowroong Sand Member of the Pebble Point Formation (marginal marine and beach deposits) is located near the town straddling unnamed alluvial floodplain deposits. East to southeast - Eumeralla Formation of the Otway group which is comprised of fluvial and braided stream deposits.
Soil suitability **Town (Locality)**	High: 0 (43) Moderate: 25 (203) Low: 0 (0) Variable soil landscapes throughout the locality (7-8 in total). The town consists of soil landscape unit ‘94’ which forms on elevated, and in parts, uplifted and dissected system of ancient cut and depositional terraces of Gellibrand River. The soils consist of grey sand soils with structured clay underneath; strongly structured sandy loam over moderately structured medium clay; to depths of more than 2m. Limitations include low fertility and restricted drainage. The area adjacent to the river consists of soil landscape unit ‘61’ which forms on the deeply dissected hills of the Otway Ranges and consists of brown gradational soils to 1.2m depth. The soils consist of moderately structured silty loam over clay loam. Limitations include acidity and restricted drainage.
Sensitivity Overlay	Depth to Groundwater Compliance: variable compliancy, but generally compliant, except around the Gellibrand River and the confluence of Carlisle River. Landslip: minimal

Characteristic	Description
	Vegetation: significant Great Otway National Park and Otway Forest Park.
Sensitivity Analysis Rating **Town (Locality)**	Very High: 0 (0) High: 0 (38) Moderate: 25 (205) Low: 0 (3)

5g. Sensitivity Analysis (Maps)

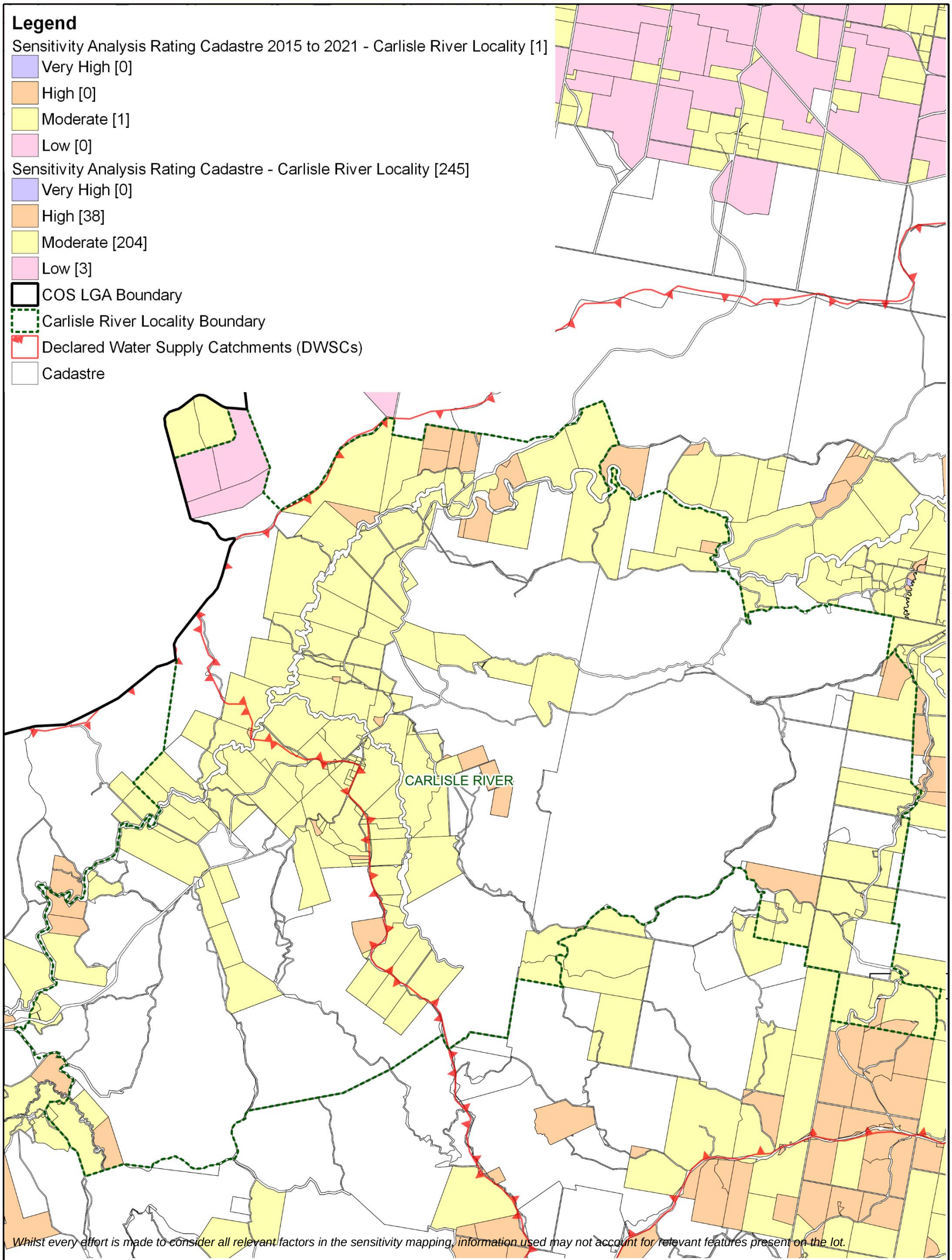


Figure g1: Sensitivity Analysis - Carlisle River Locality

Colac Otway Shire DWMP Review

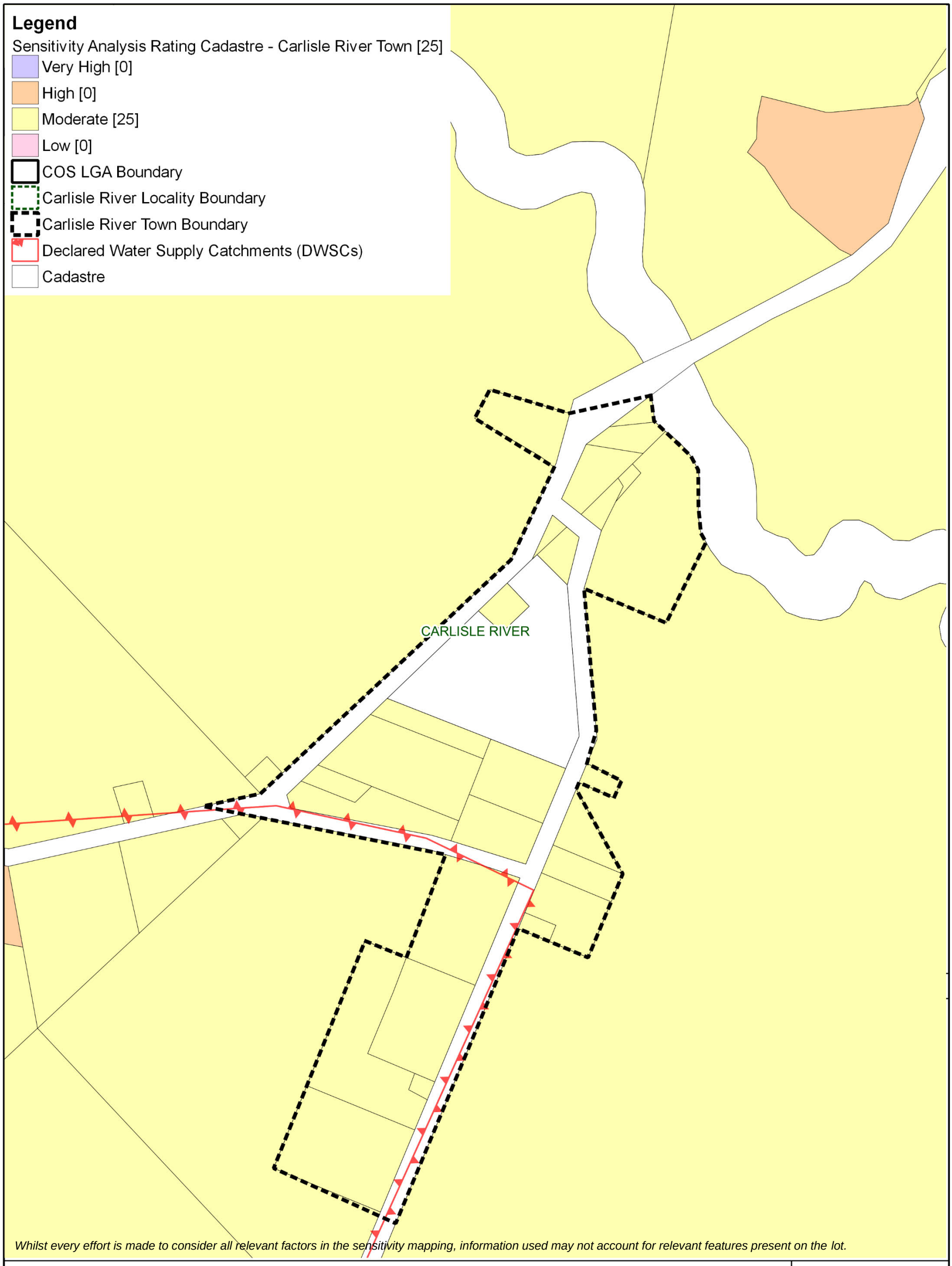
Whitehead & Associates Environmental Consultants

0 2 4 6 8 10 km

(Approx Scale)

N

Revision	3
Drawn	JK
Approved	MS


Legend
Sensitivity Analysis Rating Cadastre - Carlisle River Town [25]
Very High [0]
High [0]
Moderate [25]
Low [0]
COS LGA Boundary
Carlisle River Locality Boundary
Carlisle River Town Boundary
Declared Water Supply Catchments (DWSCs)
Cadastre
CARLISLE RIVER
Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.
Figure g2: Sensitivity Analysis - Carlisle River Town
Colac Otway Shire DWMP Review
Whitehead & Associates
Environmental Consultants
0 100 200 300 400 500 m
(Approx Scale)
N
Revision 4
Drawn JK
Approved MS

6g. System Selection

Due to the dominance of heavy-textured soils in the Carlisle River locality, conventional absorption trenches and beds are not likely to be feasible and are discouraged. Appendix A of the EPA Code of Practice (2013) prohibits LPED systems on Category 5 and 6 soils (medium to heavy clays).

EPA Code of Practice (2013) (Section 2.2.2) identifies secondary treatment standard (or better) followed by subsurface pressure-compensating irrigation as current best-practice in Victoria for substantially reducing the risk associated with unsewered development. Further, the Code describes a "Wick trench/bed" land application option that may be incorporated with secondary treatment for consideration on sites constrained by climate or lot 'useable area', particularly within the DWSCs. Any variation from this best-practice approach must be provided with detailed supporting information to demonstrate suitability.

System Sizing Tables (below) indicate which systems are likely to be the most appropriate for the locality.

7g. System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. Monthly 70th percentile rainfall and average evapotranspiration data for Carlisle River was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

The Design Loading Rates (DLRs) and Design Irrigation Rates (DIRs) were taken from the current EPA Code of Practice. Where the Code of Practice has precluded use of a particular type of system on a certain soil type, it is shown as 'Not Applicable' for that soil type in the Sizing Tables. Where the evapotranspiration deficit requires unrealistically large land application areas for a particular system on a certain soil type, it is also shown as 'Not Applicable' for that soil type in the Sizing Tables. Detailed, site-specific LCAs and system designs would be required to further investigate the feasibility of systems deemed 'Not Applicable' in the sizing tables. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained lots.

Sizing Tables for the Carlisle River locality are provided below.

8g. General Conclusion

The lots within Carlisle River, including the town, have predominantly been assigned a Moderate Sensitivity Rating to sustainable DWM. Predominantly, Standard LCAs will be required, with the use of System Sizing Tables deemed appropriate. The Low Sensitivity Rating lots within a DWSC are required to complete a Standard LCA as per the current EPA Code of Practice's requirements. Particular attention needs to be directed towards ensuring that appropriate setbacks to surface waterways and groundwater bores are maintained, that the DWM systems are sized based on the limiting soil horizon, and that the degree of slope is taken into consideration when designing the LAA.

Carlisle River

Drip and Spray Irrigation Systems* - Secondary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**		
	DIR (mm)	**5**	**5**	**4**	**3.5**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**		
Development Type	**Daily (L/day)**	**Total min. irrigation area required for zero wet weather effluent storage (m^2)†**							
5 + bedroom residence	1,080	509		960	1,726				
4 bedroom residence	900	424		800	1,439				
1-3 bedroom residence	720	339		640	1,151				
Note: * irrigation system sizes are based on the assumption that the land application area is less than 10% slope. Reductions in DIR apply for slopes above 10% according to Table M2 of AS1547:2012									
† not including spacing or setbacks									

Conventional Absorption Trenches and Beds - Primary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Weak Loams & High/Mod Clay Loams (3 & 4)**	**Weak Clay Loams (4)**	**Light Clays (5)**	**Massive Clay Loams (4)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**Not supported (Alternative Land Application System Required)**							
Development Type	**Daily (L/day)**								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								

Evapotranspiration-Absorption Trenches and Beds - Primary Treated Effluent (Category 1 to 5) and Secondary Treated Effluent only (Category 6)									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3a)**	**Weak/Massive Loams (3b)**	**High/Mod Clay Loams (4a)**	**Weak Clay Loams (4b) & Strong Light Clays (5a)**	**Massive Clay Loams (4c) and Mod & Weak Light Clays (5b, 5c)**	**Medium to Heavy Clays (6) - Secondary Effluent Only**
	DLR (mm)	**20***	**20***	**15**	**10**	**12**	**8**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing & setbacks**							
5 + bedroom residence	1,080	65		93	162	125	231		
4 bedroom residence	900	54		77	135	104	192		
1-3 bedroom residence	720	44		62	108	83	154		
Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012									

LPED Irrigation Systems - Primary or Secondary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**		
	DIR (mm)	**Not supported (Alternative Land Application System Required)**							
Development Type	**Daily (L/day)**								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								

Wick Trenches and Beds - Secondary Treated Effluent Only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2) Loams (3) & High/Mod Clay Loams (4a,b)**	**Weak Clay Loams (4)**	**Massive Clay Loams (4)**	**Strong Light Clays (5a)**	**Moderate Light Clays (5b)**	**Weak Light Clays (5c)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**25**	**30**	**20**	**10**	**12**	**8**	**8**	**N/A (Alternative Land Application System Required)**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted area' required for zero wet weather storage (m2) not including spacing & setbacks**							
5 + bedroom residence	1,080	50	41	65	162	125	231		
4 bedroom residence	900	42	34	54	135	104	192		
1-3 bedroom residence	720	34	27	44	108	83	154		

H. Coragulac Locality Report

1h. Introduction

Coragulac is a rural locality located approximately 13km northwest of Colac, in close proximity to the Cororooke and Alvie localities within the Red Rock region. The landform features undulating agricultural land on the Western Volcanic Plains.

Coragulac has a population of approximately 161 residents (ABS Census, 2016). There are approximately 188 and 73 unsewered lots located within the Coragulac locality and town, respectively. There are 13 new lots with DWM systems within the locality from June 2015-2021. There are 43 DWM system permits that have been inspected to date by COS (including PTI and CTU). The current DWM permits and their associated treatment system and LAA method within the Coragulac locality are summarised as follows:

- 1 AWTS (3 subsurface irrigation, 3 drip irrigation, and 1 unknown);
- 1 worm farm (1 unknown);
- 2 sand filter (1 trench and 1 unknown);
- 22 septic tanks (4 trenches and 18 unknown); and
- 11 unknown (2 trenches and 9 unknown).

No field investigations were conducted within the Coragulac locality as part of the 2014 field assessments.

2h. Background Documentation

Refer to the following documents for additional detail regarding the locality:

- Red Rock Region Community Infrastructure Plan (September, 2013);
- COS Planning Scheme; and
- Rural Living Strategy (2011).

3h. Summary of Constraints to DWM

Characteristic	Description
Climate Zone	Zone 2.
Surface waterways & catchments	Minimal surface waterways, with only Lake Coragulac and Lake Purdiguluc along the north-western locality border. Not located within a DWSC.
Groundwater	Proximity to groundwater bores: distributed throughout the locality, similar to Cororooke.
Land subject to inundation	Minimal; small amount to the west.
Useable lot area	High: 26 (37)

Characteristic	Description
Town (Locality)	Moderate: 16 (30) Low: 31 (119) Compliant: 0 (2)
Minimum lot size compliance with Planning Scheme Zoning	The locality is predominantly zoned Farming Zone, with the town zoned Township Zone and Low Density Residential Zone. Compliancy is variable throughout the locality, with the rural lots surrounding the town generally non-compliant. Compliant: 57 (55) Non-compliant: 16 (133)
Slope **Town (Locality)**	High: 0 (1) Moderate: 0 (1) Low: 73 (186)
Geology	Underlain by the Newer Volcanic Group with unnamed phreatomagmatic (tuff ring) deposits in the west (including the town) and unnamed stony rises and hummocky lava flows in the east.
Soil suitability **Town (Locality)**	High: 0 (0) Moderate: 73 (188) Low: 0 (0) The locality consists of soil landscape units ‘123’ and ‘114’ which form on gently undulating plains and stony rises of the Volcanic Western Plains. Soil type changes significantly with landform, but generally consists of moderately to strongly structured, friable clay loam over strongly structured medium clay to less than 1.5m depth. Limitations include restricted drainage.
Sensitivity Overlay	Depth to Groundwater Compliance: all compliant. Landslip: Nil. Vegetation: locality borders Lake Coragulac to the northwest.
Sensitivity Analysis Rating **Town (Locality)**	Very High: 0 (0) High: 0 (0) Moderate: 43 (70) Low: 30 (118)

4h. Sensitivity Analysis (Maps)

Legend

Sensitivity Analysis Rating Cadastre 2015 to 2021 - Coragulac Locality [13]

- Very High [0]
- High [0]
- Moderate [2]
- Low [11]

Sensitivity Analysis Rating Cadastre - Coragulac Locality [175]

- Very High [0]
- High [0]
- Moderate [68]
- Low [107]
- COS LGA Boundary
- Coragulac Locality Boundary
- Cadastre

CORAGULAC

Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure h1: Sensitivity Analysis - Coragulac Locality

Colac Otway Shire DWMP Review

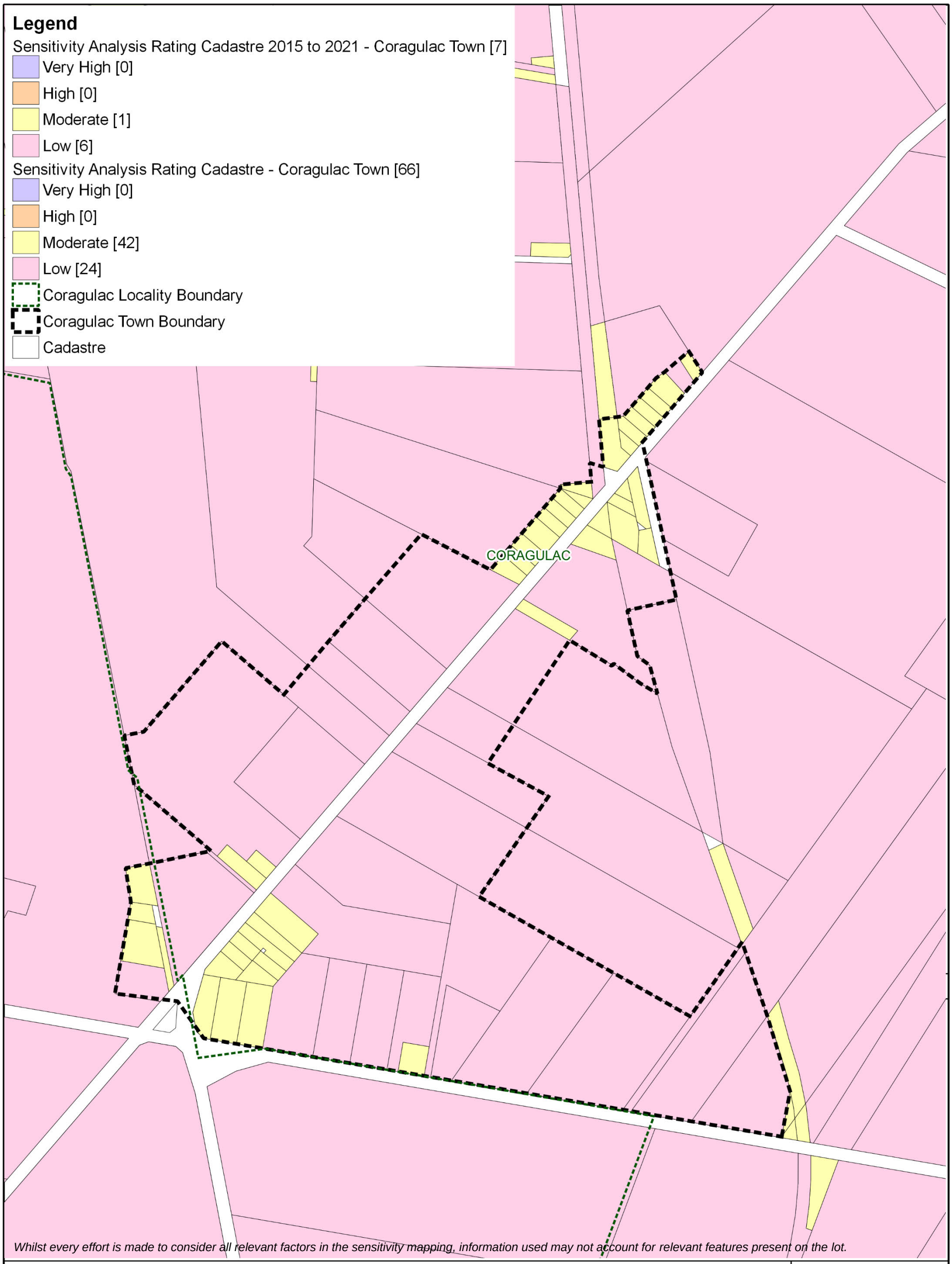
N

Whitehead & Associates
Environmental Consultants

0 500 1,000 1,500 2,000 2,500 m

(Approx Scale)

Revision	4
Drawn	JK
Approved	MS



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure h2: Sensitivity Analysis - Coragulac Town

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 150 300 450 600 750 m

(Approx Scale)

N

Revision	4
Drawn	JK
Approved	MS

5h. System Selection

Due to the dominance of heavy-textured soils in the Coragulac locality, conventional absorption trenches and beds are not likely to be feasible and are discouraged. Appendix A of the EPA Code of Practice (2013) prohibits LPED systems on Category 5 and 6 soils (medium to heavy clays). The System Sizing Tables (below) indicate which systems are likely to be the most appropriate for the locality.

6h. System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. The water balances used monthly 70th percentile rainfall and average evapotranspiration data for a single geographic point between Coragulac and Cororooke, due to their proximity. The climate data was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

The Design Loading Rates (DLRs) and Design Irrigation Rates (DIRs) were taken from the current EPA Code of Practice. Where the Code of Practice has precluded use of a particular type of system on a certain soil type, it is shown as 'Not Applicable' for that soil type in the Sizing Tables. Where the evapotranspiration deficit requires unrealistically large land application areas for a particular system on a certain soil type, it is also shown as 'Not Applicable' for that soil type in the Sizing Tables. Detailed, site-specific LCAs and system designs would be required to further investigate the feasibility of systems deemed 'Not Applicable' in the sizing tables. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained lots.

Sizing Tables for the Coragulac locality are provided below.

7h. General Conclusion

The lots within Coragulac have been assigned a Moderate or Low Sensitivity Rating to sustainable DWM. Both Standard and Council LCAs will be required, with the use of System Sizing Tables deemed appropriate. The constraints within Coragulac are quite low in comparison to other localities, with particular attention directed towards ensuring that the quality of the groundwater resources is maintained and the correct decommissioning of groundwater bores occurs where necessary.

Coragulac

Drip and Spray Irrigation Systems* - Secondary Treated Effluent only

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3)	Clay Loams (4)	Light Clays (5)	Medium to Heavy Clays (6)		
	DIR (mm)	5	5	4	3.5	3	2		
Development Type	Daily (L/day)	Total min. irrigation area required for zero wet weather effluent storage (m^2) not including spacing & setbacks							
5 + bedroom residence	1,080	287		390	476	610	1,397		
4 bedroom residence	900	239		325	396	508	1,164		
1-3 bedroom residence	720	191		260	317	407	932		

Note: * irrigation system sizes are based on the assumption that the land application area is less than 10% slope. Reductions in DIR apply for slopes above 10% according to Table M2 of AS1547:2012

Conventional Absorption Trenches and Beds - Primary or Secondary Treated Effluent

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3)	Weak Loams & High/Mod Clay Loams (3 & 4)	Weak Clay Loams (4)	Massive Clay Loams (4)	Light Clays (5)	Medium to Heavy Clays (6)
	DLR (mm)	Not supported (Alternative Land Application System Required)							
Development Type	Daily (L/day)								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								

Evapotranspiration-Absorption Trenches and Beds - Primary or Secondary Treated Effluent (Category 1 to 5) and Secondary Treated Effluent only (Category 6)

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3a)	Weak/Massive Loams (3b)	High/Mod Clay Loams (4a)	Weak Clay Loams (4b) & Strong Light Clays (5a)	Massive Clay Loams (4c) and Mod & Weak Light Clays (5b, 5c)	Medium to Heavy Clays (6) - Secondary Effluent Only
	DLR (mm)	20*	20*	15	10	12	8	5	5
Development Type	Daily (L/day)	Total min. basal or 'wetted' area required for zero wet weather effluent storage (m^2) not including spacing & setbacks							
5 + bedroom residence	1,080	59		80	127	103	165	305	
4 bedroom residence	900	49		67	106	86	138	254	
1-3 bedroom residence	720	39		54	85	69	110	203	

Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012

LPED Irrigation Systems - Primary or Secondary Treated Effluent

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3)	Clay Loams (4)	Light Clays (5)	Medium to Heavy Clays (6)		
	DIR (mm)	N/A (Alternative Land Application System Required)	4	3.5	3	2.5	N/A (Alternative Land Application System Required)		
Development Type	Daily (L/day)		Total min. basal or 'wetted' area for zero wet weather storage (m^2)†						
5 + bedroom residence	1,080		424	527	697	1,029			
4 bedroom residence	900		353	440	581	858			
1-3 bedroom residence	720		283	352	465	686			

† not including spacing & setbacks

Wick Trenches and Beds - Secondary Treated Effluent Only

	Soil Category	Gravels & Sands (1)	Sandy Loams (2) Loams (3) & High/Mod Clay Loams (4a,b)	Weak Clay Loams (4)	Massive Clay Loams (4)	Strong Light Clays (5a)	Moderate Light Clays (5b)	Weak Light Clays (5c)	Medium to Heavy Clays (6)
	DLR (mm)	25	30	20	10	12	8	8	5
Development Type	Daily (L/day)	Total min. basal or 'wetted' area required for zero wet weather effluent storage (m^2) not including spacing & setbacks							
5 + bedroom residence	1,080	46	38	59	127	103	165		305
4 bedroom residence	900	39	32	49	106	86	138		254
1-3 bedroom residence	720	31	26	39	85	69	110		203

I. Cororooke Locality Report

1i. Introduction

Cororooke is a rural locality located approximately 7km northwest of Colac in close proximity to the Coragulac and Alvie localities within the Red Rock region. The landform features undulating agricultural land on the Western Volcanic Plains.

The locality has a population of approximately 310 residents (ABS Census, 2016). There are approximately 285 and 123 unsewered lots located within the Cororooke locality and town, respectively. There are 31 new lots with DWM systems within the locality from June 2015-2021. There are 78 DWM system permits that have been inspected to date by COS (including PTI and CTU). The current DWM permits and their associated treatment system and LAA method within the Cororooke locality are summarised as follows:

- 19 AWTS (5 drip irrigation, 1 irrigation, 1 trench and 12 unknown);
- 1 sand filter (1 drip irrigation);
- 44 septic tanks (3 trenches, 1 irrigation, 1 subsurface irrigation and 39 unknown); and
- 14 unknown (2 trenches and 12 unknown).

No field investigations were conducted in the Cororooke locality as part of the 2014 field assessments.

2i. Background Documentation

Refer to the following documents for additional detail regarding the locality:

- Red Rock Region Community Infrastructure Plan (September, 2013);
- COS Planning Scheme; and
- Rural Living Strategy (2011).

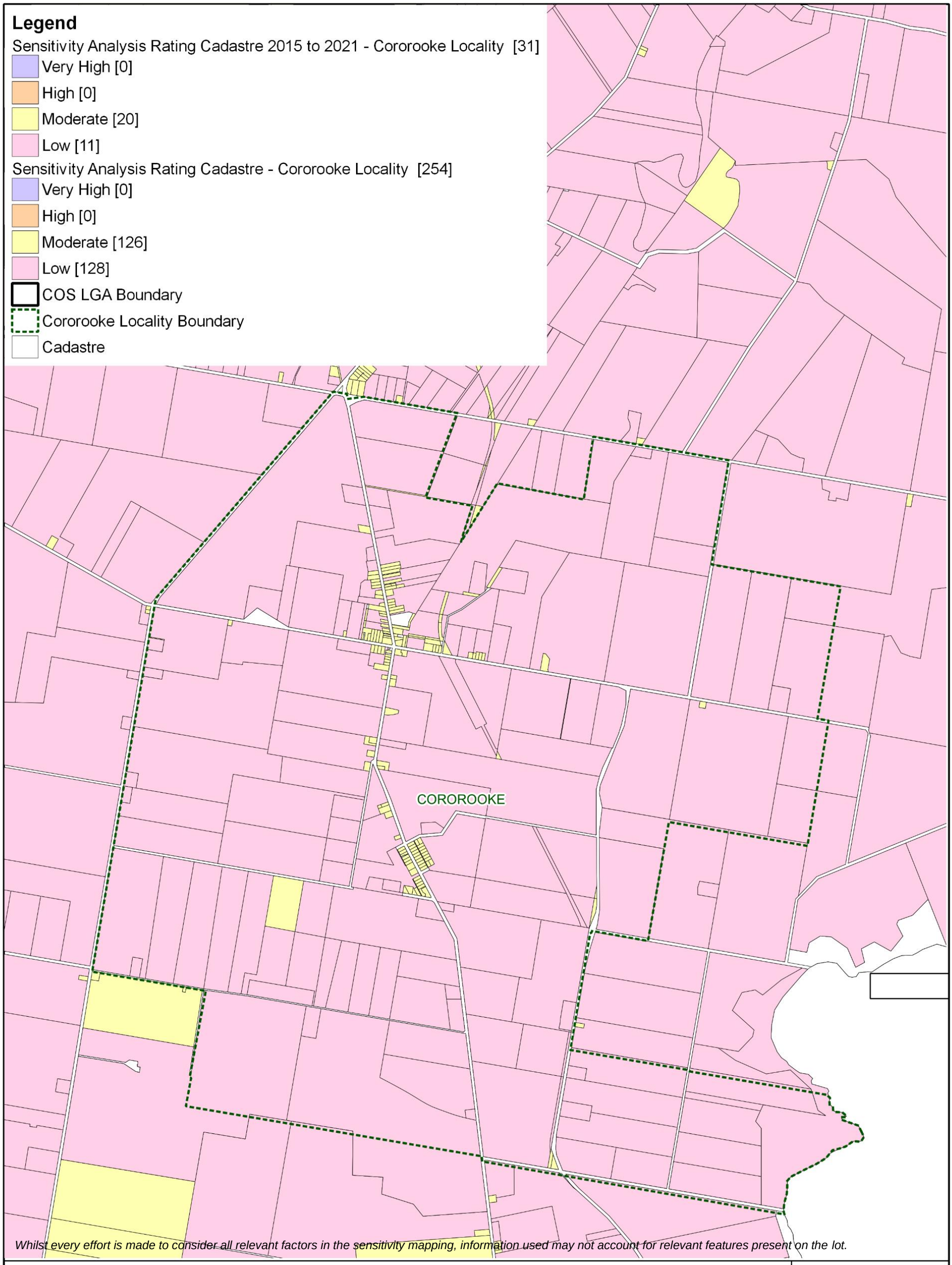
3i. Summary of Constraints to DWM

Characteristic	Description
Climate Zone	Zone 2.
Surface waterways & catchments	Located outside of a DWSC. Minimal drainage features, with Lake Colac to the east.
Groundwater	Proximity to groundwater bores: distributed throughout the locality, similar to Coragulac.
Land subject to inundation	Nil but extensive to the east (associated with Lake Colac).
Useable lot area **Town (Locality)**	High: 82 (102) Moderate: 28 (44)

Characteristic	Description
	Low: 13 (134) Compliant: 0 (5)
Minimum lot size compliance with Planning Scheme Zoning	The locality is predominantly zoned Farming Zone. The town is zoned Township Zone and Rural Living Zone. Compliancy is variable throughout the locality, with the majority of the rural lots non-compliant. Compliant: 79 (87) Non-compliant: 44 (198)
Slope **Town (Locality)**	High: 0 (0) Moderate: 0 (0) Low: 123 (285)
Geology	Variable. The town is predominately underlain by unnamed stony rises and hummocky lava flows of the Newer Volcanic Group Transversing east-west. North of the town – unnamed phreatomagmatic deposits (tuff rings) of Newer Volcanic Group South of the town – Quaternary unnamed swamp, lake and estuarine deposits. Southern region – Hanson Plain sand of the Brighton Group which is comprised of fluvial and minor shallow marine deposits Along southern boundary – unnamed sheet flow basalt of the Newer Volcanic Group.
Soil suitability **Town (Locality)**	High: 0 (1) Moderate: 123 (284) Low: 0 (0) Variable throughout locality (6 in total). The dominant soil landscape unit, which also includes the town, is ‘114’ which forms on gently undulating plains and stony rises of the Volcanic Western Plains. Soil type changes significantly with landform, but generally consists of moderately to strongly structured, friable clay loam over strongly structured medium clay to less than 1.5m depth. Limitations include restricted drainage.
Sensitivity Overlay	Depth to Groundwater Compliance: all compliant, including town, except for the eastern lots around Lake Colac.

Characteristic	Description
	Landslip: Nil Vegetation: Lake Colac to southeast.
Final Sensitivity Rating **Town (Locality)**	Very High: 0 (0) High: 0 (0) Moderate: 110 (146) Low: 13 (139)

4i. Sensitivity Analysis (Maps)



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure i1: Sensitivity Analysis - Cororooke Locality

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 500 1,000 1,500 2,000 2,500 m

(Approx Scale)

N

Revision	4
Drawn	JK
Approved	MS

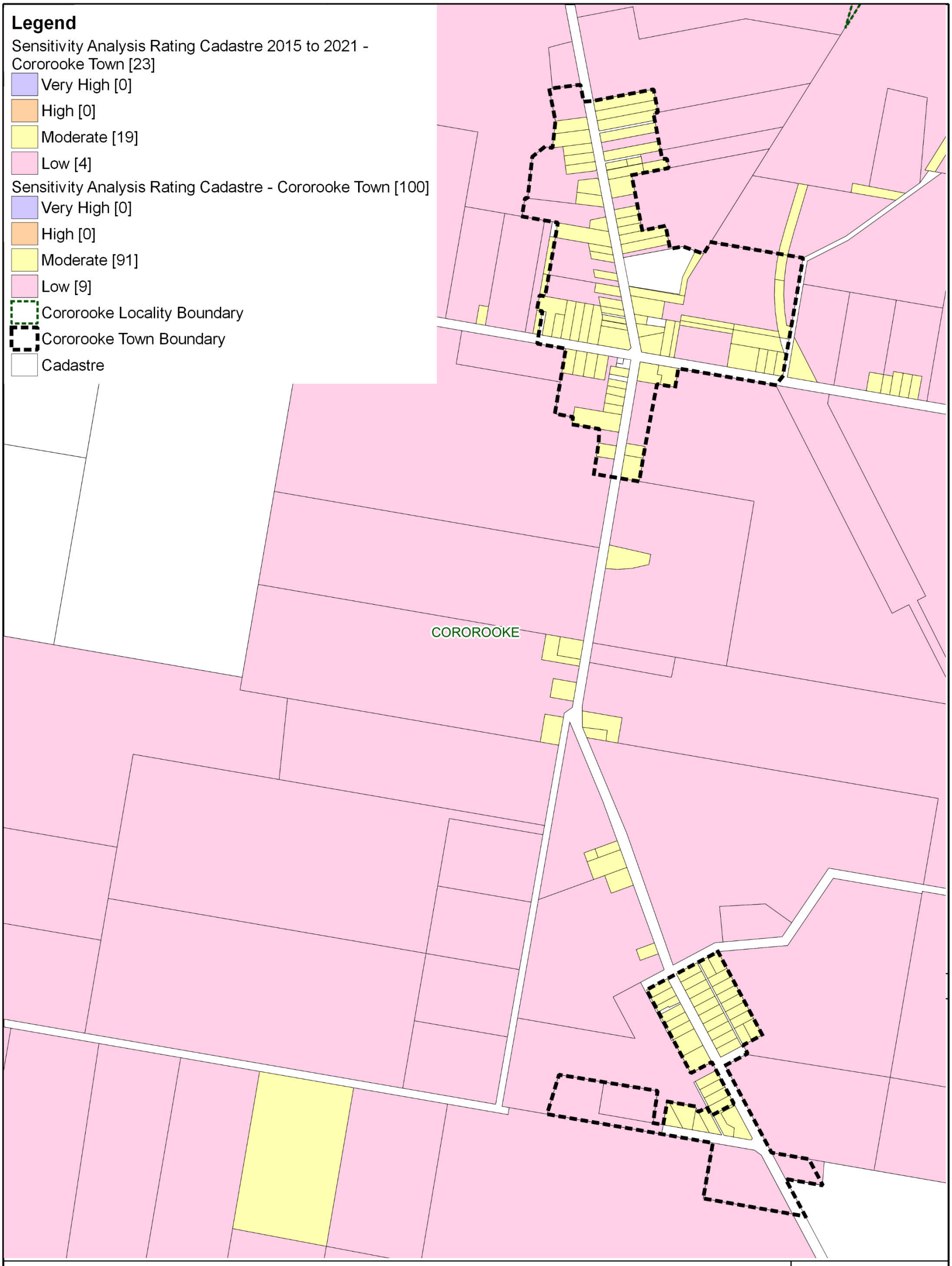


Figure i2: Sensitivity Analysis - Cororooke Town

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 200 400 600 800 1,000 m

(Approx Scale)

N

Revision	4
Drawn	JK
Approved	MS

5i. System Selection

Based on soil types and indicative depths, the Cororooke locality has the potential to sustainably accommodate a broad range of system types, depending on the influences of climate. The System Sizing Tables (below) indicate which systems are likely to be the most appropriate for the locality.

6i. System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. The water balances used monthly 70th percentile rainfall and average evapotranspiration data for a single geographic point between Cororooke and Coragulac, due to their proximity. The climate data was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

The Design Loading Rates (DLRs) and Design Irrigation Rates (DIRs) were taken from the current EPA Code of Practice. Where the Code of Practice has precluded use of a particular type of system on a certain soil type, it is shown as 'Not Applicable' for that soil type in the Sizing Tables. Where the evapotranspiration deficit requires unrealistically large land application areas for a particular system on a certain soil type, it is also shown as 'Not Applicable' for that soil type in the Sizing Tables. Detailed, site-specific LCAs and system designs would be required to further investigate the feasibility of systems deemed 'Not Applicable' in the sizing tables. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained lots.

Sizing Tables for the Cororooke locality are provided below.

7i. General Conclusion

The lots within Cororooke have been assigned a Moderate or Low Sensitivity Rating to sustainable DWM. Both Standard and Council LCAs will be required, with the use of System Sizing Tables deemed appropriate. The constraints within Cororooke are quite low in comparison to other localities. Particular attention should be directed towards ensuring that the quality of the groundwater resources is maintained and the correct decommissioning of groundwater bores occurs where necessary.

Cororooke

Drip and Spray Irrigation Systems* - Secondary Treated Effluent								
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**	
	DIR (mm)	**5**	**5**	**4**	**3.5**	**3**	**2**	
Development Type	**Daily (L/day)**	**Total min. irrigation area required for zero wet weather effluent storage (m^2) not including spacing & setbacks**						
5 + bedroom residence	1,080	287		390	476	610	1,397	
4 bedroom residence	900	239		325	396	508	1,164	
1-3 bedroom residence	720	191		260	317	407	932	
Note: * irrigation system sizes are based on the assumption that the land application area is less than 10% slope. Reductions in DIR apply for slopes above 10% according to Table M2 of AS1547:2012								

Conventional Absorption Trenches and Beds - Primary or Secondary Treated Effluent								
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Weak Loams & High/Mod Clay Loams (3 & 4)**	**Weak Clay Loams (4)**	**Massive Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**20***	**20***	**15**	**10**	**6**	**4**	**5**	**N/A (Alternative Land Application System Required)**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted' area required for zero wet weather effluent storage (m^2) not including spacing & setbacks**							
5 + bedroom residence	1,080	59		80	127	238	424	305	
4 bedroom residence	900	49		67	106	198	353	254	
1-3 bedroom residence	720	39		54	85	159	283	203	
Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012									

Evapotranspiration-Absorption Trenches and Beds - Primary or Secondary Treated Effluent (Category 1 to 5) and Secondary Treated Effluent only (Category 6)									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3a)**	**Weak/Massive Loams (3b)**	**High/Mod Clay Loams (4a)**	**Weak Clay Loams (4b) & Strong Light Clays (5a)**	**Massive Clay Loams (4c) and Mod & Weak Light Clays (5b, 5c)**	**Medium to Heavy Clays (6) - Secondary Effluent Only**
	DLR (mm)	**20***	**20***	**15**	**10**	**12**	**8**	**5**	**5**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted' area required for zero wet weather effluent storage (m^2) not including spacing & setbacks**							
5 + bedroom residence	1,080	59		80	127	103	165	305	
4 bedroom residence	900	49		67	106	86	138	254	
1-3 bedroom residence	720	39		54	85	69	110	203	
Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012									

LPED Irrigation Systems - Primary or Secondary Treated Effluent								
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**	
	DIR (mm)	**N/A (Alternative Land Application System Required)**	**4**	**3.5**	**3**	**2.5**	**N/A (Alternative Land Application System Required)**	
Development Type	**Daily (L/day)**		**Total min. basal or 'wetted' area for zero wet weather storage (m^2)†**					
5 + bedroom residence	1,080		424	527	697	1,029		
4 bedroom residence	900		353	440	581	858		
1-3 bedroom residence	720		283	352	465	686		
† not including spacing & setbacks								

Wick Trenches and Beds - Secondary Treated Effluent Only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2) Loams (3) & High/Mod Clay Loams (4a,b)**	**Weak Clay Loams (4)**	**Massive Clay Loams (4)**	**Strong Light Clays (5a)**	**Moderate Light Clays (5b)**	**Weak Light Clays (5c)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**25**	**30**	**20**	**10**	**12**	**8**	**8**	**5**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted' area required for zero wet weather effluent storage (m^2) not including spacing & setbacks**							
5 + bedroom residence	1,080	46	38	59	127	103	165		305
4 bedroom residence	900	39	32	49	106	86	138		254
1-3 bedroom residence	720	31	26	39	85	69	110		203

J. Forrest Locality Report

1j. Introduction

Forrest is located approximately 22km southeast of Colac in the northern hinterlands of the Otway Ranges. The town is located along a ridgeline that separates two well defined catchments. The majority of the locality is located outside DWSCs; however, small portions (10%) along the north-western and south-eastern boundaries fall within the Gellibrand River and Upper Barwon DWSCs, respectively.

The locality has a population of approximately 230 residents (ABS Census, 2016). There are approximately 349 and 167 unsewered lots within the Forrest locality and town, respectively. There are 5 new lots with DWM systems within the locality from June 2015-2021. There are 159 DWM system permits that have been inspected to date by COS (including PTI and CTU). The current DW permits and their associated treatment system and LAA method within Forrest are summarised as follows:

- 32 AWTS (9 drip irrigation, 2 trenches, 7 subsurface irrigation and 14 unknown);
- 39 sand filters (1 trench, 37 subsurface irrigation and 1 unknown);
- 45 septic tanks (10 trenches, 1 irrigation and 34 unknown);
- 4 worm farms (2 trenches, and 2 unknown); and
- 29 unknown (10 trenches, 1 subsurface irrigation and 18 unknown).

No field investigations were conducted within the Forrest locality as part of the 2014 field assessments.

There have been 21 notified wastewater complaints to Council within the township of Forrest regarding DWM systems and associated land applications that have been registered in Council's Health Manager database from 2015- 2021. The reticulation/sewering of Forrest would be beneficial as wastewater management complaints are received in this township. There are a number of site constraints that are present within these township properties. Protecting the environment and public health through the sewering of Forrest would be supported.

2j. Background Documentation

Refer to the following documents for additional detail regarding the locality:

- Forrest Structure Plan (2011);
- Birregurra and Forrest Township Community Infrastructure Plans (2012);
- Colac Otway Domestic Wastewater Management Plan (2007);
- COS Planning Scheme; and
- Rural Living Strategy (2011).

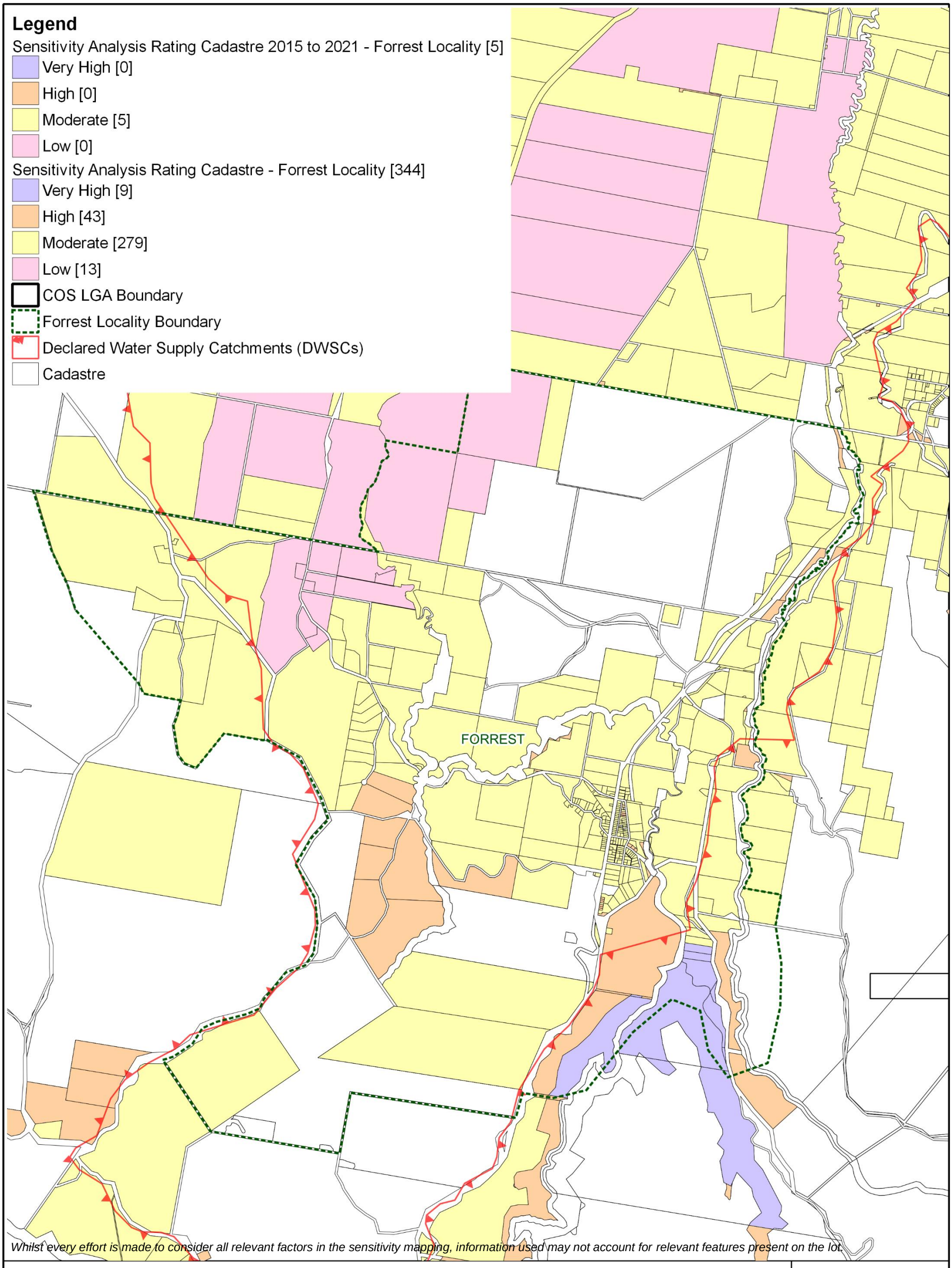
3j. Summary of Constraints to DWM

Characteristic	Description
Climate Zone	Zones 2 and 3.

Characteristic	Description
Surface waterways & catchments	A small region of the locality is located with DWSCs, being the Upper Barwon and Gellibrand River, but the town is located outside a DWSC. West Barwon Reservoir is located approximately 8km to the south of the town inside Barwon DWSC. Barwon River West Branch traverses north and east of the town. Other waterways within the locality include: Road Knight Creek, Porcupine Creek, and Barwon River East Branch. Limited surface water concerns are located along the ridgeline.
Groundwater	Proximity to groundwater bores: distributed throughout the northern region and along the river, but density is less than other localities.
Land subject to inundation	Transverses locality north-south along Barwon River West Branch which runs along the eastern perimeter of the town.
Useable lot area **Town (Locality)**	High: 8 (125) Moderate: 5 (62) Low: 24 (156) Compliant: 0 (6)
Minimum lot size compliance with Planning Scheme Zoning	The locality is zoned a variety of different uses, predominantly being zoned Farming Zone, Public Conservation and Resource Zone, and Public Use Zone around the reservoir. The town is zoned as Township Zone, Rural Living Zone and Rural Activity Zone. Compliancy is variable throughout the locality, with the majority of the lots within the town compliant and surrounding lots non-compliant. Compliant: 148 (170) Non-compliant: 19 (179)
Slope **Town (Locality)**	High: 6 (84) Moderate: 22 (63) Low: 139 (202)
Geology	Town – Dilwyn Formation of Wangeripp Group (shallow marine, coastal barrier and back beach lagoonal deposit); North: Gellibrand Marl of Hytesbury Group (continental shelf deposit); South – Eumeralla Formation of the Otway Group (fluvial and braided stream deposits) with alluvial flood plain deposits along the creek.
Soil suitability **Town (Locality)**	High: 0 (28) Moderate: 167 (321) Low: 0 (0)

Characteristic	Description
	The town consists of soil landscape unit '73' which form on the steep rolling hills on the northern periphery of the Otway Range and consists of texture contrast soils with ironstone to 2m depth. The soils consist of weakly structured sandy loam over strongly structured medium to heavy clay. Limitations include low fertility, low p-sorb, sodic, dispersive, restricted drainage and coarse fragments. The regions adjacent to the river to the north and west of the town consist of soil landscape unit '95' which forms on the alluvial floodplain of the Barwon River and its tributaries with numerous cut-off meanders. The soil consists of a moderately structured fine sandy clay loam over medium clay to more than 2m depth. Limitations include restricted drainage and dispersive. South and east facing slopes are linear and consist of in situ weathered rock with brown gradational soils covered by loam. North and west facing slopes consist of in situ weathered rock with brown duplex soils covered by loam.
Sensitivity Overlay	Depth to Groundwater Compliance: predominantly compliant, except in the northeast of the locality along Barwon River East Branch. Landslip: extensive around locality and surrounding locality Vegetation: Otway Forest Park surrounds the town, with a small region of Great Otway National Park.
Sensitivity Analysis Rating **Town (Locality)**	Very High: 0 (9) High: 14 (43) Moderate: 153 (284) Low: 0 (13)

4j. Sensitivity Analysis (Maps)



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure j1: Sensitivity Analysis - Forrest Locality

Colac Otway Shire DWMP Review

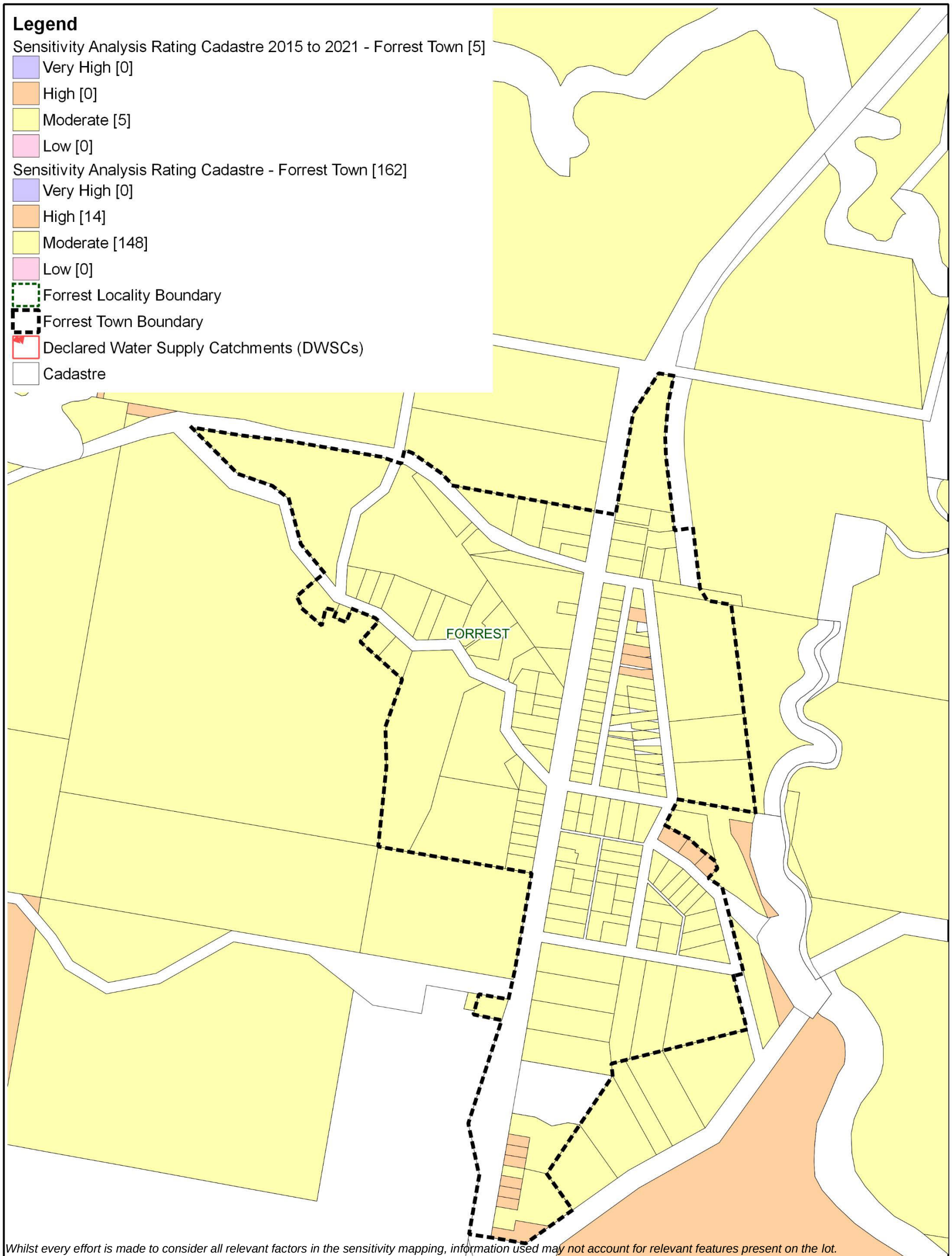
Whitehead & Associates Environmental Consultants

0 1 2 3 4 5 km

(Approx Scale)

N

Revision	4
Drawn	JK
Approved	MS



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure j2: Sensitivity Analysis - Forrest Town

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 150 300 450 600 750 m

(Approx Scale)

N

Revision	4
Drawn	JK
Approved	MS

5j. System Selection

Due to the dominance of heavy-textured soils in the Forrest area, conventional absorption trenches and beds are not likely to be feasible and are discouraged. Appendix A of the EPA Code of Practice (2013) prohibits LPED systems on Category 5 and 6 soils (medium to heavy clays). The System Sizing Tables (below) indicate which systems are likely to be the most appropriate for the locality.

6j. System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. The water balances used monthly 70th percentile rainfall and average evapotranspiration data for Gellibrand, as it was compared with that of Forrest and found to be very similar, with very little size differences in water balance results. The climate data for Gellibrand was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

The Design Loading Rates (DLRs) and Design Irrigation Rates (DIRs) were taken from the current EPA Code of Practice. Where the Code of Practice has precluded use of a particular type of system on a certain soil type, it is shown as 'Not Applicable' for that soil type in the Sizing Tables. Where the evapotranspiration deficit requires unrealistically large land application areas for a particular system on a certain soil type, it is also shown as 'Not Applicable' for that soil type in the Sizing Tables. Detailed, site-specific LCAs and system designs would be required to further investigate the feasibility of systems deemed 'Not Applicable' in the sizing tables. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained lots.

Sizing Tables for the Forrest locality are provided below.

7j. General Conclusion

The lots within Forrest have been assigned all classes of Sensitivity Rating to sustainable DWM, with the majority of the lots assigned a Moderate Sensitivity Rating. Predominantly, Standard LCAs will be required, with the use of System Sizing Tables deemed appropriate. The Low Sensitivity Rating lots that fall within a DWSC are required to complete a Standard LCA as per the current EPA Code of Practice's requirements. Particular attention needs to be directed towards ensuring that the degree of slope is taken into consideration when designing the LAA. The locality is also extensively considered to be prone to landslip; a geotechnical report by a suitably qualified person will need to be conducted to address this constraint.

Forrest

Drip and Spray Irrigation Systems* - Secondary Treated Effluent only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**		
	DIR (mm)	**5**	**5**	**4**	**3.5**	**3**	**2**		
Development Type	**Daily (L/day)**	**Total min. irrigation area required for zero wet weather effluent storage (m^2) not including spacing or setbacks**							
5 + bedroom residence	1,080	380		586	804	1,269	1,881		
4 bedroom residence	900	317		489	670	1,068	1,568		
1-3 bedroom residence	720	254		391	536	854	1,254		
Note: * irrigation system sizes are based on the assumption that the land application area is less than 10% slope. Reductions in DIR apply for slopes above 10% according to Table M2 of AS1547:2012									

Conventional Absorption Trenches and Beds - Primary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Weak Loams & High/Mod Clay Loams (3 & 4)**	**Weak Clay Loams (4)**	**Light Clays (5)**	**Massive Clay Loams (4)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**Not supported (Alternative Land Application System Required)**							
Development Type	**Daily (L/day)**								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								

Evapotranspiration-Absorption Trenches and Beds - Primary Treated Effluent (Category 1 to 5) and Secondary Treated Effluent only (Category 6)									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3a)**	**Weak/Massive Loams (3b)**	**High/Mod Clay Loams (4a)**	**Weak Clay Loams (4b) & Strong Light Clays (5a)**	**Massive Clay Loams (4c) and Mod & Weak Light Clays (5b, 5c)**	**Medium to Heavy Clays (6) - Secondary Effluent Only**
	DLR (mm)	**20***	**20***	**15**	**10**	**12**	**8**	**5**	**5**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing & setbacks**							
5 + bedroom residence	1,080	62		87	144	114	197	431	
4 bedroom residence	900	52		72	120	95	164	360	
1-3 bedroom residence	720	42		58	96	76	131	288	
Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012									

LPED Irrigation Systems - Primary or Secondary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**		
	DIR (mm)	**N/A (Alternative Land Application System Required)**	**4**	**3.5**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**		
Development Type	**Daily (L/day)**		**Total min. basal or 'wetted area'†**						
5 + bedroom residence	1,080		717	1,073					
4 bedroom residence	900		598	895					
1-3 bedroom residence	720		478	716					
† required for zero wet weather storage (m^2) not including spacing & setbacks									

Wick Trenches and Beds - Secondary Treated Effluent Only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2) Loams (3) & High/Mod Clay Loams (4a,b)**	**Weak Clay Loams (4)**	**Massive Clay Loams (4)**	**Strong Light Clays (5a)**	**Moderate Light Clays (5b)**	**Weak Light Clays (5c)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**25**	**30**	**20**	**10**	**12**	**8**	**8**	**N/A (Alternative Land Application System Required)**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing & setbacks**							
5 + bedroom residence	1,080	48	40	62	145	114	197		
4 bedroom residence	900	40	33	52	121	95	164		
1-3 bedroom residence	720	32	27	42	97	76	132		

K. Gellibrand Locality Report

1k. Introduction

Gellibrand is located approximately 21km south of Colac. It is located on elevated and dissected terraces or deeply dissected hills, abutting the Gellibrand River. Gellibrand is located on relatively flat land gently slopes in a northerly direction to the convergence of Charleys Creek and Lardner Creek. Notably, the entire locality is located within the Gellibrand River DWSC.

The locality has an estimated permanent population of approximately 210 residents (ABS Census, 2016). There are approximately 265 and 69 unsewered lots located within the Gellibrand locality and town, respectively. There are 5 new lots with DWM systems within the locality from June 2015-2021. There are 110 DWM system permits that have been inspected to date by COS (including PTI and CTU). The current DWM permits and their associated treatment system and LAA method within the Gellibrand locality are summarised as follows:

- 12 AWTS (5 drip irrigation, 1 trenches, 1 irrigation and 4 unknown);
- 1 constructed reed beds wetland (1 trench);
- 35 sand filters (1 drip irrigation and 34 subsurface irrigation);
- 36 septic tanks (12 trenches, 1 subsurface irrigation and 23 unknown); and
- 26 unknown (10 trenches and 16 unknown).

2k. Background Documentation

Refer to the following documents for additional detail regarding the locality:

- Gellibrand River Township Master Plan Report (October, 2005); and
- Colac Otway Domestic Wastewater Management Plan (2007);
- COS Planning Scheme; and
- Rural Living Strategy (2011).

3k. Site Assessment Results

The following table summarises the results from the representative audits conducted by Consultant staff in September 2014.

Characteristic	Description
Land use	Comprises of a range of land uses, including dairy, forestry, rural living and tourism.
Occupancy rates	2.3 (Gellibrand State Suburb, ABS Census, 2011).
Typical soils	Duplex profile. Very dark grey brown sandy clay loam surface soil overlying abruptly at 35cm a strongly mottled yellow brown, grey, strong brown silty clay, overlying a stratum of white and yellow coarse gravelly sand with rounded quartz pebbles between 140-170cm, overlying strongly mottled clay to at least 200cm. Drainage and permeability are variable depending on slope and position.

Characteristic	Description
AS/NZS 1547:2012 soil categories	5 (Light Clays)
Existing Systems	**Separate Blackwater and Greywater** Of the seven systems inspected during field investigations, three systems (43%) comprised separate blackwater treatment in a septic tank, with direct greywater diversion to either an adjacent paddock or street drain. Where discharged to paddocks or neighbouring vacant lots, greywater was typically ponded near the diversion outlet pipe, and often in areas trampled by livestock (cattle and sheep). The blackwater septic tanks were typically 40+ years old and less than half had been pumped out within the last ten years. Septic effluent discharged to one or more conventional absorption trenches, some of which could not be identified without the owner present. The majority of trenches were located on land of less than 8% slope and appeared to be parallel with contours (i.e. running across slope, not down it). There was evidence of blackwater effluent surcharging to the surface on one property (of three with separate blackwater and greywater systems). Soils were typically soft or boggy, mainly due to recent high rainfall. **Combined Blackwater and Greywater** Four of the seven systems (57%) inspected had combined wastewater treatment systems or were assumed to have combined systems, based on layout of pipework. It is likely that the proportion of combined systems in Gellibrand is likely to be less than this; however, this should be confirmed by ongoing inspections by Council. Septic effluent discharged to one or more conventional absorption trenches. At least one of the four properties had undersized trenches for the number of bedrooms; and on one property the LAA could not be identified and there was inadequate suitable space for an appropriately sized LAA.

4k. Summary of Constraints to DWM

Characteristic	Description
Climate Zone	Zone 3.
Surface waterways & catchments	The locality is located entirely within the Gellibrand River DWSC. There is an extensive drainage network surrounding the town; including Gellibrand River transversing southeast to northwest, Love Creek, Charleys Creek, Lardner Creek and Asplin Creek.
Groundwater	Proximity to groundwater bores: significantly dense distribution throughout the town and along the river, similar to Kawarren.

Characteristic	Description
	Groundwater depth: 1.5 – 2m below surface.
Land subject to inundation	Extensive along Gellibrand River, Charleys Creek, Lardner Creek and Love Creek; envelopes the town.
Useable lot area **Town (Locality)**	High: 19 (58) Moderate: 32 (46) Low: 18 (148) Compliant: 0 (13)
Minimum lot size compliance with Planning Scheme Zoning	The locality is predominantly zoned Farming Zone and Public Conservation and Resource Zone. The town is zoned Township Zone, Public Park and Recreation Zone and Public Use Zone. Compliancy is variable throughout the locality, with the majority of the lots within the town compliant. Compliant: 62 (93) Non-compliant: 7 (172)
Slope **Town (Locality)**	High: 0 (84) Moderate: 0 (24) Low: 69 (157)
Geology	Various underlying geology. Majority of town is a river terrace with clay and sand which is moderately sorted and poorly consolidated. Northern tip is alluvial floodplain with silt, sand, and gravel deposits which are also moderately sorted and poorly consolidated. South – Eumeralla Formation of the Otway Group. Dilwyn Formation of Wangeripp Group is directly south of town. Older Volcanic Group (volcanic plugs, sills, dykes, pillow and pyroclastic deposits) to the east and north of town. Wiridjil Gravel Member of Pebble Point Formation to west of town towards Carlisle River. South eastern edge is a shallow marine deposit with sand, clay and silt.
Soil suitability **Town (Locality)**	High: 63 (124) Moderate: 6 (141) Low: 0 (0)

Characteristic	Description
	The majority of the town is classified as having a high soil suitability constraint. The dominant soil landscape unit of the town consists of '67' which forms on deeply dissected hills abutting the Gellibrand River to the west of Love Creek. The soils consist of brown gradational soils, strongly structured sandy clay loam over weakly structured light clay, to 0.9m depth. Limitations include acidity. The western and southern regions of the town consist of soil landscape unit '94' which forms on elevated, and in parts, uplifted and dissected system of ancient cut and depositional terraces of Gellibrand River. The soils consist of grey sand soils with structured clay underneath; strongly structured sandy loam over moderately structured medium clay; to depths of more than 2m. Limitations include low fertility and restricted drainage. The northern region of the locality consists of soil landscape unit '90' which forms on the rolling hills in the northern upper reaches of the Gellibrand catchment and consists of mottled gradational soil to more than 2m depth. The soil consists of apedal fine sandy loam over weakly structured silty clay loam. Limitations include low p-sorb, low fertility and restricted drainage. The southern half of the locality consists of soil landscape unit '61' which forms on the deeply dissected hills of the Otway Ranges and consist of brown gradational soils to 1.2m depth. The soils consist of moderately structured silty loam over clay loam. Limitations include acidity and restricted drainage. Predominant soil is yellow sandy gravel fill over brown clayey sandy silt overlying dark brown silty fine sand. Soil capacity for good drainage but waterlogged during wetter months.
Sensitivity Overlay	Depth to Groundwater Compliance: variable throughout locality. Non-compliant particularly to the southeast of the locality around Gellibrand River and Lardner Creek. Landslip: excessive, particularly to northwest of town. Vegetation: Otway Forest Park in southeast corner.
Sensitivity Analysis Rating **Town (Locality)**	Very High: 0 (2) High: 19 (61) Moderate: 50 (202) Low: 0 (0)

5k. Sensitivity Analysis (Maps)

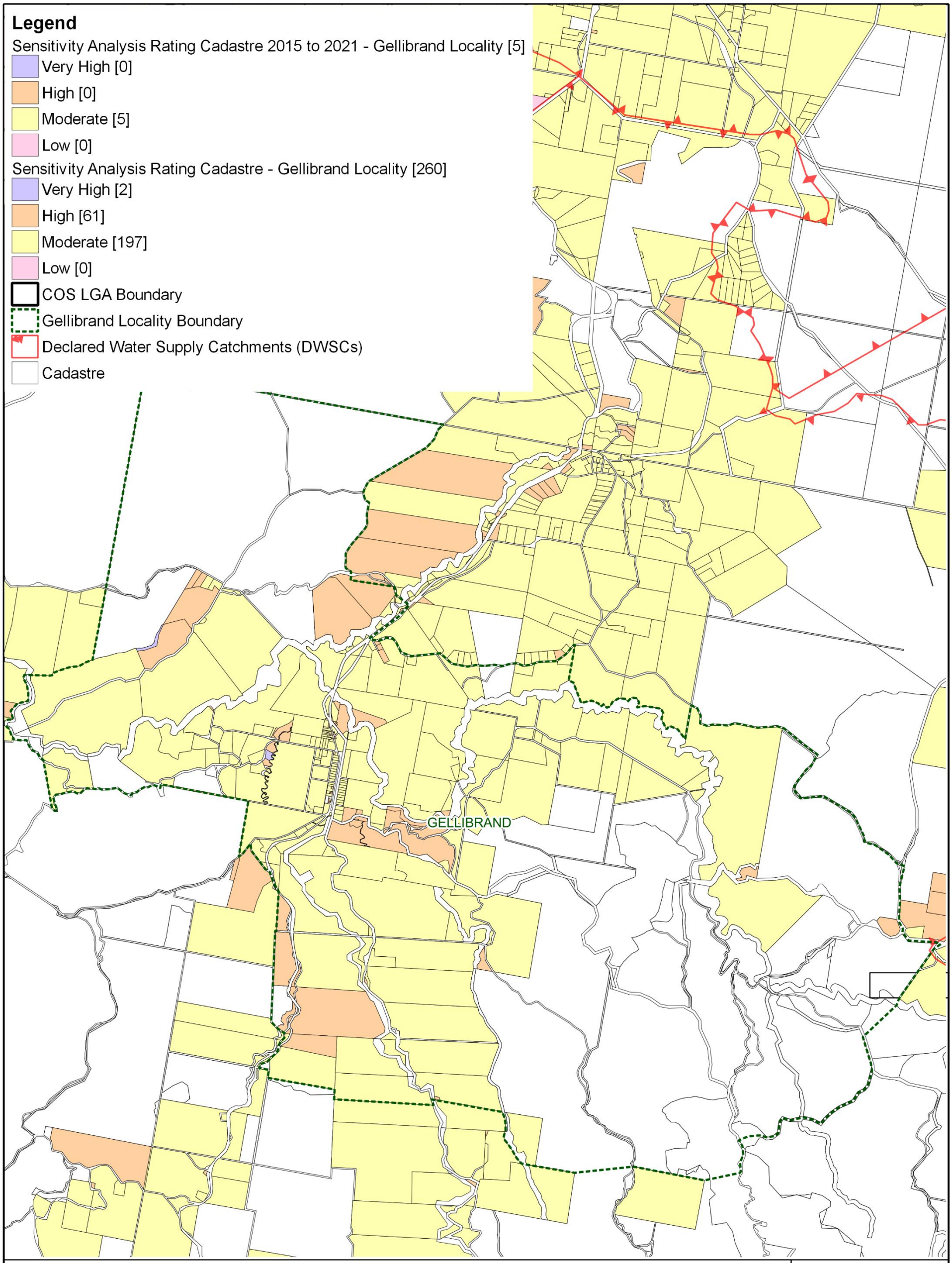


Figure k1: Sensitivity Analysis - Gellibrand Locality

Colac Otway Shire DWMP Review

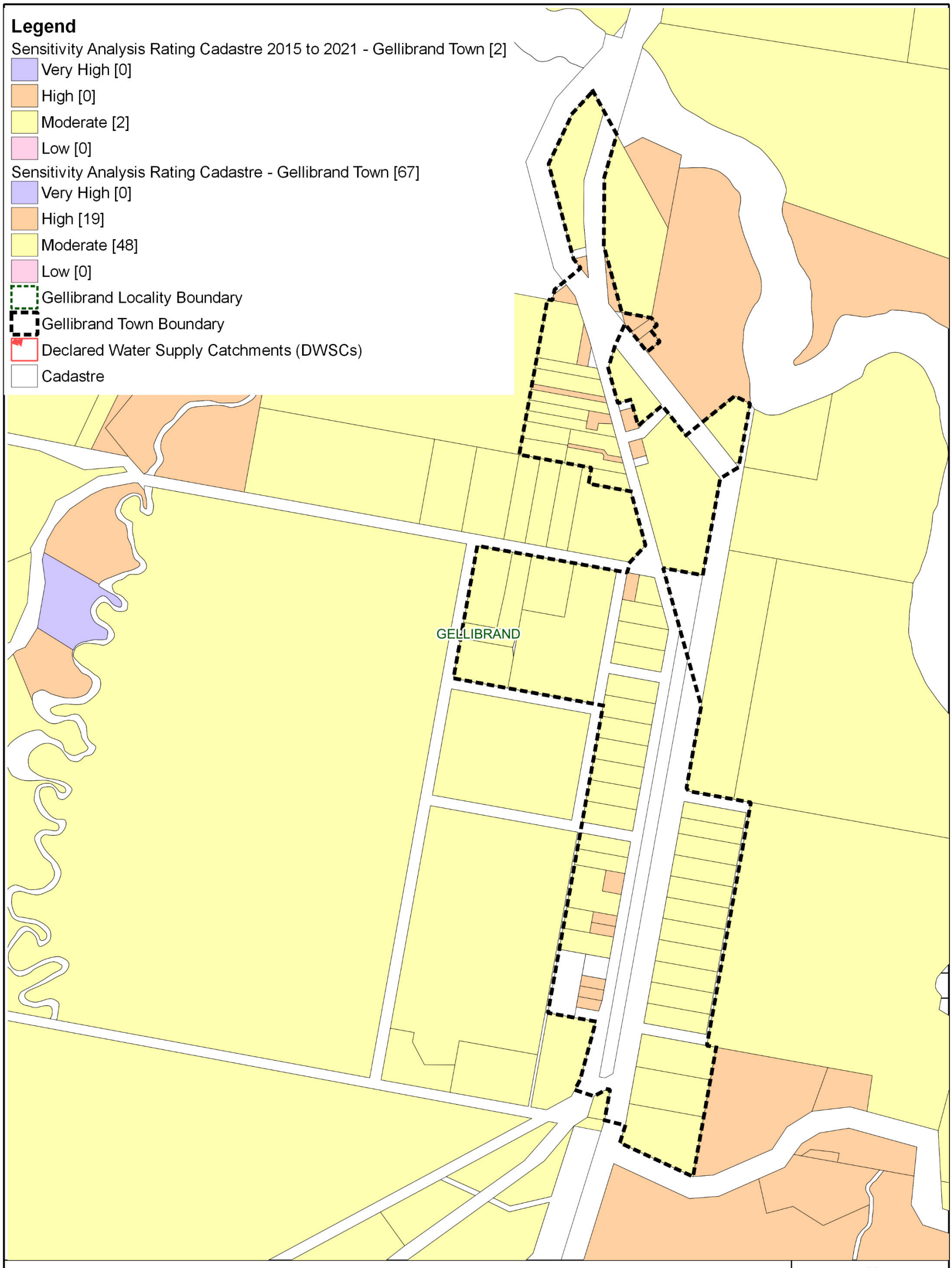


Figure k2: Sensitivity Analysis - Gellibrand Town

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 150 300 450 600 750 m

(Approx Scale)

N

Revision	4
Drawn	JK
Approved	MS

6k. System Selection

Due to the dominance of heavy-textured soils in the Gellibrand locality, conventional absorption trenches and beds are not likely to be feasible and are discouraged. Appendix A of the EPA Code of Practice (2013) prohibits LPED systems on Category 5 and 6 soils (medium to heavy clays).

EPA Code of Practice (2013) (Section 2.2.2) identifies secondary treatment standard (or better) followed by subsurface pressure-compensating irrigation as current best-practice in Victoria for substantially reducing the risk associated with unsewered development. Further, the Code describes a "Wick trench/bed" land application option that may be incorporated with secondary treatment for consideration on sites constrained by climate or lot 'useable area', particularly within the DWSCs. Any variation from this best-practice approach must be provided with detailed supporting information to demonstrate suitability. The System Sizing Tables (below) indicate which systems are likely to be the most appropriate for the locality.

7k. System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. Monthly 70th percentile rainfall and average evapotranspiration data for Gellibrand was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

The Design Loading Rates (DLRs) and Design Irrigation Rates (DIRs) were taken from the current EPA Code of Practice. Where the Code of Practice has precluded use of a particular type of system on a certain soil type, it is shown as 'Not Applicable' for that soil type in the Sizing Tables. Where the evapotranspiration deficit requires unrealistically large land application areas for a particular system on a certain soil type, it is also shown as 'Not Applicable' for that soil type in the Sizing Tables. Detailed, site-specific LCAs and system designs would be required to further investigate the feasibility of systems deemed 'Not Applicable' in the sizing tables. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained lots.

Sizing Tables for the Gellibrand locality are provided below.

8k. General Conclusion

The Rural Living Strategy (2011) identified Gellibrand as having 'deferred' growth potential, dependent on water catchment constraints and bushfire hazard being satisfactorily addressed. The Sensitivity Analysis concludes that development is feasible given its predominantly Moderate Sensitivity to DWM, particular within the town. Particular attention needs to be directed towards ensuring that appropriate setbacks to surface waterways, groundwater bores and flood prone areas are maintained, that the DWM systems are sized based on the limiting soil horizon and that the depth to groundwater during site-specific LCAs is ascertained. It is imperative that there is sufficient useable area to sustainably manage wastewater on-site. Some areas within the locality are considered to be extensively prone to landslip; a geotechnical report by a suitably qualified person will need to be conducted to address this constraint. Predominantly, Standard and Detailed LCAs will be required, with the use of System Sizing Tables deemed appropriate for the lots assigned a Moderate Sensitivity Rating. The Low Sensitivity Rating lots within a DWSC are required to complete a Standard LCA as per the current EPA Code of Practice's requirements.

Gellibrand & Kawarren

Drip and Spray Irrigation Systems* - Secondary Treated Effluent only								
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**	
	DIR (mm)	**5**	**5**	**4**	**3.5**	**3**	**2**	
Development Type	**Daily (L/day)**	**Total min. irrigation area required for zero wet weather effluent storage (m^2)†**						
5 + bedroom residence	1,080	379		584	800	1,269	2,329	
4 bedroom residence	900	316		487	667	1,058	1,941	
1-3 bedroom residence	720	253		389	533	846	1,553	

Note: * irrigation system sizes are based on the assumption that the land application area is less than 10% slope. Reductions in DIR apply for slopes above 10% according to Table M2 of AS1547:2012

† not including spacing or setbacks

Conventional Absorption Trenches and Beds - Primary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Weak Loams & High/Mod Clay Loams (3 & 4)**	**Weak Clay Loams (4)**	**Light Clays (5)**	**Massive Clay Loams (4)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**Not supported (Alternative Land Application System Required)**							
Development Type	**Daily (L/day)**								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								

Evapotranspiration-Absorption Trenches and Beds - Primary Treated Effluent (Category 1 to 5) and Secondary Treated Effluent only (Category 6)									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3a)**	**Weak/Massive Loams (3b)**	**High/Mod Clay Loams (4a)**	**Weak Clay Loams (4b) & Strong Light Clays (5a)**	**Massive Clay Loams (4c) and Mod & Weak Light Clays (5b, 5c)**	**Medium to Heavy Clays (6) - Secondary Effluent Only**
	DLR (mm)	**20***	**20***	**15**	**10**	**12**	**8**	**5**	**5**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing & setbacks**							
5 + bedroom residence	1,080	62		87	145	114	197	433	
4 bedroom residence	900	52		73	121	95	164	361	
1-3 bedroom residence	720	42		58	97	76	132	289	

Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012

LPED Irrigation Systems - Primary or Secondary Treated Effluent								
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**	
	DIR (mm)	**N/A (Alternative Land Application System Required)**	**4**	**3.5**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**	
Development Type	**Daily (L/day)**		**Total min. basal or 'wetted area'†**					
5 + bedroom residence	1,080		723	1,086				
4 bedroom residence	900		603	905				
1-3 bedroom residence	720		482	724				

† required for zero wet weather storage (m^2) not including spacing & setbacks

Wick Trenches and Beds - Secondary Treated Effluent Only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2) Loams (3) & High/Mod Clay Loams (4a,b)**	**Weak Clay Loams (4)**	**Massive Clay Loams (4)**	**Strong Light Clays (5a)**	**Moderate Light Clays (5b)**	**Weak Light Clays (5c)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**25**	**30**	**20**	**10**	**12**	**8**	**8**	**N/A (Alternative Land Application System Required)**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing & setbacks**							
5 + bedroom residence	1,080	49	40	62	145	114	197		
4 bedroom residence	900	41	33	52	121	95	164		
1-3 bedroom residence	720	33	27	42	97	76	132		

L. Kawarren Locality Report

1l. Introduction

Kawarren is located approximately 16km south of Colac. It is located on rolling hills or dissected hills abutting rivers and streams or large flood plains with undulating agricultural land. Notably, approximately 90% of the locality is located within a DWSC; predominantly Gellibrand River DWSC and a small portion in the northeast corner located within Barwon Downs Wellfield Intake DWSC.

The locality has an estimated permanent population of approximately 166 residents (ABS Census, 2016). There are approximately 215 and 72 unsewered lots located within the Kawarren locality and settlement, respectively. There are 3 new lots with DWM systems within the locality from June 2015-2021. There are 71 DWM system permits that have been inspected to date by COS (including PTI and CTU). The current DWM permits and their associated treatment system and LAA method within the Kawarren locality are summarised as follows:

- 11 AWTS (1 drip irrigation, 1 trench, 1 irrigation and 7 unknown);
- 1 composting toilet (1 trench);
- 3 sand filter (1 irrigation and 2 subsurface irrigation);
- 40 septic tank (12 trenches and 28 unknown); and
- 16 unknown (10 trenches and 6 unknown).

2l. Background Documentation

Refer to the following documents for additional detail regarding the locality:

- COS Planning Scheme; and
- Rural Living Strategy (2011).

3l. Site Assessment Results

The following table summarises the results from the representative audits conducted by Consultant staff in September 2014.

Characteristic	Description
Land use	Comprises of a range of land uses, including dairy, forestry, rural living and tourism.
Occupancy rates	2.3 persons (Part of the Gellibrand State Suburb ABS Census, 2011)[5].
Typical soils	Grey brown fine sandy loam to fine sandy clay loam becoming mottled at 15cm, abrupt change at 30cm to mottled light yellow grown and grey brown silty clay loam, grading to increasing mottling with depth to bright dark yellow brown, strong brown silty clay loam with some black

[5] No separate data for individual small townships and localities.

Characteristic	Description
	small concretions below 80cm depth. Drainage and permeability are variable depending on slope and position.
AS/NZS 1547:2012 soil categories	4 (Clay Loams) to 5 (Light Clays)
Existing Systems	**Separate Blackwater and Greywater** Of the 8 systems inspected during field investigations, 75% of systems comprised separate blackwater treatment in a septic tank, with direct greywater diversion to an adjacent paddock (not to street drains, due to blocks generally sloping away from the street frontage). Greywater was typically ponded near the diversion outlet pipe, and often in areas trampled by livestock (cattle and sheep). The blackwater septic tanks were typically 40+ years old and approximately half had been pumped out within the last ten years. Septic effluent discharged to one or more conventional absorption trenches, some of which could not be identified without the owner present. The majority of trenches were located on land of less than 8% slope and appeared to be parallel with contours (i.e. running across slope, not down it). There was no evidence of blackwater effluent surcharging to the surface; however, soils were typically soft or boggy, mainly due to recent high rainfall. **Combined Blackwater and Greywater** 25% of systems inspected had combined wastewater treatment systems or were assumed to have combined systems, based on layout of pipework. It is likely that the proportion of combined systems in Kawarren is less than this; however, this should be confirmed by ongoing inspections by Council. Septic effluent discharged to one or more conventional absorption trenches, which were all undersized for the number of bedrooms, and/or located in inadequately sized available land application areas (LAAs).

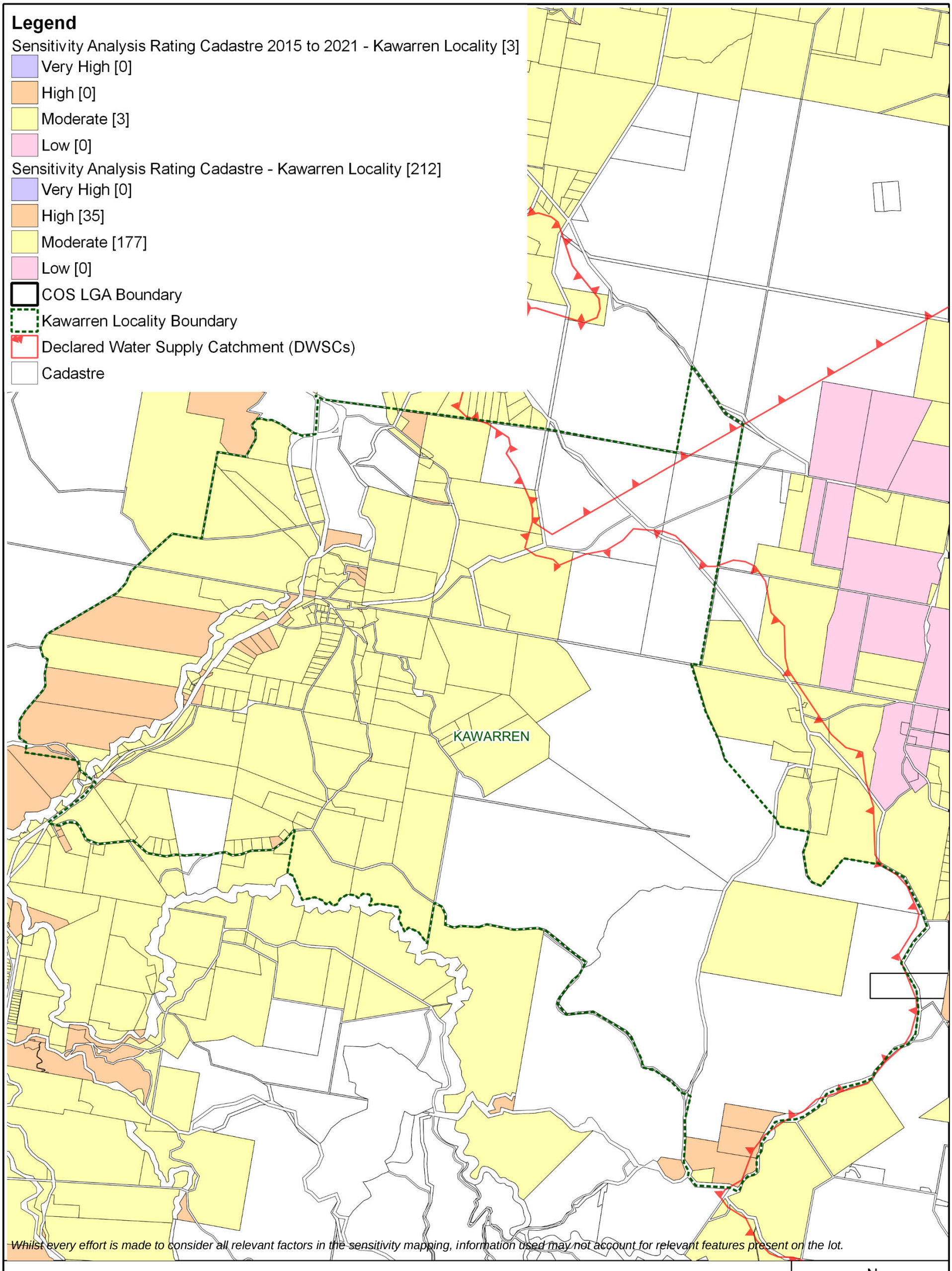
4l. Summary of Constraints to DWM

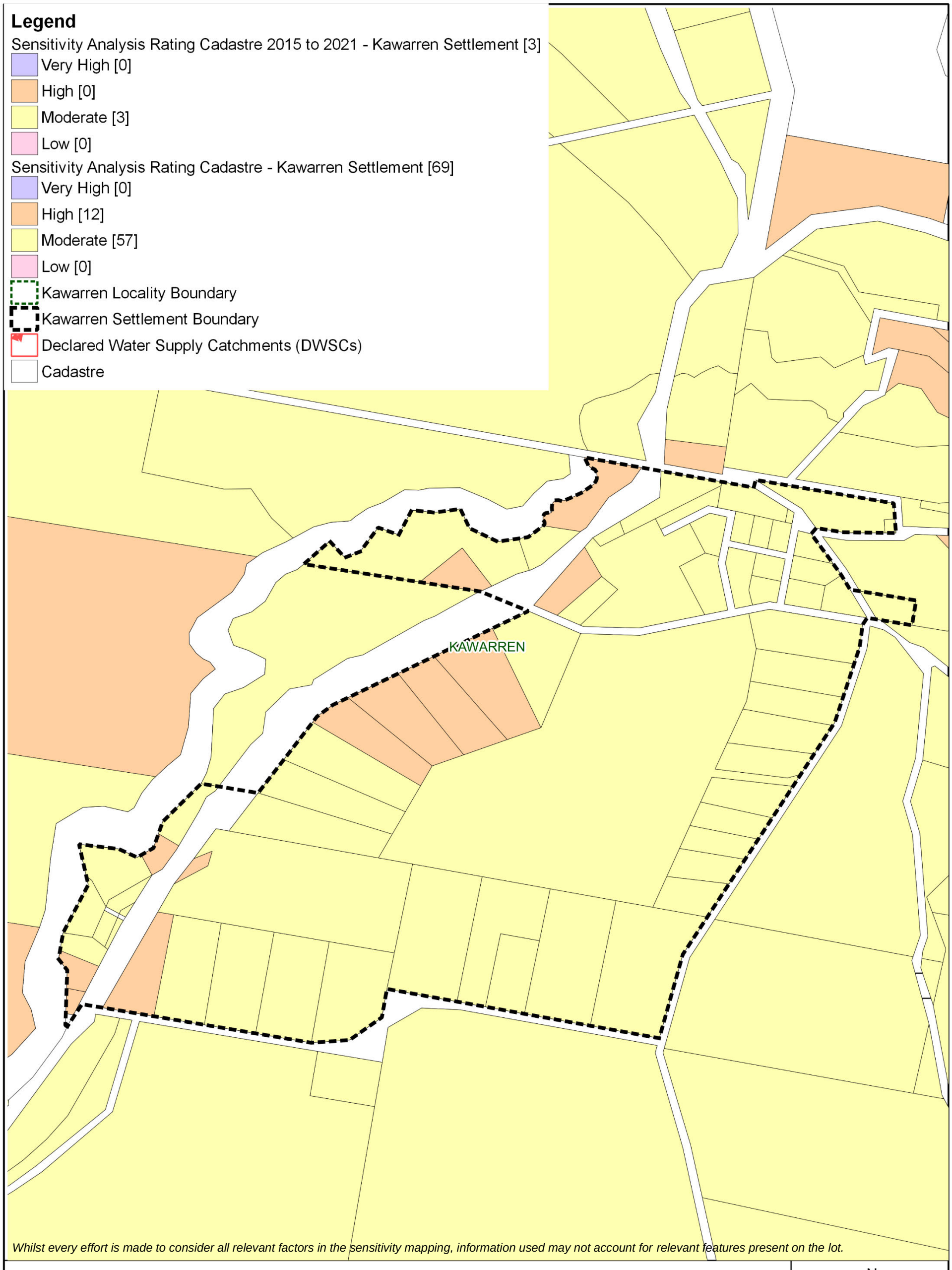
Characteristic	Description
Climate Zone	Zones 2 and 3.
Surface waterways & catchments	The locality is located within the Gellibrand River and Barwon Downs Wellfield Intake DWSCs. The waterways include: Love Creek to the north of the settlement, Yahoo Creek, Ten Mile Creek, and Porcupine Creek which contains an extensive waterbody.

Characteristic	Description
Groundwater	Proximity to groundwater bores: significantly dense distribution throughout the settlement and along the river, similar to Gellibrand.
Land subject to inundation	Nil.
Useable lot area **Settlement (Locality)**	High: 37 (72) Moderate: 6 (16) Low: 29 (121) Compliant: 0 (6)
Minimum lot size compliance with Planning Scheme Zoning	The locality is predominantly zoned Farming Zone and Public Conservation and Resource Zone. The settlement is zoned Rural Living Zone. The majority of lots are non-compliant, particularly within the settlement. Compliant: 1 (24) Non-compliant: 71 (191)
Slope **Settlement (Locality)**	High: 6 (58) Moderate: 29 (74) Low: 37 (83)
Geology	Gellibrand Marl of Heytesbury Group (continental shelf deposits) is dominant with Older Volcanic Group to the west and north of settlement. The Clifton Formation of Heytesbury Group straddles the Older Volcanic Group and alluvial flood plain deposits. Demons Bluff Formation of the Nirranda Group is to the north of locality.
Soil suitability **Settlement (Locality)**	High: 0 (13) Moderate: 72 (202) Low: 0 (0) Variable soil landscapes throughout locality (5 in total). The settlement and the majority of the locality consists of soil landscape unit ‘90’ which forms on the rolling hills in the northern upper reaches of the Gellibrand catchment and consists of mottled gradational soil to more than 2m depth. The soil consists of apedal fine sandy loam over weakly structured silty clay loam. Limitations include low p-sorb, low fertility and restricted drainage. The settlement and to the east of the locality consists of soil landscape unit ‘76’ which forms on undulating plains. The soil consists of grey

Characteristic	Description
	sand soils to more than 2m depth with weak loamy sand overlying apedal sand. Limitations include low fertility.
Sensitivity Overlay	Depth to Groundwater Compliance: predominantly compliant, except for along Love Creek which transverses northeast to southwest around the settlement. Landslip: minimal, with a few large regions to the east of the settlement. Vegetation: eastern half of locality consists of Otway Forest Park and Great Otway National Park.
Sensitivity Analysis Rating **Settlement (Locality)**	Very High: 0 (0) High: 12 (35) Moderate: 60 (180) Low: 0 (0)

5l. Sensitivity Analysis (Maps)


Legend
Sensitivity Analysis Rating Cadastre 2015 to 2021 - Kawarren Locality [3]
Very High [0]
High [0]
Moderate [3]
Low [0]
Sensitivity Analysis Rating Cadastre - Kawarren Locality [212]
Very High [0]
High [35]
Moderate [177]
Low [0]
COS LGA Boundary
Kawarren Locality Boundary
Declared Water Supply Catchment (DWSCs)
Cadastre
KAWARREN
Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.
Figure I1: Sensitivity Analysis - Kawarren Locality
Colac Otway Shire DWMP Review
N
Whitehead & Associates
Environmental Consultants
0 1 2 3 4 5 km
(Approx Scale)
Revision 4
Drawn JK
Approved MS



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure I2: Sensitivity Analysis - Kawarren Settlement

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 0.25 0.5 0.75 1 1.25 km

(Approx Scale)

N

Revision	4
Drawn	JK
Approved	MS

6l. System Selection

Based on soil types and indicative depths, the Kawarren locality has the potential to sustainably accommodate a broad range of system types, depending on the influences of climate.

EPA Code of Practice (2013) (Section 2.2.2) identifies secondary treatment standard (or better) followed by subsurface pressure-compensating irrigation as current best-practice in Victoria for substantially reducing the risk associated with unsewered development. Further, the Code describes a "Wick trench/bed" land application option that may be incorporated with secondary treatment for consideration on sites constrained by climate or lot 'useable area', particularly within the DWSCs. Any variation from this best-practice approach must be provided with detailed supporting information to demonstrate suitability.

System Sizing Tables (below) indicate which systems are likely to be the most appropriate for the locality.

7l. System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. Monthly 70th percentile rainfall and average evapotranspiration data for Kawarren was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

The Design Loading Rates (DLRs) and Design Irrigation Rates (DIRs) were taken from the current EPA Code of Practice. Where the Code of Practice has precluded use of a particular type of system on a certain soil type, it is shown as 'Not Applicable' for that soil type in the Sizing Tables. Where the evapotranspiration deficit requires unrealistically large land application areas for a particular system on a certain soil type, it is also shown as 'Not Applicable' for that soil type in the Sizing Tables. Detailed, site-specific LCAs and system designs would be required to further investigate the feasibility of systems deemed 'Not Applicable' in the sizing tables. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained lots.

Sizing Tables for the Kawarren locality are provided below.

8l. General Conclusion

The lots within the locality have predominantly been assigned a Moderate Sensitivity Rating to sustainable DWM; however, some lots, particularly in the settlement, have been assigned a High and Low Sensitivity Rating. Predominantly, Standard LCAs will be required, with the use of System Sizing Tables deemed appropriate. The Low Sensitivity Rating lots within a DWSC are required to complete a Standard LCA as per the current EPA Code of Practice's requirements. Particular attention needs to be directed towards ensuring that appropriate setbacks to surface waterways, groundwater bores and flood prone areas are maintained. It is imperative that there is sufficient useable area to sustainably manage wastewater on-site.

Gellibrand & Kawarren

Drip and Spray Irrigation Systems* - Secondary Treated Effluent only								
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**	
	DIR (mm)	**5**	**5**	**4**	**3.5**	**3**	**2**	
Development Type	**Daily (L/day)**	**Total min. irrigation area required for zero wet weather effluent storage (m^2)†**						
5 + bedroom residence	1,080	379		584	800	1,269	2,329	
4 bedroom residence	900	316		487	667	1,058	1,941	
1-3 bedroom residence	720	253		389	533	846	1,553	

Note: * irrigation system sizes are based on the assumption that the land application area is less than 10% slope. Reductions in DIR apply for slopes above 10% according to Table M2 of AS1547:2012

† not including spacing or setbacks

Conventional Absorption Trenches and Beds - Primary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Weak Loams & High/Mod Clay Loams (3 & 4)**	**Weak Clay Loams (4)**	**Light Clays (5)**	**Massive Clay Loams (4)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**Not supported (Alternative Land Application System Required)**							
Development Type	**Daily (L/day)**								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								

Evapotranspiration-Absorption Trenches and Beds - Primary Treated Effluent (Category 1 to 5) and Secondary Treated Effluent only (Category 6)									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3a)**	**Weak/Massive Loams (3b)**	**High/Mod Clay Loams (4a)**	**Weak Clay Loams (4b) & Strong Light Clays (5a)**	**Massive Clay Loams (4c) and Mod & Weak Light Clays (5b, 5c)**	**Medium to Heavy Clays (6) - Secondary Effluent Only**
	DLR (mm)	**20***	**20***	**15**	**10**	**12**	**8**	**5**	**5**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing & setbacks**							
5 + bedroom residence	1,080	62		87	145	114	197	433	
4 bedroom residence	900	52		73	121	95	164	361	
1-3 bedroom residence	720	42		58	97	76	132	289	

Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012

LPED Irrigation Systems - Primary or Secondary Treated Effluent								
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**	
	DIR (mm)	**N/A (Alternative Land Application System Required)**	**4**	**3.5**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**	
Development Type	**Daily (L/day)**		**Total min. basal or 'wetted area'†**					
5 + bedroom residence	1,080		723	1,086				
4 bedroom residence	900		603	905				
1-3 bedroom residence	720		482	724				

† required for zero wet weather storage (m^2) not including spacing & setbacks

Wick Trenches and Beds - Secondary Treated Effluent Only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2) Loams (3) & High/Mod Clay Loams (4a,b)**	**Weak Clay Loams (4)**	**Massive Clay Loams (4)**	**Strong Light Clays (5a)**	**Moderate Light Clays (5b)**	**Weak Light Clays (5c)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**25**	**30**	**20**	**10**	**12**	**8**	**8**	**N/A (Alternative Land Application System Required)**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing & setbacks**							
5 + bedroom residence	1,080	49	40	62	145	114	197		
4 bedroom residence	900	41	33	52	121	95	164		
1-3 bedroom residence	720	33	27	42	97	76	132		

M. Kennett River Locality Report

1m. Introduction

Kennett River is a coastal locality along the south-eastern coastline of COS, approximately 20km northeast of Apollo Bay, in the heavily vegetated foothills of the south-eastern section of the Otway Ranges. The locality is not located within a DWSC.

The locality has an estimated permanent population of approximately 41 residents (ABS Census, 2016). There are 183 and 180 unsewered lots within the Kennett River locality and town, respectively. There are no new lots with DWM systems within the locality from June 2015-2021. There are 120 DWM system permits that have been inspected to date by COS (including PTI and CTU). The current DWM permits and their associated treatment system and LAA method within the Kennett River locality is summarised as follows:

- 39 AWTS (13 drip irrigation, 3 irrigation, 4 subsurface irrigation, 2 trenches and 17 unknown);
- 52 sand filters (50 subsurface irrigation, 1 trench and 1 unknown)
- 10 septic tanks (2 trenches and 8 unknown)
- 19 unknown (5 trenches, 1 subsurface irrigation and 13 unknown).

No field investigations were conducted in Kennett River as part of the 2014 field assessments.

2m. Background Documentation

Refer to the following documents for additional detail regarding the locality.

- Colac Otway Shire Coastal Community Revitalisation Project (April 2003);
- Colac Otway Shire, Three Towns Stormwater Management Strategy, Concept Study (October 2004);
- Concept Design for Wye River Separation Creek and Kennett River, (June 2006);
- Kennett River, Wye River and Separation Creek Structure Plans (February 2008);
- COS Planning Scheme; and
- Rural Living Strategy (2011).

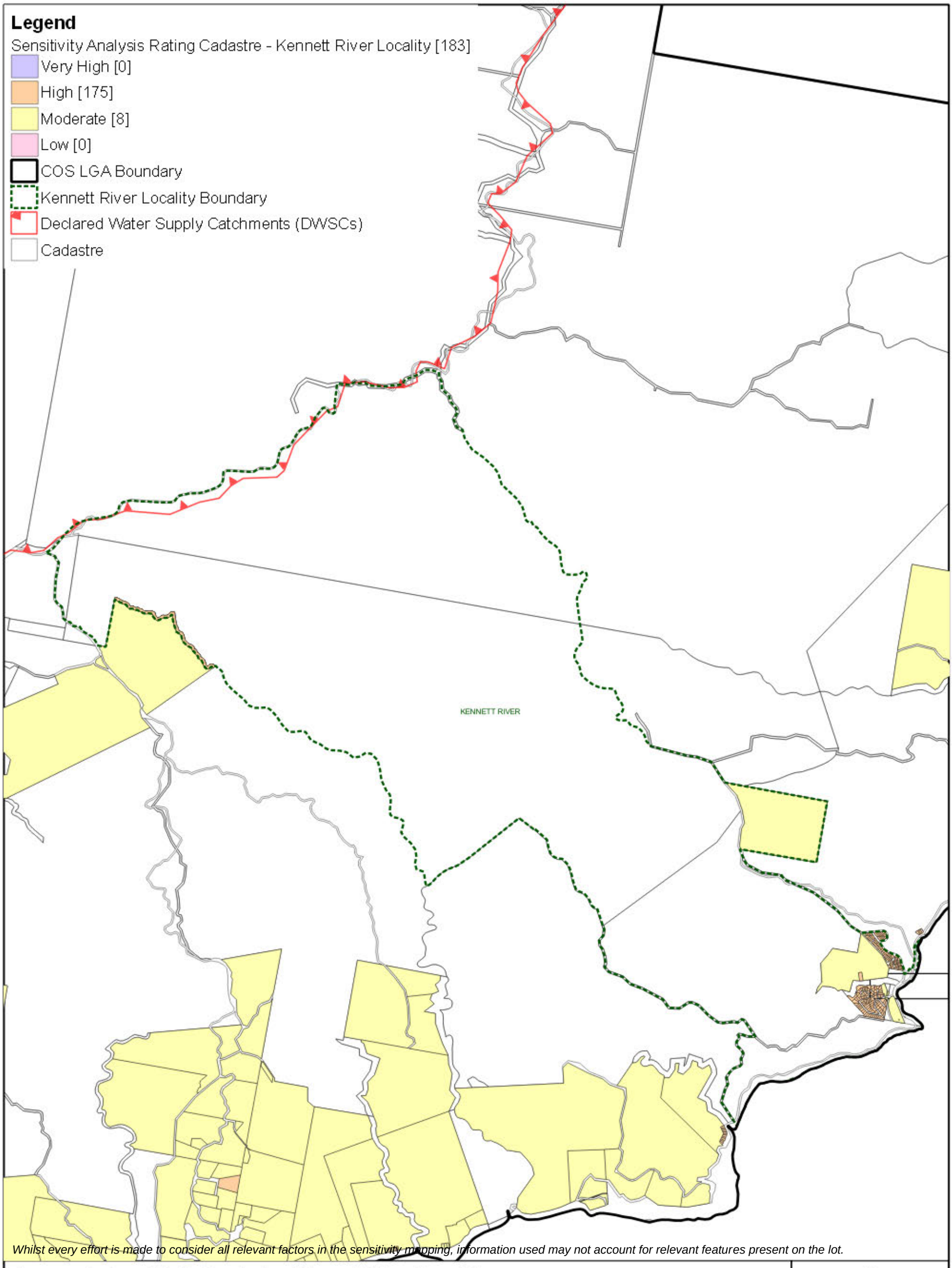
3m. Summary of Constraints to DWM

Characteristic	Description
Climate Zone	Zone 2.
Surface waterways & catchments	The locality is not located within a DWSC. Kennett River and its tributaries form the major waterway within this region and confluences with the Southern Ocean. Kennett River east and west branches are located in the top of the catchment before merging. Additional waterways within the Kennett River locality include, Grey River and Carisbrook Creek which flows along the western locality boundary.

Characteristic	Description
Groundwater	Proximity to groundwater bores: none.
Land subject to inundation	Along the confluences of Kennett River around the town.
Useable lot area **Town (Locality)**	High: 172 (172) Moderate: 7 (8) Low: 1 (2) Compliant: 0 (1)
Minimum lot size compliance with Planning Scheme Zoning	The locality is predominantly zoned Public Conservation and Resource Zone, with small sections of Rural Conservation Zone. The town is zoned Township Zone, with Public Use Zone along the foreshore. The majority of the lots are compliant. There are prescribed minimum lot sizes for subdivisions, as per Design and Development Overlay Schedule 4 (DDO4 – Coastal Towns: Skenes Creek, Kennett River, Wye River and Separation Creek). Compliant: 178 (179) Non-compliant: 2 (4)
Slope **Town (Locality)**	High: 160 (163) Moderate: 15 (15) Low: 5 (5)
Geology	Eumeralla Formation of the Otway Group with alluvial floodplain deposits around the Kennett River confluence.
Soil suitability **Town (Locality)**	High: 0 (0) Moderate: 180 (183) Low: 0 (0) Along the coastline and town consists of soil landscape ‘64’ (moderate rating) which forms in the similar landscape as detailed in ‘61’. It consists of brown texture contrast soils to 0.9m depth. The soils consist of weakly structured clay sand over strongly structured clay loam. The northern half of the locality consists of soil landscapes ’61 and 59’, which are located within the forested regions of the Great Otway National Park.
Sensitivity Overlay	No depth to groundwater data. Landslip: minimal, found along the foreshore and a small section along the eastern boundary to the north of the town.

Characteristic	Description
	Vegetation: all land surrounding the town is defined as Great Otway National Park and Kennett River Coastal Reserve.
Sensitivity Analysis Rating **Town (Locality)**	Very High: 0 (0) High: 174 (175) Moderate: 6 (8) Low: 0 (0)

4m. Sensitivity Analysis (Maps)



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure m1: Sensitivity Analysis - Kennett River Locality

Colac Otway Shire DWMP Review

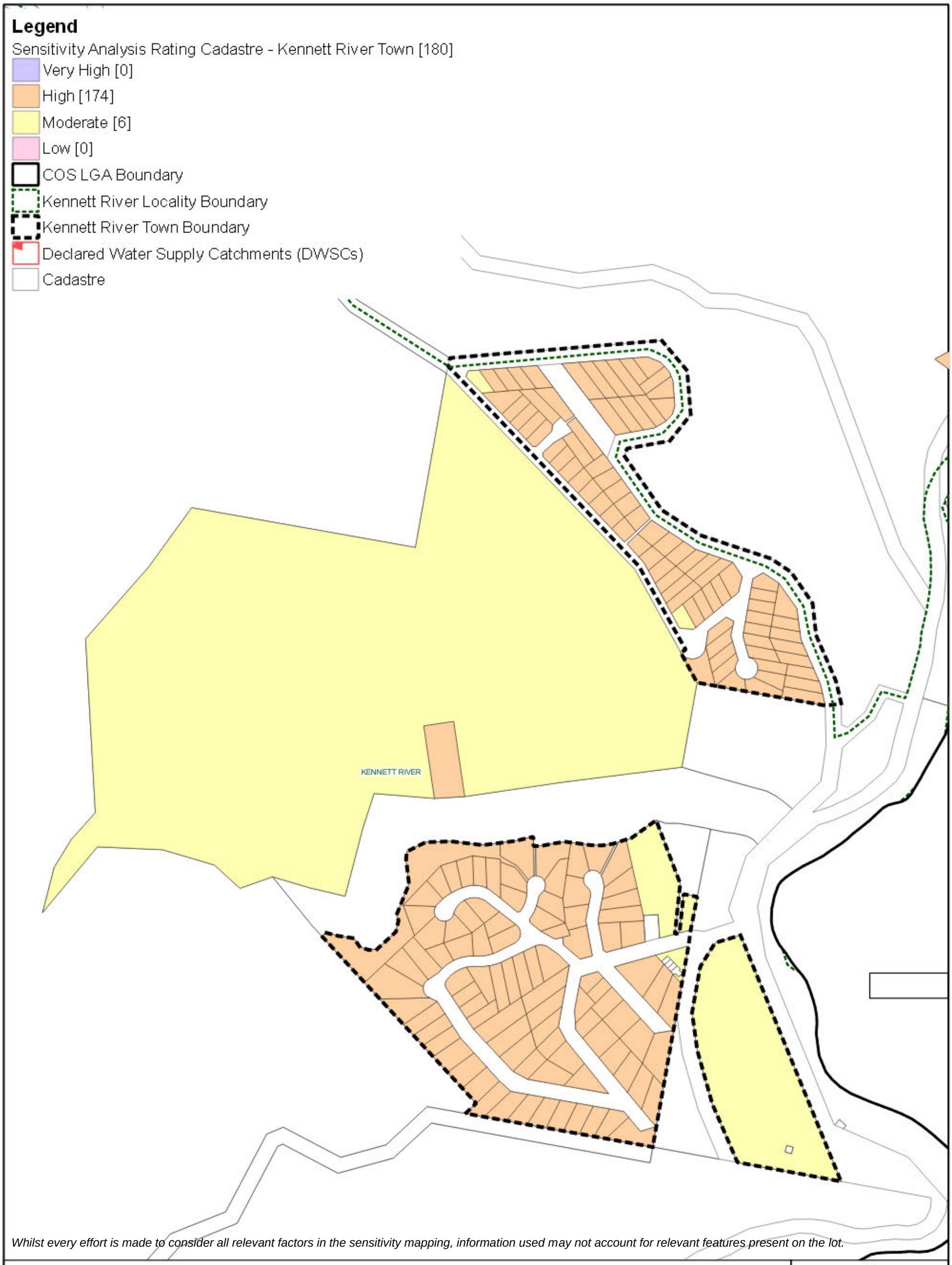
Whitehead & Associates Environmental Consultants

0 1 2 3 4 5 km

(Approx Scale)

N

Revision	3
Drawn	JK
Approved	MS


Legend
Sensitivity Analysis Rating Cadastre - Kennett River Town [180]
Very High [0]
High [174]
Moderate [6]
Low [0]
COS LGA Boundary
Kennett River Locality Boundary
Kennett River Town Boundary
Declared Water Supply Catchments (DWSCs)
Cadastre
KENNETT RIVER
Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.
Figure m2: Sensitivity Analysis - Kennett River Town
Colac Otway Shire DWMP Review
Whitehead & Associates
Environmental Consultants
0 100 200 300 400 500 m
(Approx Scale)
N
Revision 2
Drawn JK
Approved MS

5m. System Selection

Soil types vary significantly in the Kennett River area depending on position in the landscape (i.e. sand deltas or hill slopes). Appendix A of the EPA Code of Practice (2013) prohibits conventional and modified trenches and beds as well as LPED systems on Category 1 soils (sands), which preclude these systems on the delta areas. Landslip risks and land gradients are major constraints for DWM on lots located on the hillslopes in the locality. As such, site-specific LCA investigations and system designs are recommended; however, the sizing tables (below) provide some guidance on which systems may be appropriate. Note that the DIR for subsurface irrigation systems has not been reduced to account for slopes above 10% (as is recommended in AS/NZS 1547:2012). Surface irrigation is not recommended on slopes greater than 10%.

6m. System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. Monthly 70th percentile rainfall and average evapotranspiration data for the Kennett River and Sugarloaf area was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

The Design Loading Rates (DLRs) and Design Irrigation Rates (DIRs) were taken from the current EPA Code of Practice. Where the Code of Practice has precluded use of a particular type of system on a certain soil type, it is shown as 'Not Applicable' for that soil type in the Sizing Tables. Where the evapotranspiration deficit requires unrealistically large land application areas for a particular system on a certain soil type, it is also shown as 'Not Applicable' for that soil type in the Sizing Tables. Detailed, site-specific LCAs and system designs would be required to further investigate the feasibility of systems deemed 'Not Applicable' in the sizing tables. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained lots.

Sizing Tables for the Kennett River locality are provided below.

7m. General Conclusion

The lots within the locality have been assigned a Moderate or High Sensitivity Rating to sustainable DWM, with the majority of the town assigned as High. Both Standard and Detailed LCAs will be required, with the use of System Sizing Tables deemed appropriate for the Standard LCAs. Particular attention needs to be directed towards ensuring that the DWM systems are sized based on the limiting soil horizon, which may be relatively shallow, and that the systems selected are appropriate for steeper slopes with correct construction. The majority of lots within the region also have less than 1,500m^2 of useable area for DWM, which also does not exclude heavily vegetated areas. This will limit design options and it is imperative that the LCA DWM system design ensure that DWM is contained on-site.

Kennett River (& Sugarloaf)

Drip and Spray Irrigation Systems* - Secondary Treated Effluent only

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3)	Clay Loams (4)	Light Clays (5)	Medium to Heavy Clays (6)		
	DIR (mm)	5	5	4	3.5	3	N/A (Alternative Land Application System Required)		
Development Type	Daily (L/day)	Total min. irrigation area required for zero wet weather effluent storage (m^2)†							
5 + bedroom residence	1,080	338		491	626	900			
4 bedroom residence	900	282		410	530	750			
1-3 bedroom residence	720	225		328	424	600			

Note: * irrigation system sizes are based on the assumption that the land application area is less than 10% slope. Reductions in DIR apply for slopes above 10% according to Table M2 of AS1547:2012

† not including spacing or setbacks

Conventional Absorption Trenches and Beds - Primary Treated Effluent

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3)	Weak Loams & High/Mod Clay Loams (3 & 4)	Weak Clay Loams (4)	Light Clays (5)	Massive Clay Loams (4)	Medium to Heavy Clays (6)
	DLR (mm)	20*	20*	15	10	6	5	4	N/A (Alternative Land Application System Required)
Development Type	Daily (L/day)	Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing or setbacks							
5 + bedroom residence	1,080	61		85	138	281	379	584	
4 bedroom residence	900	51		71	115	234	316	487	
1-3 bedroom residence	720	41		57	92	187	253	389	

Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012

Evapotranspiration-Absorption Trenches and Beds - Primary Treated Effluent (Category 1 to 5) and Secondary Treated Effluent only (Category 6)

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3a)	Weak/Massive Loams (3b)	High/Mod Clay Loams (4a)	Weak Clay Loams (4b) & Strong Light Clays (5a)	Massive Clay Loams (4c) and Mod & Weak Light Clays (5b, 5c)	Medium to Heavy Clays (6) - Secondary Effluent Only
	DLR (mm)	20*	20*	15	10	12	8	5	5
Development Type	Daily (L/day)	Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing & setbacks							
5 + bedroom residence	1,080	61		85	138	110	185	379	
4 bedroom residence	900	51		71	115	92	154	316	
1-3 bedroom residence	720	41		57	92	74	124	253	

Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012

LPED Irrigation Systems - Primary or Secondary Treated Effluent - Slopes only

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3)	Clay Loams (4)	Light Clays (5)	Medium to Heavy Clays (6)		
	DIR (mm)	N/A (Alternative Land Application System Required)	4	3.5	3	N/A (Alternative Land Application System Required)	N/A (Alternative Land Application System Required)		
Development Type	Daily (L/day)		Total min. basal or 'wetted area'†						
5 + bedroom residence	1,080		584	800	1,269				
4 bedroom residence	900		487	666	1,057				
1-3 bedroom residence	720		389	533	846				

† required for zero wet weather storage (m^2) not including spacing & setbacks

Wick Trenches and Beds - Secondary Treated Effluent Only

	Soil Category	Gravels & Sands (1)	Sandy Loams (2) Loams (3) & High/Mod Clay Loams (4a,b)	Weak Clay Loams (4)	Massive Clay Loams (4)	Strong Light Clays (5a)	Moderate Light Clays (5b)	Weak Light Clays (5c)	Medium to Heavy Clays (6)
	DLR (mm)	25	30	20	10	12	8	8	5
Development Type	Daily (L/day)	Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing & setbacks							
5 + bedroom residence	1,080	48	39	61	138	110	185		379
4 bedroom residence	900	40	33	51	115	92	154		316
1-3 bedroom residence	720	32	26	41	92	74	124		253

N. Lavers Hill Locality Report

1n. Introduction

Lavers Hill is located approximately 41km southwest of Colac within the southern section of COS. The locality centres on a narrow ridgeline on the Great Ocean Road. The landform consists of undulating, dissected crests and rolling hills of the Otway Ranges. Notably, the locality on the northern side of the ridgeline is located within the Gellibrand River (South Otway) DWSC as indicated by the surface water informative map A1, Appendix A.

The locality has an estimated permanent population of approximately 78 residents (ABS Census, 2016). There are approximately 194 and 84 unsewered lots located within the Lavers Hill locality and town, respectively. There are 5 new lots with DWM systems within the locality from June 2015-2021. There are 50 DWM system permits that have been inspected to date by COS (including PTI and CTU). The current DWM permits and their associated treatment system and LAA method within the Lavers Hill locality are summarised as follows:

- 16 AWTS (4 drip irrigation, 3 trenches, 1 subsurface irrigation and 8 unknown);
- 12 septic tanks (5 trenches, 1 subsurface irrigation and 6 unknown);
- 1 worm farm (1 unknown); and
- 21 unknown (11 trenches, 1 irrigation, 1 subsurface irrigation and 8 unknown).

2n. Background Documentation

Refer to the following documents for additional detail regarding the locality:

- Amended Urban Design Framework Plan for Lavers Hill (June, 2006);
- COS Planning Scheme; and
- Rural Living Strategy (2011).

3n. Site Assessment Results

The following table summarises the results from the representative audits conducted by Consultant staff in September 2014.

Characteristic	Description
Land use	Comprises a range of land uses, including dairy, forestry, rural living and tourism.
Occupancy rates	2.3 (Part of the Beech Forest State Suburb, ABS Census, 2011).
Typical soils	Gradational profile with very dark grey brown silty clay loam topsoil becoming mottled with dark grey brown and dark yellow brown between 40-60 cm, then more strongly mottled dark yellow brown, yellow brown and grey brown silty clay to 80+ cm. Drainage and permeability are variable depending on slope and position.
AS/NZS 1547:2012 soil categories	4 (Clay Loams) and 5 (Light Clays).

Characteristic	Description
Existing Systems	**Separate Blackwater and Greywater** Of the six systems inspected during field investigations, two or three systems (33-50%) comprised separate blackwater treatment in a septic tank, with direct greywater diversion to an adjacent paddock or within the property boundary. The blackwater septic tanks were typically 30+ years old (or not found) and the time since last pump-out was generally unknown (partly due to owner not being home to ascertain). Septic effluent discharged to one or more conventional absorption trenches (or was assumed to if trenches could not be identified). The trench dimensions were generally unclear, and it is likely that most trenches were undersized for the number of bedrooms. One property had poorly-treated blackwater effluent being discharged to the ground surface from a broken pipe. LAA slopes ranged from 2-10%. **Combined Blackwater and Greywater** Three or four systems (50-67%) inspected have a combined wastewater treatment system, or were assumed to have based on layout of pipework and age of dwelling. This included one combined AWTS (less than 2 years old) for a commercial property, and a retrofitted AWTS using one of three existing septic tanks on another commercial property. Septic tank effluent discharged to a series of conventional absorption trenches in LAAs generally of less than 4% slope. Most trenches could be identified and all were undersized for the number of bedrooms and/or the type of property. The standalone AWTS discharged effluent to subsurface irrigation which appeared to be undersized based on the likely patronage over the peak tourism season, and had boggy sections. The retrofitted AWTS discharged effluent to an undersized trench LAA.

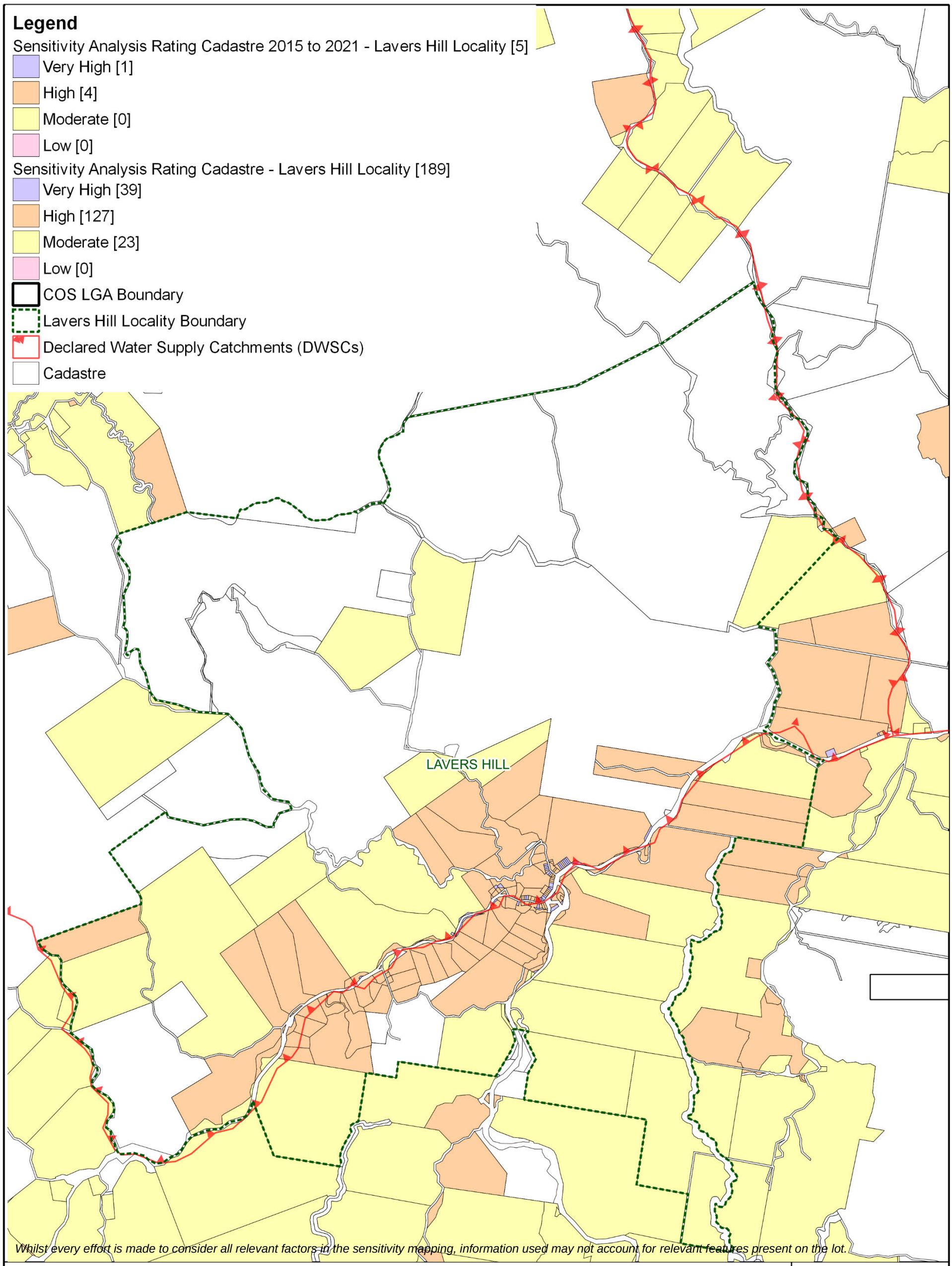
4n. Summary of Constraints to DWM

Characteristic	Description
Climate Zone	The town is included within Zone 4 and part of the surrounding locality is located within Zone 3.
Surface waterways & catchments	Lavers Hill is similar to Beech Forest, whereby the northern half of the locality is within a DWSC, Gellibrand River. The DWSC boundary runs along the ridgeline which forms the main road which divides the town. The waterways include: Chapple Creek South and North Branch, Skinner Creek, Sandy Creek, Melba Gully and Ford River West Branch.

Characteristic	Description
Groundwater	Proximity to groundwater bores: Nil.
Land subject to inundation	Nil
Useable lot area **Town (Locality)**	High: 50 (62) Moderate: 20 (27) Low: 12 (93) Compliant: 0 (12)
Minimum lot size compliance with Planning Scheme Zoning	The locality is predominantly zoned Farming Zone and Public Conservation and Resource Zone. The town is zoned Township Zone. Compliancy is variable throughout the locality, with the majority of the lots on the southern side of the main road outside of the DWSC non-compliant. Compliant: 80 (104) Non-compliant: 2 (90)
Slope **Town (Locality)**	High: 26 (96) Moderate: 22 (54) Low: 34 (44)
Geology	Predominately Eumeralla Formation of the Otway Group, with Wiridjil Gravel Member of the Pebble Point Formation to the northwest.
Soil suitability **Town (Locality)**	High: 82 (182) Moderate: 0 (12) Low: 0 (0) The ridgeline and town consist of soil landscape unit '60' which form on rolling hills along the top of the Otway Ranges. The soil consists of brown friable gradational soils with weakly structured clay loam over light clay to 0.9m depth. Limitations include restricted drainage. Flanking either side of '60' is soil landscape unit '61' which forms on the deeply dissected hills of the Otway Ranges and consists of brown gradational soils to 1.2m depth. The soils consist of moderately structured silty loam over clay loam. Limitations include acidity and restricted drainage.
Sensitivity Overlay	No depth to groundwater data. Landslip: minimal.

Characteristic	Description
	Vegetation: extensive regions of Great Otway National Park and Otway Forest Park primarily to the north of the town.
Sensitivity Analysis Rating **Town (Locality)**	Very High: 29 (40) High: 53 (131) Moderate: 0 (23) Low: 0 (0)

5n. Sensitivity Analysis (Maps)



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure n1: Sensitivity Analysis - Lavers Hill Locality

Colac Otway Shire DWMP Review

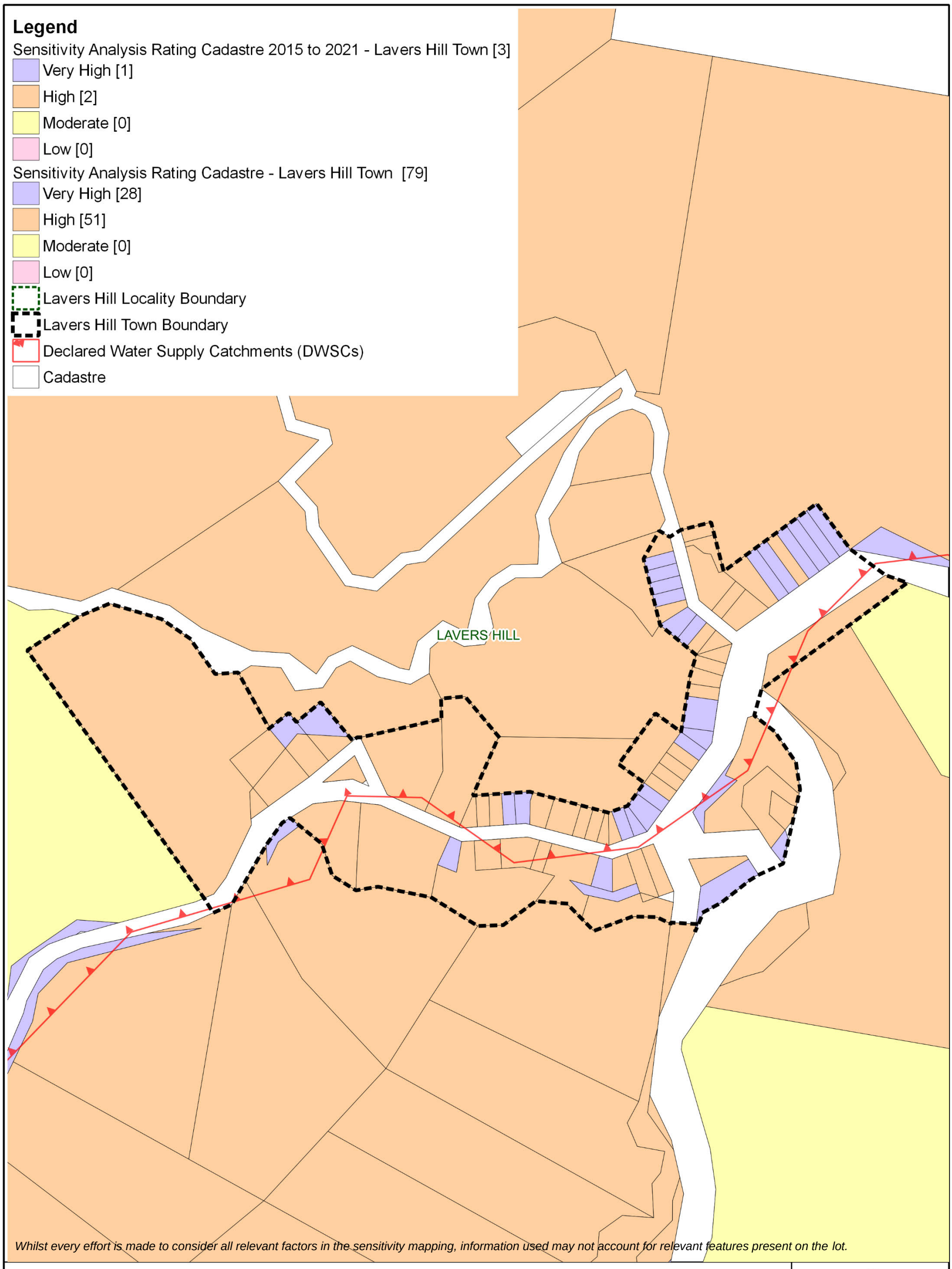
Whitehead & Associates Environmental Consultants

0 1 2 3 4 5 km

(Approx Scale)

N

Revision	3
Drawn	JK
Approved	MS



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure n2: Sensitivity Analysis - Lavers Hill Town

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 150 300 450 600 750 m

(Approx Scale)

N

Revision	4
Drawn	JK
Approved	MS

6n. System Selection

Due to the dominance of heavy-textured soils in the Lavers Hill locality, conventional absorption trenches and beds are not likely to be feasible and are discouraged. Appendix A of the EPA Code of Practice (2013) prohibits LPED systems on Category 5 and 6 soils (medium to heavy clays).

The wet climate of the Lavers Hill area makes it a high risk for DWM and site-specific, detailed land capability assessment and design will be required for unsewered lots in this area. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area) may be required to sustainably achieve land application of effluent on constrained lots.

EPA Code of Practice (2013) (Section 2.2.2) identifies secondary treatment standard (or better) followed by subsurface pressure-compensating irrigation as current best-practice in Victoria for substantially reducing the risk associated with unsewered development. Further, the Code describes a "Wick trench/bed" land application option that may be incorporated with secondary treatment for consideration on sites constrained by climate or lot 'useable area', particularly within the DWSCs. Any variation from this best-practice approach must be provided with detailed supporting information to demonstrate suitability.

Sizing Tables (discussed below) are not applicable for the Lavers Hill locality.

7n. System Sizing Tables

Sizing Tables for each system type were tested using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. Monthly 70th percentile rainfall was sourced from the Wyelangta BoM station (090087) and average evapotranspiration data for Lavers Hill was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

70th percentile monthly rainfall exceeds average monthly evapotranspiration for the entire 'design' climate year in and around Lavers Hill. As a result, there is a month-to-month surplus of hydraulic inputs and subsequently the monthly water balance does not resolve itself and cannot produce meaningful results for land application area sizing.

8n. General Conclusion

The majority of the lots within the locality have been assigned a High Sensitivity Rating to sustainable DWM. Predominantly, Detailed LCAs will be required, with all levels of LCA required to complete a site-specific design due to the higher rainfall associated with this region. System Sizing Tables were not generated for Lavers Hill and site-specific design is required for all lots that are located within Climate Zone 4, as per Figure 3 of the DWMP Technical Document, and System Sizing Tables cannot be used. Particular attention needs to be directed towards ensuring that the DWM systems are sized based on the limiting soil horizon and that the systems selected are appropriate for steeper slopes with correct construction.

Lavers Hill (and Wyelangta)

Drip and Spray Irrigation Systems* - Secondary Treated Effluent only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**		
	DIR (mm)	**Not supported (Alternative Land Application System or Extensive/Modified Design Required)**							
Development Type	**Daily (L/day)**								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								
Note: * irrigation system sizes are based on the assumption that the land application area is less than 10% slope. Reductions in DIR apply for slopes above 10% according to Table M2 of AS1547:2012									
† not including spacing or setbacks									
Conventional Absorption Trenches and Beds - Primary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Weak Loams & High/Mod Clay Loams (3 & 4)**	**Weak Clay Loams (4)**	**Light Clays (5)**	**Massive Clay Loams (4)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**Not supported (Alternative Land Application System Required)**							
Development Type	**Daily (L/day)**								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								
Evapotranspiration-Absorption Trenches and Beds - Primary Treated Effluent (Category 3a to 5a) only									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3a)**	**Weak/Massive Loams (3b)**	**High/Mod Clay Loams (4a)**	**Weak Clay Loams (4b) & Strong Light Clays (5a)**	**Massive Clay Loams (4c) and Mod & Weak Light Clays (5b, 5c)**	**Medium to Heavy Clays (6) - Secondary Effluent Only**
	DLR (mm)	**20***	**20***	**15**	**10**	**12**	**8**	**N/A (Alternative Land Application System Required)**	**N/A (Alternative Land Application System Required)**
Development Type	**Daily (L/day)**	**Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing & setbacks**							
5 + bedroom residence	1,080	**Not Supported (not considered best-practice)**		131	332	206	862**		
4 bedroom residence	900			110	277	172	719**		
1-3 bedroom residence	720			88	222	138	575**		
Note: * Gravels, Sands and Sandy loams are generally unsuitable for ETA trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012. ** Will require specialist advice regarding engineering and construction detail for installation.									
LPED Irrigation Systems - Primary or Secondary Treated Effluent									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2)**	**Loams (3)**	**Clay Loams (4)**	**Light Clays (5)**	**Medium to Heavy Clays (6)**		
	DIR (mm)	**Not supported (Alternative Land Application System Required)**							
Development Type	**Daily (L/day)**								
5 + bedroom residence	1,080								
4 bedroom residence	900								
1-3 bedroom residence	720								
Wick Trench - Secondary Treated Effluent Only - as per Section 7.4 design for High Rainfall Areas									
	Soil Category	**Gravels & Sands (1)**	**Sandy Loams (2) Loams (3) & High/Mod Clay Loams (4a,b)**	**Weak Clay Loams (4)**	**Massive Clay Loams (4)**	**Strong Light Clays (5a)**	**Moderate Light Clays (5b)**	**Weak Light Clays (5c)**	**Medium to Heavy Clays (6)**
	DLR (mm)	**25**	**30**	**20**	**10**	**12**	**8**	**8**	**N/A (Alternative Land Application System Required)**
Development Type	**Daily (L/day)**	**Total effluent application area footprint (m^2), including interbed spacing**							
5 + bedroom residence	1,080	**Not Supported (not considered best-practice)**		295	945	620	1,600**		
4 bedroom residence	900			230	720	555	1,400**		
1-3 bedroom residence	720			165	620	425	1,140**		
Note: ** Will require specialist advice regarding engineering and construction detail for installation.									

O. Wye River and Separation Creek Locality Report

1o. Introduction

Wye River and Separation Creek are two separate adjacent localities, with respective towns, that are located along the south-eastern coastline of COS approximately 23km northeast of Apollo Bay. They are located in the heavily vegetated foothills of the south-eastern section of the Otway Ranges. The localities are not located within a DWSC.

Previous studies have found that it is not technically feasible to sewer the towns, particularly due to the heavily vegetated steep slopes and landslip potential of the region. Extensive assessment, outlined in the background documentation listed below, has been conducted within this region about the perceived environmental and public health risks in both the Wye River and Separation Creek estuaries associated with DWM systems.

The locality has an estimated permanent population of approximately 63 and 19 residents for Wye River and Separation Creek, respectively (ABS Census, 2016). Note that there is a high seasonal population fluctuation within these localities.

There are approximately 389 and 373 unsewered lots located within the Wye River locality and town, respectively, and 129 and 117 in the Separation Creek locality and town, respectively. There are 13 and zero new lots with DWM systems within the Wye River and Separation Creek localities from June 2015-2021, respectively. There are 217 and 103 DWM system permits that have been inspected to date by COS for Wye River and Separation Creek respectively (including PTI and CTU). The 2015 bushfires that swept through this region is the major contributor to the higher number of inspections that have occurred in association with the rebuild of this region. The current DWM permits and their associated treatment system and LAA method within the Wye River and Separation Creek localities are summarised as follows:

Wye River:

- 149 AWTS (24 drip irrigation, 2 trenches, 11 irrigation, 16 subsurface irrigation and 96 unknown);
- 2 composting toilet (2 unknown);
- 32 septic tanks (5 trenches and 27 unknown);
- 5 worm farms (3 trenches and 3 irrigation); and
- 25 unknown (5 drip irrigation, 1 trench, 1 irrigation and 18 unknown).

Separation Creek:

- 50 AWTS (8 drip irrigation, 5 trenches, 4 irrigation, 7 subsurface irrigation, 26 unknown);
- 22 sand filters (21 subsurface irrigation and 1 unknown);
- 15 septic tanks (1 subsurface irrigation, 1 trench and 13 unknown); and
- 16 unknown (2 trenches, 2 subsurface irrigation and 12 unknown).

There were two official complaints relating to DWM systems directed to COS in 2015; failed land application area with improvement directed by COS, and a system failing (odour) and unsuitably sized for intermittent holiday loading.

No field investigations were conducted in the Wye River and Separation Creek localities.

2o. Background Documentation

Refer to the following documents for additional detail regarding the localities.

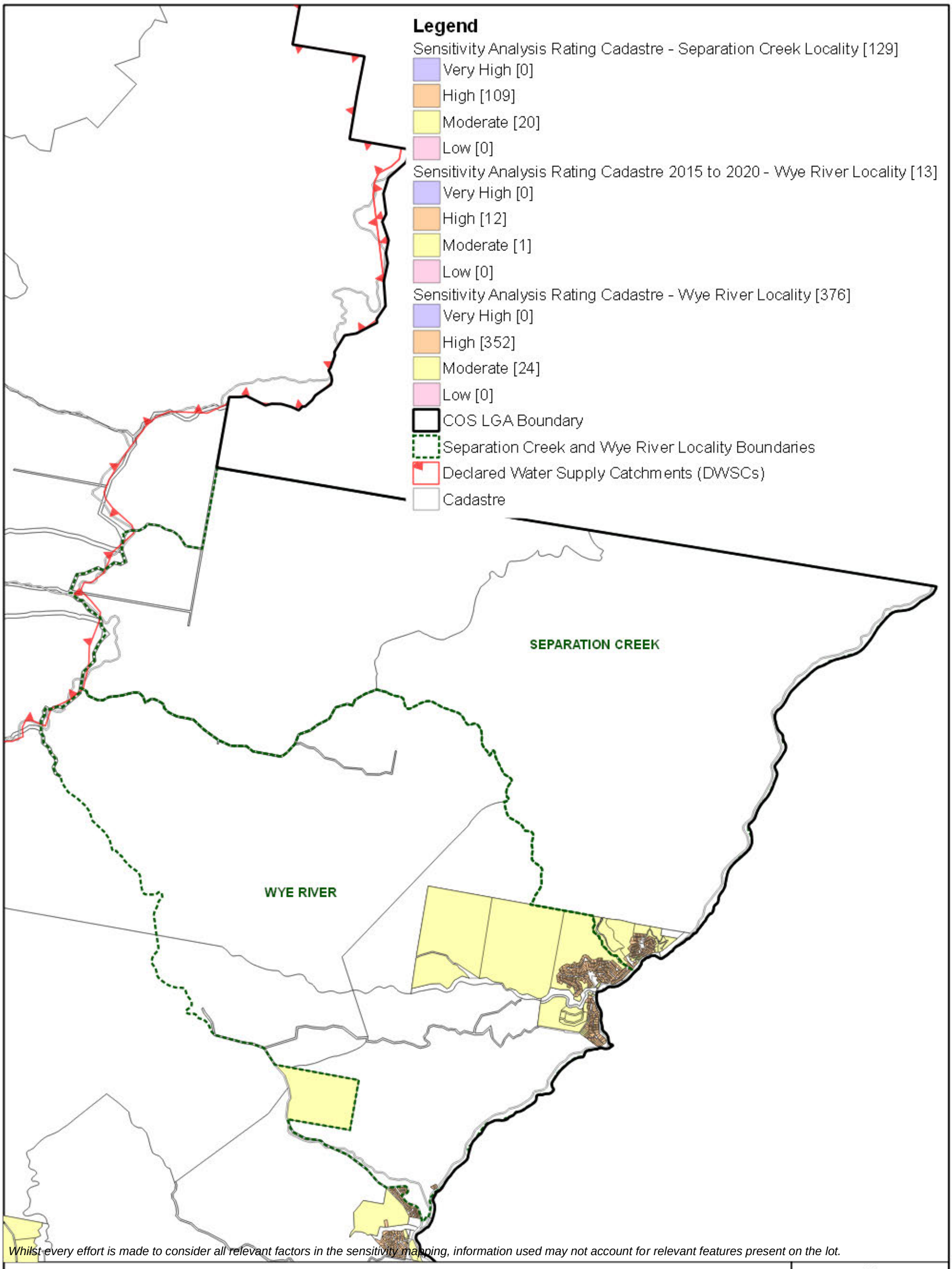
- Wye River and Separation Creek Site Survey Property Reports (November 2013);
- Wye River and Separation Creek Quantitative Microbial Risk Assessment and Ecological Risk Assessment (September 2014);
- Issues Paper Wastewater Management Wye River and Separation Creek (May 2002);
- Wye River Drainage Reserve Land Management Plan: Assessment and Recommendations (February 2012);
- Colac Otway Shire Coastal Community Revitalisation Project (April 2003);
- Colac Otway Shire, Three Towns Stormwater Management Strategy, Concept Study (October 2004);
- Concept Design for Wye River Separation Creek and Kennett River, (June 2006);
- Kennett River, Wye River and Separation Creek Structure Plans (February 2008);
- GIS Atlas - Climate Paper (June, 2000);
- COS Planning Scheme; and
- Rural Living Strategy (2011).

3o. Summary of Constraints to DWM

Characteristic	Description
Climate Zone	Zone 2.
Surface waterways & catchments	The localities are not located within a DWSC. Both Separation Creek and Wye River form the major waterways within this region and confluence with the Southern Ocean. Additional waterways within Separation Creek include Jamieson Creek and Cumberland River. Additional waterways within Wye River include Monash Gully and Hitchcock Gully.
Groundwater	Proximity to groundwater bores: insignificant (only one).
Land subject to inundation	Along the confluences of Wye River and Separation Creek within the towns.
Useable lot area **Town (Locality)**	High: WR 327 (330) SC 118 (121) Moderate: WR 45 (45) SC 0 (1) Low: WR 2 (11) SC 0 (7) Compliant: WR 0 (3) SC 0 (0)

Characteristic	Description
Minimum lot size compliance with Planning Scheme Zoning	The localities are predominantly zoned Rural Conservation Zone and Public Conservation and Resource Zone. The towns are predominantly zoned Township Zone. The majority of lots are compliant, with only the larger lots adjacent to the towns non-compliant. These are prescribed minimum lot sizes for subdivisions within the Township Zone, under the provisions of Design and Development Overlay Schedule 4 (DDO4 – Coastal Towns: Skenes Creek, Kennett River, Wye River and Separation Creek). Compliant: WR 363 (366) SC 116 (117) Non-compliant: WR 10 (23) SC 2 (12)
Slope **Town (Locality)**	High: WR 359 (375) SC 100 (111) Moderate: WR 7 (7) SC 5 (5) Low: WR 7 (7) SC 13 (13)
Geology	Eumeralla Formation of the Otway Group with alluvial flood plain deposits.
Soil suitability **Town (Locality)**	High: WR 0 (0) SC 0 (0) Moderate: WR 373 (389) SC 118 (129) Low: WR 0 (0) SC 0 (0) Along the coastline and the towns consists of soil landscape unit ’64’ (moderate rating) which forms in the similar landscape as detailed in ‘61’. It consists of brown texture contrast soils to 0.9m depth. The soils consist of weakly structured clay sand over strongly structured clay loam.
Sensitivity Overlay	No depth to groundwater data. Landslip: extensive, particularly around coastal extents around the town. Vegetation: all land surrounding the town is defined as Great Otway National Park and Wye River Coastal Reserve.
Sensitivity Analysis Rating **Town (Locality)**	Very High: WR 0 (0) SC 0 (0) High: WR 360 (364) SC 105 (109) Moderate: WR 13 (25) SC 13 (20) Low: WR 0 (0) SC 0 (0)

4o. Sensitivity Analysis (Maps)



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure o1: Sensitivity Analysis - Separation Creek and Wye River Localities

Colac Otway Shire DWMP Review

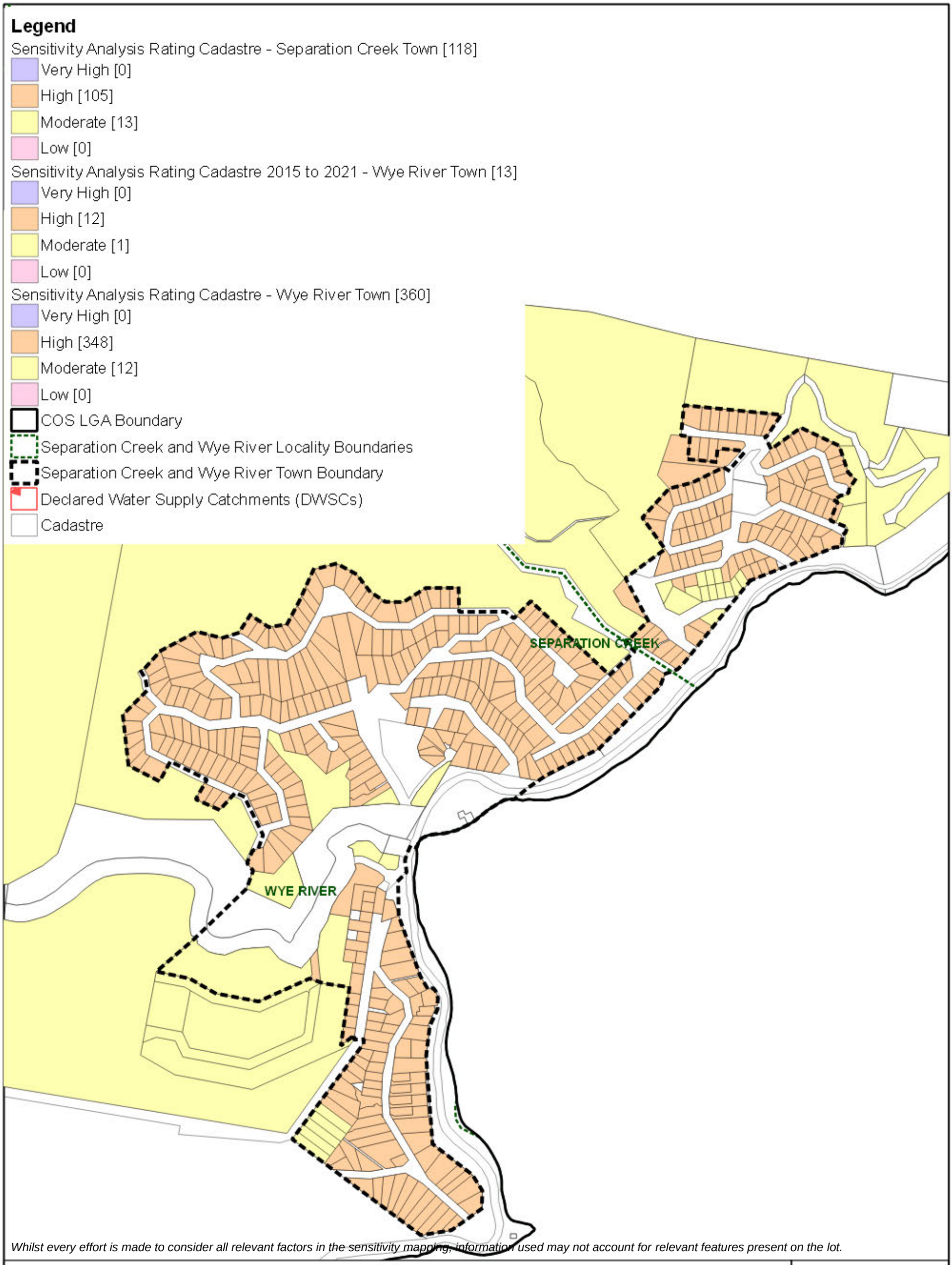
Whitehead & Associates Environmental Consultants

0 1 2 3 4 5 km

(Approx Scale)

N

Revision	3
Drawn	JK
Approved	MS



Whilst every effort is made to consider all relevant factors in the sensitivity mapping, information used may not account for relevant features present on the lot.

Figure o2: Sensitivity Analysis - Separation Creek and Wye River Towns

Colac Otway Shire DWMP Review

Whitehead & Associates Environmental Consultants

0 150 300 450 600 750 m

(Approx Scale)

N

Revision	2
Drawn	JK
Approved	MS

5o. System Selection

Soil types vary significantly in the Wye River and Separation Creek localities, depending on position in the landscape (i.e. sand deltas or hill slopes). Appendix A of the EPA Code of Practice (2013) prohibits conventional and modified trenches and beds as well as LPED systems on Category 1 soils (sands), which preclude these systems on the delta areas. Landslip risks and land gradients are major constraints for DWM on lots located on the hillslopes in these localities. As such, site-specific LCA investigations and system designs are recommended; however, the sizing tables (below) provide some guidance on which systems may be appropriate. Note that the DIR for subsurface irrigation systems has not been reduced to account for slopes above 10% (as is recommended in AS/NZS 1547:2012). Surface irrigation is not recommended on slopes greater than 10%.

6o. System Sizing Tables

Sizing Tables for each system type were created using conservative monthly water balances, following methods described in the MAV Model LCA, 2014. Monthly 70th percentile rainfall and average evapotranspiration data for the Wye River and Separation Creek localities was sourced from SILO (Scientific Information for Land Owners) climate databases, which are managed by the Queensland Government. The SILO databases use accurate meteorological data collected throughout Australia over long time periods.

The Design Loading Rates (DLRs) and Design Irrigation Rates (DIRs) were taken from the current EPA Code of Practice. Where the Code of Practice has precluded use of a particular type of system on a certain soil type, it is shown as 'Not Applicable' for that soil type in the Sizing Tables. Where the evapotranspiration deficit requires unrealistically large land application areas for a particular system on a certain soil type, it is also shown as 'Not Applicable' for that soil type in the Sizing Tables. Detailed, site-specific LCAs and system designs would be required to further investigate the feasibility of systems deemed 'Not Applicable' in the sizing tables. Mitigation measures (such as importation of topsoil to appropriate depths in the land application area), may be required to sustainably achieve land application of effluent on constrained lots.

Sizing Tables for the Wye River and Separation Creek localities are provided below.

7o. General Conclusion

The lots within the localities have been assigned a Moderate or High Sensitivity Rating to sustainable DWM, with the majority of the towns assigned as High. Both Standard and Detailed LCAs will be required, with the use of System Sizing Tables deemed appropriate for the Standard LCAs. Particular attention needs to be directed towards ensuring that the DWM systems are sized based on the limiting soil horizon and that the systems selected are appropriate for steeper slopes with correct construction. The majority of lots within the region also have less than 1,500m^2 of useable area for DWM, which also does not exclude heavily vegetated areas. This will limit design options and it is imperative that the LCA DWM system design ensures that DWM is contained on-site. The area is also extensively considered to be prone to landslip; a geotechnical report by a suitably qualified person will need to be conducted to address this constraint.

Wye River and Separation Creek

Drip and Spray Irrigation Systems* - Secondary Treated Effluent only - Slopes or Sand Delta

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3)	Clay Loams (4)	Light Clays (5)	Medium to Heavy Clays (6)		
	DIR (mm)	5	5	4	3.5	3	N/A (Alternative Land Application System Required)		
Development Type	Daily (L/day)	Total min. irrigation area required for zero wet weather effluent storage (m^2)†							
5 + bedroom residence	1,080	332		480	616	862			
4 bedroom residence	900	277		400	514	718			
1-3 bedroom residence	720	222		320	411	575			

Note: * irrigation system sizes are based on the assumption that the land application area is less than 10% slope. Reductions in DIR apply for slopes above 10% according to Table M2 of AS1547:2012

† not including spacing or setbacks

Conventional Absorption Trenches and Beds - Primary Treated Effluent - Slopes only (not Sand Delta)

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3)	Weak Loams & High/Mod Clay Loams (3 & 4)	Weak Clay Loams (4)	Light Clays (5)	Massive Clay Loams (4)	Medium to Heavy Clays (6)
	DLR (mm)	20*	20*	15	10	6	5	4	N/A (Alternative Land Application System Required)
Development Type	Daily (L/day)	Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing or setbacks							
5 + bedroom residence	1,080	61		84	136	274	366	553	
4 bedroom residence	900	51		70	114	228	305	461	
1-3 bedroom residence	720	41		56	91	183	244	369	

Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012

Evapotranspiration-Absorption Trenches and Beds - Primary Treated Effluent (Category 1 to 5) and Secondary Treated Effluent only (Category 6) - Slopes only (not sand delta)

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3a)	Weak/Massive Loams (3b)	High/Mod Clay Loams (4a)	Weak Clay Loams (4b) & Strong Light Clays (5a)	Massive Clay Loams (4c) and Mod & Weak Light Clays (5b, 5c)	Medium to Heavy Clays (6) - Secondary Effluent Only
	DLR (mm)	20*	20*	15	10	12	8	5	5
Development Type	Daily (L/day)	Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing & setbacks							
5 + bedroom residence	1,080	61		84	136	109	182	366	
4 bedroom residence	900	51		70	114	91	152	305	
1-3 bedroom residence	720	41		56	91	73	121	244	

Note: * Gravels, Sands and sandy loams are unsuitable for conventional absorption trenches and beds if there is a high watertable, including seasonal and perched watertables. Value based on average of conservative rate and maximum rate for Category 2b and 3a soils in AS1547:2012

LPED Irrigation Systems - Primary or Secondary Treated Effluent - Slopes only (not Sand Delta)

	Soil Category	Gravels & Sands (1)	Sandy Loams (2)	Loams (3)	Clay Loams (4)	Light Clays (5)	Medium to Heavy Clays (6)		
	DIR (mm)	N/A (Alternative Land Application System Required)	4	3.5	3	N/A (Alternative Land Application System Required)	N/A (Alternative Land Application System Required)		
Development Type	Daily (L/day)		Total min. basal or 'wetted area'†						
5 + bedroom residence	1,080		553	743	1,133				
4 bedroom residence	900		461	620	944				
1-3 bedroom residence	720		369	496	755				

† required for zero wet weather storage (m^2) not including spacing & setbacks

Wick Trenches and Beds - Secondary Treated Effluent Only - Slopes or Sand Delta

	Soil Category	Gravels & Sands (1)	Sandy Loams (2) Loams (3) & High/Mod Clay Loams (4a,b)	Weak Clay Loams (4)	Massive Clay Loams (4)	Strong Light Clays (5a)	Moderate Light Clays (5b)	Weak Light Clays (5c)	Medium to Heavy Clays (6)
	DLR (mm)	25	30	20	10	12	8	8	5
Development Type	Daily (L/day)	Total min. basal or 'wetted area' required for zero wet weather storage (m^2) not including spacing & setbacks							
5 + bedroom residence	1,080	48	39	61	136	109	182		366
4 bedroom residence	900	40	33	51	114	91	152		305
1-3 bedroom residence	720	32	26	41	91	73	121		244

Appendix C

Acceptable Monthly Climate Data

Locality	Longitude	Latitude	70th Percentile Rainfall	Median Annual Wet Months	Average Rainfall	Average ET_0	Rainfall January	ET_0 January	Rainfall February	ET_0 February	Rainfall March	ET_0 March	Rainfall April	ET_0 April	Rainfall May	ET_0 May	Rainfall June	ET_0 June	Rainfall July	ET_0 July	Rainfall August	ET_0 August	Rainfall September	ET_0 September	Rainfall October	ET_0 October	Rainfall November	ET_0 November	Rainfall December	ET_0 December
Alvie (& Warrion)	143.5E	38.2S	641	5	588	928	32	143	31	118	35	97	48	59	53	36	57	24	58	28	66	40	61	59	61	87	47	106	40	130
Barongarook	143.6E	38.4S	1,007	7	929	863	44	133	41	110	52	91	73	54	86	34	98	22	108	26	106	37	99	55	97	81	69	98	57	121
Barramunga	143.7E	38.6S	1,561	8	1,432	790	65	122	63	100	82	82	119	50	133	30	167	20	168	23	170	34	149	50	133	75	99	91	84	112
Barwon Downs	143.8E	38.5S	1,048	7	969	846	44	129	44	106	55	88	77	54	90	33	110	22	109	25	117	37	101	55	92	81	69	97	59	119
Beeac	143.6E	38.2S	644	4 5	576	932	32	144	31	118	36	98	46	59	51	36	55	25	56	28	63	41	59	60	59	88	47	106	40	131
Beech Forest[1]	143.56E	38.62S	2,046	11	1,748	804	88	121	91	100	114	83	179	51	208	32	242	21	233	25	244	36	213	53	187	77	134	93	114	112
Birregurra (& outskirts)	143.8E	38.3S	681	5	614	915	32	138	31	114	38	95	47	59	57	37	61	25	63	27	69	41	64	59	63	86	49	104	41	129
Carlisle River	143.4E	38.6S	1,257	7	1,161	860	53	129	50	106	67	88	94	55	120	35	123	24	135	27	143	40	118	57	107	83	81	98	69	118
Chapple Vale	143.3E	38.6S	1,105	7	1,038	890	49	131	46	108	61	91	85	58	105	38	109	26	121	29	128	43	105	60	94	85	74	101	62	121
Colac/ Elliminyt/ Irrewarra	143.6E	38.3S	730	5	658	909	34	140	33	115	39	95	53	58	61	35	66	24	68	27	76	40	67	58	67	86	52	103	43	128
Cororooke and Coragulac	143.5E	38.3S	740	5	665	911	34	140	33	115	39	95	54	58	61	36	67	24	69	27	78	40	69	58	68	86	51	104	43	128
Cressy	143.7E	38.1S	602	4	543	951	32	146	32	120	34	99	44	61	48	37	49	25	50	29	57	42	55	61	56	89	46	108	42	134
Forrest	143.7E	38.5S	980	6	910	865	42	131	41	108	51	89	72	55	85	34	101	23	102	26	115	39	95	56	86	83	66	99	54	121
Gellibrand	143.6E	38.5S	1,005	6	928	875	44	133	40	109	53	90	73	56	90	35	101	23	105	26	117	39	97	57	88	83	66	100	55	122
Hordern Vale	143.6E	38.8S	1,160	7	1,088	852	52	123	50	101	68	85	88	56	105	37	117	26	124	29	135	42	109	59	98	83	78	97	64	115
Johanna (& Glenaire)	143.3E	38.8S	1,016	6	951	881	45	126	43	103	58	88	79	58	96	39	108	28	109	31	118	45	94	61	83	85	64	100	54	118
Kawarren	143.5E	38.5S	1,052	7	955	886	44	133	41	110	54	91	76	57	93	36	102	24	109	27	120	40	99	58	90	84	68	101	58	123
Kennett River	143.9E	38.7S	981	6	897	897	43	129	45	106	57	90	71	58	85	39	91	28	98	32	110	44	93	61	84	87	65	102	54	121
Marengo	143.7E	38.8S	1,050	7	989	882	49	126	48	103	64	88	80	57	93	38	101	28	109	32	123	45	100	61	90	85	71	100	59	119
Pirron Yallock (& Larpent)	143.4E	38.3S	746	5	673	913	34	140	33	115	39	96	55	58	63	36	67	24	71	28	79	40	70	59	67	86	52	104	44	127
Skenes Creek North (& Tanybryn)	143.7E	38.7S	1,059	6	965	892	49	129	49	106	64	89	77	58	92	38	101	27	104	31	117	44	97	61	88	86	70	101	57	121
Wattle Hill	143.2E	38.8S	965	6	905	881	41	126	40	103	53	88	74	58	92	39	107	28	107	31	111	45	89	61	79	85	60	100	51	117
Wongarra & Sugarloaf	143.8E	38.7S	974	6	893	901	44	130	46	106	59	90	72	58	86	39	92	28	96	32	109	45	91	62	82	87	64	102	53	122
Wyelangta[2]	143.45E	38.66S	2,279	11	1,947	804	108	121	108	100	125	83	192	51	232	32	231	22	266	25	274	36	221	52	207	77	172	93	142	112

70th Percentile rainfall System Sizing Tables completed for townships shown in bold font - Appendix B of Technical Document.
70th Percentile rainfall Water Balances NOT completed for localities shown in normal font - information included for LCA assessors and Council staff - for water balance as part of a LCA, the closest climate locality should be used.
The localities of Lavers Hill, Weeaproinah, Beech Forest, Wyelangta and Barham River Catchment do not have any suitable water balances as detailed in their respective Locality reports (Appendix B Technical Document) and Section 7 of the Technical Document. As part of a detailed or comprehensive LCA, site specific designs warrant the use of appropriate Otway Ridge rainfall data from the Bureau of Meteorology. 70th percentile rainfall data from BOM stations 90006[1] Beech Forest and 90087[2] Wyelangta stations was obtained and the closest BOM station must be used for any locality within the Otway Ridge (i.e. Weeaproinah uses Beech Forest and Lavers Hill uses Wyelangta). The closest SILO ET_0 data was used for both of these BOM stations Beech Forest and Wyelangta.