WEST GIPPSLAND CATCHMENT MANAGEMENT AUTHORITY

Sustainable Irrigation Decision Support Tool

Final Report

September 2020

West Gippsland
Catchment Management Authority

Traditional Owners

We acknowledge and pay our respects to the Traditional Owners of the region, theGunaikurnai, the Bunurong, the Boonwurrung and theWurundjeriPeoples, their rich culture and spiritual connection to Country. We also acknowledge the contribution and interest of Aboriginal and/or Torres Strait Islander Peoples and organisations in natural resource management and pay respects to Elders, past, present and emerging.

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Images: Front and rear cover, and above by Craig Moodie, courtesy of DELWP

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Introduction

1.1 Purpose

This Sustainable Irrigation Decision Support Tool (the "Tool") is designed to assist irrigators, extension officers and service providers in West Gippsland to:

- Understand the opportunities for improved irrigation management
- Provide guidance on issues for consideration in a new irrigation development, planning an upgrade to an existing development, or understanding options and issues relating to specific aspects of irrigation design or management.

1.2 Background

This Tool has been developed to support the West Gippsland Sustainable Irrigation Program in the delivery of its Land and Water Management Plan.

The Land and Water Management Plan recognises the:

- Importance of irrigation to the regional economy
- Need to manage the potential for adverse impacts on communities and the environment.

Existing and new irrigation developments are therefore welcome, but the community expects careful management and hence profitable and productive agriculture that can be sustained into the future.

1.3 Role of this decision support tool

There is extensive information available on best practice irrigation management. New information is being published on a regular basis. This information is being progressively improved over time. This Tool is not intended to reproduce or improve existing information or necessarily identify the most relevant components.

The right answer will often depend upon the farmers goals and objectives, and the specific attributes of the property.

Questions on the other hand have greater longevity than do answers. The application of this Tool can assist in identifying the relevant questions.

Help in answering questions in the context of the property can be sought from agencies, industry bodies, service providers and other sources of information (e.g. internet, other farmers).

2 How to use this Decision Support Tool

2.1 The tool prompts:

- Consideration of goals and objectives for the property
- Awareness of irrigation risks and opportunities
- Consideration of irrigation design and management issues and options.

All farms are different and irrigators interests are different so for any Extension exercise, not all sections or modules will be relevant.

However the starting point for any landholder considering investing in or even just generally improving their irrigation system should be in considering their goals and aspirations. With this direction, the Tool has application to three lines of enquiry all of which inform either planning or operations:

- New irrigation developments
- Irrigators participating in the Irrigation Farm Planning Program
- Irrigators with a specific irrigation design or management interest.

These lines of enquiry are supported by six sections as illustrated by Figure 2-1. Some of the sections are then broken into modules which sign post the user to other potentially relevant parts of the Tool noting that the Irrigation Development Guidelines (the guidelines) are a separate support package outside the scope of this document. The current version of these guidelines is available from the West Gippsland Catchment Management Authority (CMA).

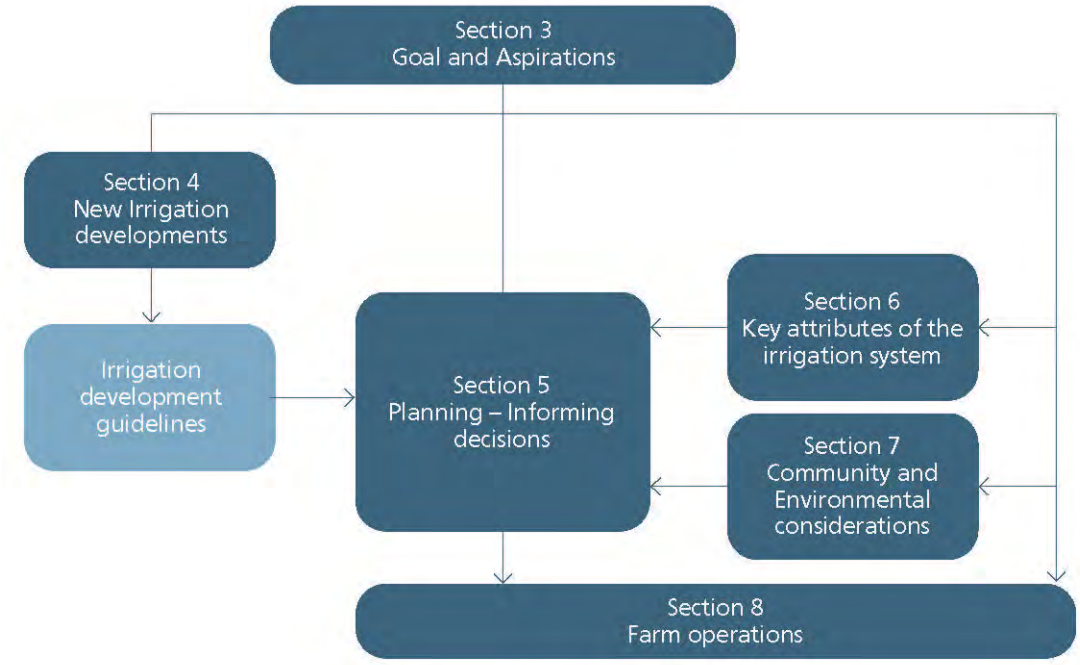

Figure 2-1: Overview of how each section of this Decision Support Tool assists irrigators undertake planning and operations aligned with their property goals and aspirations (noting that the guidelines# are contained in a separate document that is available from the CMA).

Table 2-1 provides a list of high level questions that enable the user to rapidly evaluate which sections of the Tool are relevant to the goals and aspirations of the landholder and the property. Understanding the potential relevance of a module within each section of the Tool will be improved through discussions between the extension officer and the landholder on the landholder's goals and aspirations and property scale risks and opportunities.

Table 2-1: Identifying relevant modules

Guiding Questions	Module	Relevant to enquiry		
		Not relevant	Highly relevant	Need to think about it?
Section 3 – Goals and Aspirations				
What are my goals and aspirations? Economic, lifestyle, environmental or all of these?	Goals and aspirations			
Section 4 – New Irrigation Developments				
I'm considering expanding my irrigation into new areas or increasing my water use	New irrigation developments			
Section 5 – Planning – Informing Decisions				
There are a range of irrigation methods available. What are the pros and cons of the different options?	Irrigation methods			
Support is available for planning irrigation developments. How do I access support through the Irrigation Farm Planning Program?	Irrigation Farm Planning Program			
What are the key steps in undertaking irrigation development works?	Concept plan Irrigation Farm Plan Financial Planning Scheduling Works			
Section 6 – Key Attributes of Irrigation Systems				
Do I have enough water? Are there other sources and how can I prepare for drought?	Water supply			
Can I improve the way water is delivered, stored or distributed around the farm?	Water delivery, storage & distribution			
Would my farm benefit from improved surface drainage?	Surface drainage			
How do I develop an efficient irrigation system to avoid wasting water and/or energy?	Water use efficiency Energy use efficiency			
Section 7 – Community and Environmental Considerations				
How can I understand the cultural heritage values on my farm and work with the community to support long term protection of these values?	Cultural heritage			

Guiding Questions	Module	Relevant to enquiry		
		Not relevant	Highly relevant	Need to think about it?
I know that parts of my property have potential to be affected by waterlogging from shallow watertables and salinity. What are the management options?	Waterlogging (shallow watertables) and salinity			
I know that parts of my property are subject to flooding. What are the management options?	Flooding			
How can I make best use of available nutrients on my farm?	Nutrient management			
How can I protect and enhance biodiversity on my farm in a way that improves productivity?	Native vegetation management			
Section 8 – Farm Operations				
What can be done to improve safety on my farm?	On-farm safety			
How can I prepare for droughts?	Managing through drought			
What are the quick fixes that can improve my system efficiency?	Maintenance measures for energy and water use efficiency			
How can irrigations be scheduled to meet plant water requirements?	Irrigation scheduling			
What soil management issues should I consider?	Soil management			
How can I make best use of brackish water?	Quality of applied water			

3 Irrigator goals and aspirations

A farm may be both a business and a way of life and a well-run farm requires significant investment in both time and money.

This means that the starting point for any new or major investment in re-configuring a farm, should be the consideration of the personal and business goals of the landholder. What are these goals and aspirations? Economic, lifestyle, environmental or all of these?

To keep farm development and management decisions on track, farmers should clearly think through both their short-term and long-term goals and aspirations and review these goals and aspirations on an annual basis.

Table 3-1: Irrigator goals and aspirations checklist

Issue	Checklist	Further Information & resources
Personal	Do we enjoy what we do?	Seek advice from a financial advisor
	Can we sustain the effort?	
	Do all of the team affected by the farm support what we are currently doing or thinking of doing?	
	Are we happy with the lifestyle?	
	Will we have enough financial resources to retire on?	
Retirement	Do we have a retirement plan?	
	What part does the farm play in this retirement plan? Lifestyle block? Selling to generate retirement income? Passing on to next generation?	
	Are these plans supported by all people with an interest in the farm?	
	Are the retirement plans compatible with increased investment in the farm?	
The farm	What are the productive agriculture opportunities offered by this property?	
	Does the vision include: Irrigation expansion? Farm expansion?	
	How do these opportunities align with other goals and aspirations for the farm?	
	What enterprises are planned for the farm? Short term? Long term?	
	What is the basis for this preference? Economic evaluation? Current skill set? Lifestyle?	
Management approach	Approaches to farming have and continue to change rapidly e.g. new technologies, economies of scale, access to water markets. How do these influence how the farm is managed?	Seek advice from a farm consultant
	How do I see management on my farm changing in the future?	
Environmental impacts	What are the regulatory obligations that apply to farm operations? Are there some things that I must change?	Seek advice from the CMA
	Sustainability is important to me. How do I enhance the environmental and cultural values of the property? How do I integrate the environmental values of the farm with the surrounding area?	
Planning	How should I approach improving the farm – making sure that my work and the money spent lines up with these goals?	Check out the other modules in this document and seek advice from the CMA

4 New Irrigation Developments

The Gippsland Irrigation Development Guidelines (the Guidelines) provide a clear pathway for new irrigation developments that minimises risks posed to the environment.

Irrigated agriculture is vital to the region's community and economic prosperity. Expansion and diversification of irrigation is therefore welcome providing that the development has minimal external social, cultural, environmental and economic impacts. Risks are managed through a combination of planning and regulatory processes. The Guidelines provide a means of providing coordinated agency support to the proponent so that the requirements for sustainable irrigation are met, without the processes being burdensome to the extent that it would be an impediment to development.

The Guidelines apply to previously unirrigated land for which there is no existing water-use licence (WUL) or take and use licence (T&UL) or land on which there will be a significant increase in the intensity of irrigation.

Figure 4-1 presents a basic decision tree to determine when the Guidelines are triggered.

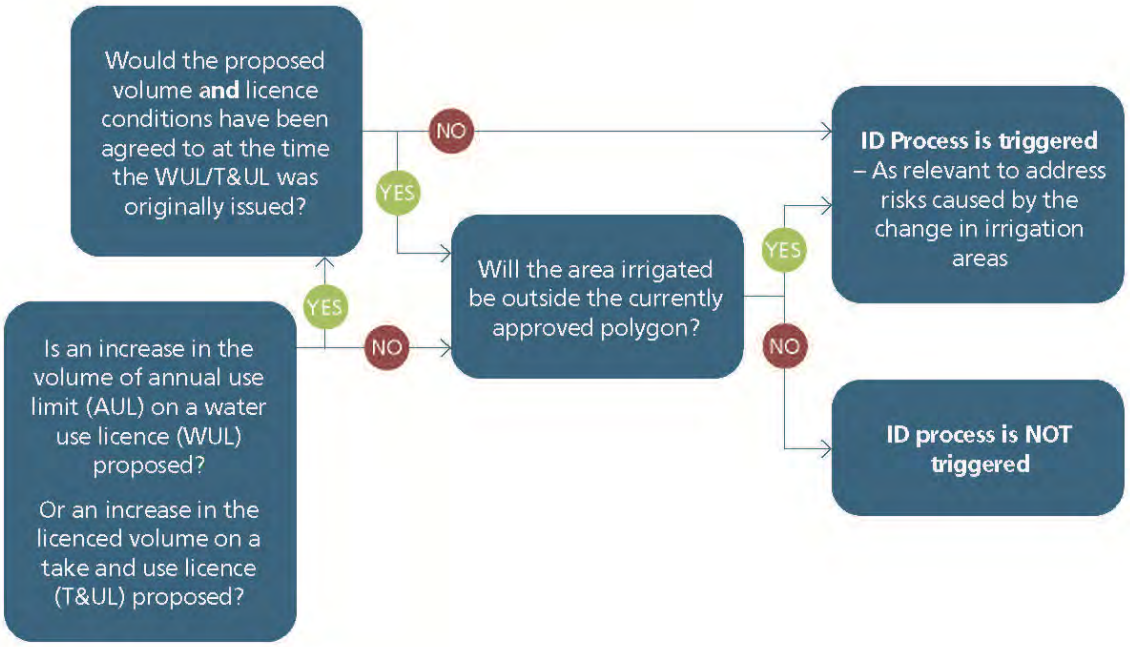

Figure 4-1: Decision tree to determine when the Irrigation Development Guidelines are triggered for an existing WUL or T&UL

If you think your development triggers the Irrigation Development Guidelines, contact the West Gippsland CMA Sustainable Irrigation Program on 1300 094 262.

5 Planning – informing decisions

5.1 Overview

The chapter on Goals and Aspirations reminds us that farming can be about both business and lifestyle. Planning encourages farmers to consider both when making decisions.

This chapter provides guidance on how to go about planning, and some of the important issues that should guide decisions in the context of productive, profitable and sustainable agriculture.

5.2 Irrigation methods

Before commencing on any major on-farm investment, it is worth taking stock of the irrigation options that best suit the long term objectives for the farm. Understanding the options, will provide the basis for a useful discussion with an irrigation designer during the first farm visit, as it may influence the scope and detail of the topographical survey. The different irrigation methods include:

- Flood Irrigation– water is released from a farm channel or 'pipe and riser' system on the highest part of the land. It is discharged into bays that are partitioned by check banks
- Furrow irrigation – as for flood irrigation but water is released into furrows
- Centre Pivot or Lateral Move – water is supplied to a mechanised travelling irrigator either via a buried pipeline for a pivot, or via an open channel for a lateral move. Lateral delivery pipes are supported by a series of wheeled legs
- Pressurised fixed-point rotary sprinklers – water is pressurised within pipelines and delivered through rotary sprinklers
- Pressurise surface micro irrigation – water is pressurised within pipelines and delivered through ground level emitters
- Pressurised sub-surface drip – drip tubes with built in emitters are placed from 150 to 300 mm below the soil surface, the depth depending on the soil type, crop and tillage practices.

Different methods have varying levels of suitability to the landscape settings and crop types.

For a particular situation, each method may provide advantages and pose different levels of risk.

Table 5-1 summarises the attributes of different irrigation methods, such as soil suitability, water use efficiency, fertigation, labour and cost. An overall suitability summary for each method is also provided.

Table 5-1: Summary of attributes of different irrigation methods

Issue	Checklist	Further Information & resources
Flood and furrow irrigation		
Soil suitability	Not generally suitable to areas with light subsoils due to excessive deep drainage	
Water use efficiency (WUE)	Low WUE on light soils	
	Capture of tailwater and re-use critical to achieving high WUE Suitability therefore dependent upon a layout that can capture and store tailwater and return it to the delivery system	
Water distribution uniformity (DU)	Important to avoid bays/furrows transecting soils with substantially different infiltration characteristics. Design of bay (length and width) and furrow (length and shape) important factors in DU outcomes	
Energy use efficiency (EUE)	Most gravity systems have low energy requirements noting some energy consumption required if: Water supply or drainage re-use is lifted to command the property Water is delivered to bays with a pipe and riser system	
Biodiversity	Potential to design around sensitive environmental values and hence reduce impact on native vegetation and wetlands	
Water quality	Filtration – Not applicable Brackish water – more suited to the use of brackish water than spray irrigation due to less risk of foliage burn	
Frost and heat control	Does not provide frost protection or significant heat control	
Fertigation	Constrained by potential for nutrients to promote weed growth in channels. Greater potential if delivery with pipe and riser systems	
Costs	Capital costs relatively low compared to other irrigation methods although costs increase with increasing amount of earthworks	
Labour	Relatively high labour inputs relative to other methods if not automated. Automation provides opportunity for significant labour savings	
Suitability summary	Most suited to broadacre irrigation on riverine plain landscapes on heavier or duplex soils Potentially selection of this method trades off WUE for energy use efficiency	

Issue	Checklist	Further Information & resources
Centre Pivot (CP) Linear Move (LM)		
Soil suitability	Suited to light to medium textured soils. Potential for wheel tracking and rutting on heavy and dispersive soils	
Water use efficiency (WUE)	Light soils - likely to provide substantially higher WUE than achievable under flood or furrow irrigation Heavy soils - WUE may not be substantially greater than achievable under flood/furrow	
	Are there opportunities for more water efficient application to crop?	
Irrigation uniformity distribution (UD)	High UD if: Soil infiltration characteristics consistent across entire CP circle or LM transect CPLM type provides continuous irrigator movement and so avoid “spoking” i.e. non-uniform application of water from “start-stop” operation of electric driven systems? Avoid use of end-gun	
Energy use efficiency (EUE)	Higher energy use compared to flood/furrow but higher EUE relative to other broadacre pressurised systems. Higher EUE able to be achieved by adopting Low Energy Precision Application (LEPA) technology?	
Biodiversity	Will native vegetation require removal in order for irrigator operation?	
Water quality	Filtration – not generally required Brackish water – Irrigator should be equipped with low pressure drop tubes to reduce spray on canopy	
Frost and heat control	System can be operated to manage frosts and heat	
Fertigation	Opportunities, particularly with LEPA emitters	
Costs	If relatively low earthworks required for flood/furrow, capital costs of CPLM likely to be higher	
Labour	Labour costs low other than for field inspections and general maintenance	
Suitability summary	Most suited to broadacre irrigation on riverine plain or river flats on moderate to sandy soils If landscape also suited to flood/furrow, potentially trading off improved energy use efficiency and the preservation of ecological benefits of remnant vegetation for improved WUE	
Pressurised fixed-point rotary sprinklers		
Soil suitability	Suited to all soil types	

Issue	Checklist	Further Information & resources
Water use efficiency (WUE)	Valved section boundaries should align with consistent soil types and elevations?	
	Sprinkler spacings should take into account prevailing wind direction and speeds, and impacts on irrigation uniformity?	
	Water use efficiency is higher in under canopy sprinkler systems	
Water distribution uniformity (DU)	Wind effects may contribute to low DU. Better DU outcomes for under canopy compared to above canopy applications	
Energy use efficiency	High energy use relative to other irrigation methods. Over canopy irrigation has lower EUE than under canopy systems	
Biodiversity	Potential to design around sensitive environmental values	
Water quality	Filtration – not generally required Brackish water – avoid use of over canopy sprinklers	
Frost and heat control	Over canopy systems provide effective control	
Fertigation	Potentially constrained by DU	
Costs	Relatively high capital costs (noting closer spacing requirements for below canopy vs over canopy)	
Labour	Labour costs low other than for field inspections and general maintenance	
Suitability summary	Most suited to medium scale high value plantings in an undulating landscape If micro irrigation is an option, likely trading off high energy use efficiency and high WUE for reduced capital costs	
Pressured surface micro-irrigation		
Soil suitability	Suited to all soil types	
Water use efficiency (WUE)	Do valve sections align with consistent soil types and elevations?	
	Drip micro-irrigation systems more efficient than jets or mini-sprinklers, and significantly more efficient than pressurised sprinklers	

Issue	Checklist	Further Information & resources
Water Distribution Uniformity (DU)	High DU because water delivered to point it is required	
Energy use efficiency (EUE)	Relatively high EUE. Drip micro-irrigation systems operate at lower pressures than jets or mini-sprinklers, and significantly lower pressures than impact sprinklers	
Biodiversity	Potential to design around sensitive environmental values	
Water quality	Filtration – Essential. Brackish water – Water applied to the rootzone and hence "micro leaching" of salts to outside of the rootzone. Application no risk to foliage	
Frost and heat control	Under canopy irrigation and hence will not provide frost protection	
Fertigation	Precision application of fertiliser to where used by plant	
Capital costs	High and hence only applicable to high value plantings	
Labour	Technology offers office-based controls and hence labour savings but field inspections necessary. Less weed control required due to smaller irrigated footprint	
Suitability summary	Highly suited to high value annual row cropping across a range of soil types	
Pressured sub-surface drip		
Soil suitability	Not suited to sandy soils due to: Rootzone drainage (low WUE) Close spacing required for drip lines (cost)	
Irrigation efficiency	High WUE except for sandy soils	
Water Distribution Uniformity (DU)	High when applied to appropriate soil types Potential for inadequate coverage to support establishment of some seed crops	
Energy use efficiency	Relatively high EUE. Operate at significantly lower pressures than impact sprinklers	
Biodiversity	Potential to design around sensitive environmental values	

Issue	Checklist	Further Information & resources
Water quality	Filtration – Essential Brackish water – Subsurface irrigation and hence will not burn foliage. Also, water applied to the rootzone and hence potential for "micro leaching" of salts to outside of the rootzone	
Frost and heat control	Does not provide protection	
Fertigation	Precision application of water and fertiliser to where it is used by the plant	
Capital costs	More costly than most alternatives and hence most suited to high value irrigation. Increase on lighter soils due to need for closer drip lines	
Labour	Technology offers office-based controls and hence labour savings but field inspections necessary. Less weed control required due to smaller irrigated footprint	
Suitability summary	Highly suited to high value annual row cropping on medium to fine textured soils.	

5.2.1 Choosing a system?

The previous module provides lots of options for irrigation systems with pros and cons for each.

The pros and cons can be financial, environmental or relate to other goals and aspirations.

In making a decision it is important to consider:

- Will it affect profitability?
- Will it affect the environment?
- Will it affect my life or my family's life in other ways?

There may be no option that provides all of the benefits and none of the costs. The pros and cons should be weighed up, providing the basis for the most informed decision.

The table below provides some examples of trade-offs.

Table 5-2: Decision trade-offs checklist

Issue	Trade off checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Selecting an irrigation method	What are the capital cost vs operating costs trade-offs for the viable irrigation methods?	☐	☐	☐	Seek advice from irrigation designer &/or farm consultant	
	What are operating cost vs production gain trade-offs (e.g. net return on investment)?	☐	☐	☐		
	What is the net cost of energy/ha over thirty years under different irrigation methods assuming a range of probable power costs?	☐	☐	☐		
	For each of the viable irrigation methods, what are the relative impacts on biodiversity?	☐	☐	☐	Seek advice from CMA	
Deciding between channels and pipelines?	What should I consider in deciding whether to use a channel or pipeline?	☐	☐	☐	Review relevant "water delivery, storage and distribution" checklist (Section 5.3)	

5.2.2 Planning – Key steps

The modules below provide insight into the planning support available to irrigators (i.e. the Irrigation Farm Planning Program) and the following key elements of good planning:

Concept Plan – what is a Concept Plan for? What should it contain?

Irrigation Farm Plan – what should be included in the Survey Plan and Irrigation Design?

Financial Farm Planning – focuses on understanding the present financial situation and the implications of decisions on profitability to progress financial goals and objectives

Scheduling of works – scoping the timeline for implementing works to ensure they are done in the right order to manage cashflow and allow smooth progress.

A range of checklists for each of the above elements is also provided to assist irrigator decision making.

Irrigation farm planning program

The Irrigation Farm Planning Program supports irrigators as they consider their long-term goals and aspirations, whilst managing the risks from irrigation, both on their property and within the broader catchment. It provides the basis for farm works and farm management activities that will help to achieve these objectives.

Effective planning requires consideration of a multitude of economic, social and environmental factors. The farm planning program provides landholders with support and independent advice to assist the landholder in each of these key areas.

The program is relevant to properties where an Irrigation Farm Plan is yet to be developed, and for updating an existing Irrigation Farm Plan if there are new opportunities for on-farm improvements.

Funding may be available to assist with the development of an Irrigation Farm Plan (see Section 0 for further information).

Table 5-3: Irrigation Farm Planning Program checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Recommended actions	Further information & resources
Support for farm planning	Has an application form been submitted, registering for participation in the program?	☐	☐	☐	Contact AgVic	
	Has approval been received before engaging an irrigation survey/designer?	☐	☐	☐		
	In participating in the program, do I have a clear understanding of the requirements to engage with the AgVic advisory officer?	☐	☐	☐		
Objectives	Am I clear about the short term and long-term objectives, and how it fits into my goals and aspirations?	☐	☐	☐	Consider the checklist in the Goals and Aspirations module (Section 3)	
	What might change these objectives?	☐	☐	☐		
Short term improvements in irrigation water use and energy efficiency assessment	Are there short-term things that could be done to improve irrigation efficiency or energy efficiency?	☐	☐	☐	Consider the checklist in the "Maintenance measures for energy and water use efficiency module (Section 8.4)	
Survey	Has a property survey been obtained?	☐	☐	☐		
Concept plan	Has a concept plan been developed?	☐	☐	☐	Engage a qualified and experienced irrigation designer (Section 5.3.3)	
Irrigation Farm Plan	Am I communicating regularly with the designer who is developing my draft plan to ensure that it meets my objectives?	☐	☐	☐		
	Has the draft plan has been discussed with advisory officer?	☐	☐	☐	Contact AgVic	

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Recommended actions	Further information & resources
	Have all necessary planning permits for works proposed in the Farm Plan been approved so that the CMA can sign off on the plan (and hence pay any approved grants)?	☐	☐	☐	Approvals from Aboriginal Victoria (Cultural Heritage) CMA (flooding) CMA (works on waterways) Local Government (clearing vegetation) SRW (water supply) SRW (drainage)	
Implementing the plan	Is the importance of carefully considering the financial and practical challenges of implementing the plan recognised?	☐	☐	☐	Seek advice from a financial advisor Consider the "Scheduling works" checklist (Section 8.5)	

5.2.3 Concept Plan

A concept plan provides a summary of the features of the whole property and surrounding area, and forms the baseline information for future management decisions.

It is an opportunity to align the whole of the property with the farmer's vision. It is best undertaken at the whole of property scale, so that the farmer fully understands all of the management options (irrigation and dryland) across the whole of the property. This includes major features of the landscape, on-farm environmental and cultural assets, on-farm built assets, and surrounding service infrastructure. It should also identify the risks and opportunities related to the farm, neighbouring properties, and the broader catchment.

Table 5-4: Concept plan checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Sources of water	Have all possible sources of water on and around the property been identified?	☐	☐	☐	Consider checklist in water supply (Section 6.2)	
Characteristics of the landscape	Have all landscape scale features been identified applicable to the farm and surrounding area such as hills, slopes, flats and waterways?	☐	☐	☐	Seek advice from AgVic on available mapping data sets	
	Are there publicly available soil maps of the property?	☐	☐	☐		
On-farm environmental & cultural assets	Have all farm scale environmental and cultural features been identified such as native vegetation (including grasslands and dead trees of potential habitat value), shelter belts, waterways and wetlands, and aboriginal heritage sites?	☐	☐	☐	Seek advice from Aboriginal Victoria and the CMA	
On-farm built assets	Have all key built assets been identified such as houses, sheds, fences, laneways, feed pads, effluent pond, water supply points, power supply points?	☐	☐	☐	Landholder to draw upon his/her knowledge of the property and surrounds	
Surrounding service infrastructure	Have you identified all nearby public infrastructure providing (or potentially providing) inputs to the farm such as irrigation water supply infrastructure, surface and/or sub-surface drainage infrastructure, power supply lines and roads?	☐	☐	☐	Seek advice from power companies and SRW	

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Neighbouring farms	Do long term neighbours have knowledge of my property that may add value to planning and decision making?	☐	☐	☐	Liaise with neighbouring property owners	
	Have you identified neighbouring assets that should be considered as part of your planning such as native vegetation, drainage lines?	☐	☐	☐		
	Have planning concepts been discussed with neighbours to explore opportunities for collaboration planning?	☐	☐	☐		
	If expansion is one of my goals and aspirations, should I consider how my farm may integrate with a neighbouring allotment if it should become available in the future?	☐	☐	☐		
Threats to on-farm assets	Have on-farm threats been considered such as areas prone to shallow watertables, flooding or erosion? Mapping of saline soils?	☐	☐	☐	Landholder to draw upon his/her knowledge of the property and consider the checklists on Waterlogging & salinity Flooding Nutrient management	
Threats to off-farm assets	Have ways been considered to reduce the impact of this farm on the catchment? For example, nutrients, sediment and flood paths?	☐	☐	☐		

5.2.4 Irrigation farm plan

An Irrigation Farm Plan (IFP) is a holistic and flexible roadmap for development of the farm. To fully achieve its purpose, the plan should meet a set of minimum requirements.

IFPs assist landholders to implement best practice irrigation systems on their land. An IFP is made up of a survey and a design.

Survey

The survey includes the current layout and topography of the farm.

A survey plan is a property or part property plan showing surveyed ground levels, and levels of key hydrological assets such as water supply points and drainage inverts that inform irrigation layout and design.

The survey is used to generate topographical contours which inform decisions on the direction, length and slope of flood bays or furrows. For flood systems the data is used within specialised software to calculate supply levels.

For pressurised irrigation systems, the survey captures the undulation, and high and low points on the property, so that the elevation head from the supply point can be calculated, and so that the design of valve units effectively contribute to irrigation uniformity.

The survey also informs an understanding of natural drainage, as well as the need for and design of drainage earthworks.

Development of a survey map is required for all irrigation design and drainage planning. Where an existing IFP is to be updated, a new survey plan may not be required, unless supply or farm changes mean that the survey data is outdated.

Some surveying may also be advantageous in rainfed cropping areas of the property, particularly on slopes to inform the risk of erosion.

Design

The design includes the future layout of the farm including irrigation, fencing, laneways, and gravity and pressurised irrigation design. It also ensures that natural and built assets identified within the Concept Plan such as floodways, wetlands, waterways, native vegetation and regional infrastructure are considered during development.

An IFP guides major investment decisions. Minimum standards are important for the development of all Plans so that farmers have confidence that their plan takes into account all major design issues

Table 5-5: Survey & Irrigation Farm Plan checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and / or regulatory issue (action req'd)	Actions	Further information & resources
General	Is the proposed surveyor /planner recognised within the industry?	☐	☐	☐	Seek advice from Irrigation Australia	https://www.irrigationaustralia.com.au
	Have all of the elements of the concept plan been considered?	☐	☐	☐	See Concept Plan	
	Does the plan explain the reasons for any areas not surveyed, and include the location of any relevant features identified on the Concept Plan?	☐	☐	☐	Discuss with surveyor/designer	
Minimum requirements	Has the plan been checked against minimum requirements for border check/furrow irrigation system plans?	☐	☐	☐	A detailed checklist is available in the MID Incentives Program Landholder Booklet. For a copy of this booklet and to discuss your specific requirements please contact the AgVic irrigation team	
	Has the plan been checked against minimum standards for spray/ drip irrigation system plans?	☐	☐	☐		

5.2.5 Financial planning

A farm financial plan is a statement of short-term and long-term goals, and a costed assessment of how the business will achieve these goals.

Irrigation improvements can involve significant capital outlays. If a landholder is considering a significant capital investment, then it is important to first establish whether it is worth it.

Financial planning should be undertaken for all major capital investments. Annual financial planning is also important to ensure that cash flow can meet year-to-year commitments taking into account estimates of long-term trends in input costs, including increasing value of feed and water in drier years, and the volatility in commodity prices, particularly those linked to international markets.

Table 5-6: Financial planning checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Why invest?	Does it help achieve goals and aspirations? Is it the best way, or one of the best ways, to achieve them?	☐	☐	☐	Financial advisor and/or independent farm consultant Review response to "Goals and Aspirations" checklist	
Review financial performance and capacity	What are the current profits and losses? What are the reasons for this level of performance?	☐	☐	☐		
Is the investment/project worth it?	What is the potential profitability or return of the investment? What are the cash flow implications? What are the equity/debt considerations?	☐	☐	☐		
How best to implement it?	Has cash flow planning been undertaken?	☐	☐	☐	See scheduling of works (Section 5.3.5)	

5.2.6 Scheduling works

The development of a new farm or redevelopment of an existing farm is a significant investment. Constraints on farm cash flow mean developments are commonly rolled out over many years. A schedule provides a planned basis for undertaking these works.

There are financial risks in a development. A commercial farm is a business and hence planning should seek to ensure viability over the development period and beyond. The planning process should develop a schedule that does not compromise farm profitability during the period of redevelopment and capitalise on the benefits of successive stages of works.

Scheduling has application to all significant investments where development or redevelopment works are to be staged. For single stage developments, or redevelopments, the schedule may include a single costing and financial assessment confirming financial viability.

Table 5-7: Scheduling works checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Development costs	What are the indicative costs of the proposed works?	☐	☐	☐	Seek quotes from contractors/suppliers	
	What are the indicative costs of each stage?	☐	☐	☐		
Implementation Plan	Which stages are independent of other stages, and so would make a logical starting point and progressive steps for works, enabling the maintenance of farm production?	☐	☐	☐	Seek advice from financial advisor and/or independent farm consultant	
Financing works	Do these steps align with my financial situation?	☐	☐	☐	Develop a financial plan (Section 0) that includes financing the schedule of works	

6 Key attributes of the irrigation system

6.1 Overview

There are a range of irrigation development or design issues that farmers may need advice on either as part of a farm planning process, or in implementing works. The following modules provide insights into issues that may warrant consideration to support design and development decisions:

- Water supply
- Water delivery, storage and distribution
- Surface drainage
- Water use efficiency
- Energy use efficiency.

Each module contains an easy-to-use checklist to guide irrigator best practice.

6.2 Water supply

Water sources include:

- Regulated surface water systems
- Unregulated surface water systems (including private farm dams)
- Groundwater
- Regional drainage systems in irrigation areas, and
- Wastewater.

An irrigation system is dependent upon one or more of these sources and an authorisation to take and use the water for irrigation purposes.

A secure water supply is fundamental to on-going irrigation and new developments in the region. Supply is a function of the water source, a volumetric water share, flow rate and reliability. These attributes are all factors for consideration in the area, design and choice of crops to be grown.

All existing and new irrigation properties must have physical access to water and the authorisation to use the water

Table 6-1: Water supply checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Physical sources of water	Have all possible water sources on and around property have been identified?	☐	☐	☐	Contact Southern Rural Water (SRW) for further information if you need assistance answering these questions	
Authorisation to take water	Have or will water sources (entitlements, delivery shares) be sought?	☐	☐	☐		
Regulated surface water supplies	What is the entitlement volume for regulated surface water?	☐	☐	☐		
	Is there potential to improve the supply rate?	☐	☐	☐		
	Is there potential to collaborate with SRW for a modernised water supply outlet in the Macalister Irrigation Area.	☐	☐	☐		
	Is there potential to trade in water?	☐	☐	☐		
Unregulated surface water supplies	What is the entitlement volume for unregulated surface water?	☐	☐	☐		
	Is there potential to trade in water?	☐	☐	☐		
Groundwater supplies	What is the entitlement volume for groundwater?	☐	☐	☐		
	Is there potential for a new entitlement or to trade in water?	☐	☐	☐		
Drainage diversion	Does the property have a drain diversion licence from the regional drainage system?	☐	☐	☐		
	Is there potential to gain a diversion licence?	☐	☐	☐		
	Is there potential to capture neighbour's tailwater (if not currently re-used)?	☐	☐	☐		

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Reliability of supply	Is the reliability of supply of each water source/entitlement understood?	☐	☐	☐		
Collaboration with neighbours	For any of the above sources, is there potential for neighbours to share the infrastructure costs, and so make access more economically viable?	☐	☐	☐	Discuss your plans with neighbours	
Water quality	If one or more of the water sources are brackish, have the risks associated with the use of such water been considered in the design?	☐	☐	☐	Review "Quality of applied water" checklist (Section 8.7)	
Water budget	What is the net entitlement volume from all sources?	☐	☐	☐	Contact AgVic if you need assistance answering these questions	
	What is the net available water in a typical year?	☐	☐	☐		
	What is the net available water in a dry year?	☐	☐	☐		
	What is the preferred approach to managing drought risk – carry over or trade?	☐	☐	☐		
	Based on the above, what is my net water available for irrigation in typical or dry years?	☐	☐	☐		
	Assuming typical water usage for intended crops (and any aspirations for expansion), what is an appropriate design "planted area"?	☐	☐	☐		
Wastewater	Is there a potential source of wastewater (municipal or industry) that warrants investigation?	☐	☐	☐	Discuss opportunities with any food processing industries in the area or Urban Water Corporation Discuss regulatory issues with the EPA	

6.3 Water delivery, storage & distribution

Irrigation systems require infrastructure to deliver water to the farm, in some cases store water on the farm, and distribute water around the farm. The means by which water is delivered to the farm, and distributed around the farm, has implications capital and operational cost implications, and have varying levels of water delivery efficiencies.

In the Macalister Irrigation Area, water is supplied to the farm in established irrigation areas through a meter outlet. Outside the defined irrigation area, works in the form of pumps, dams and pipelines deliver water to the farm. Channels and/or pipelines are used to distribute water around the farm.

Table 6-2: Water delivery, storage and distribution checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Supply points	What are the current and potential future water supply points around my property?	☐	☐	☐	Seek advice from SRW Consider development of an Irrigation Farm Plan	
	Is there potential to rationalise the number of supply points? For example, in the Macalister Irrigation Area, is there potential to reduce the number of outlets, achieving higher command levels/flow rates or connect to delivery pipelines?	☐	☐	☐		
	Have I considered how on-farm water sources are best integrated with external water sources?	☐	☐	☐		
Works on crown land	If channel or pipeline works are to be constructed on crown land, have approvals been sought and granted?	☐	☐	☐	Seek advice from SRW	
On-farm storage	Are there potential benefits from an on-farm water storage on my property? Water on demand? Higher supply point capacity compared to low flow sources? Environmental? Tailwater capture?	☐	☐	☐	Seek advice from an Irrigation designer?	
	Is the topography and soil type etc suited to a water storage?	☐	☐	☐		

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
	Is a permit or licence required for the storage?	☐	☐	☐		
	Are the potential benefits commensurate with the cost?	☐	☐	☐		
Delivery capacity design	Taking into account supply point constraints and intended crop type and cropped area, what is the delivery capacity required to meet peak evaporative demand of the highest water using crop in an extended heatwave?	☐	☐	☐		
	In estimating peak evaporative demand, have I considered the historic evaporation record for my area? Have I factored in climatic trends towards prolonged periods of hotter weather?	☐	☐	☐		
	Is my intended crop(s) of sufficient value to warrant investigating the potential to increase the delivery capacity of the supply point to avoid 'drought stress'?	☐	☐	☐		
Channel distribution vs pump/pipeline setup?	What is the difference in capital cost of a channel compared with the range of pump/pipeline setups to meet the required delivery capacity?	☐	☐	☐	Seek advice an Irrigation designer?	
	What are the maintenance costs of channels (including labour) compared with pump/pipeline setups?	☐	☐	☐		
	For channel systems (assumed surface area) what are the estimated leakage/seepage/evaporation losses? What is the estimated value of this loss?	☐	☐	☐		

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
	Based upon estimates of capital costs, operating costs (including best estimated of maintenance, water losses and future power costs), and assuming a twenty-year asset life, which is the best option?	☐	☐	☐		
Pipeline design	Have a range of alternative pumping/pipelines setups been considered to balance capital and operating costs?	☐	☐	☐		
	Can the design cope with unexpected pressure spikes?	☐	☐	☐		

6.4 Surface drainage

Surface drainage is the degree to which flat areas are provided with enhanced artificial drains and so provided with relief from rainfall or irrigation induced inundation.

Drainage is critical to profitable, productive and sustainable agriculture both in irrigation and dryland landscapes to manage salinity and waterlogging threats.

The ecological values of wetlands are dependent upon natural wetting and drying cycles and so planning and design of drainage systems should seek to avoid damage to ecologically sensitive systems.

Table 6-3: Surface drainage checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Natural and regional drainage	Do all parts of the property have natural drainage or is there potential to benefit from constructed drainage lines?	☐	☐	☐	Seek advice on MID drains from SRW Seek advice on drainage to natural waterways from the CMA	
	For parts of the property without natural drainage, is the property serviced by a regional drainage network?	☐	☐	☐		
	If no regional drainage services, is there potential for improved access to regional drainage?	☐	☐	☐		
Collaboration with neighbours	Is there community interest in low cost improvements in surface drainage through removing obstacles to natural flows within the landscape, thereby providing dual benefits of drainage relief and floodplain restoration?	☐	☐	☐	Discuss plans with neighbours and seek advice from CMA on whether there is likely to be broader community interest	
Prevention of impacts on neighbouring properties	Do any of the proposed earthworks or structures have the potential to change the quality or flow of water across the property boundary?	☐	☐	☐	If interested in developing an Irrigation Farm Plan, contact the CMA and review Section 5.3.1 checklist	

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Protection of biodiversity	Are wetlands, natural drainage lines and native terrestrial vegetation buffered or otherwise protected from irrigation tailwater?	☐	☐	☐	If seeking technical advice, contact AgVic See re-use checklist in the Irrigation Water Use Efficiency module (Section 6.5)	
Drainage re-use	In thinking about improved drainage, have opportunities for re-use been considered?	☐	☐	☐		
Design standards	Are drains designed to enable efficient maintenance?	☐	☐	☐	Seek advice from designers and cross check with AgVic	
	Are drain slopes consistent with design standards?	☐	☐	☐		
	Are all relevant drain design features captured on the irrigation farm plan?	☐	☐	☐		

6.5 Water use efficiency

Water Use Efficiency (WUE) is an indicator of irrigation performance, commonly referring to the proportion of water applied to the crop that is used by the plant, but there can be other measures (e.g. water use relative to production units).

For any given irrigation method, integration of best practice design or technologies are available to improve the irrigation efficiency performance of the system. The benefits include:

- Using water more efficiently can reduce input cost in your irrigated farm business
- Aligning water use with productivity measures can improve profitability
- Not applying excess water can reduce the risk of erosion, water logging, salinity and nutrient losses from your farm
- Water has a value. Wastage is therefore a direct cost to the business or a wasted opportunity for other productive or environmental use.

For all irrigation methods (see Section 5.2), there are options available to improve management to achieve improved irrigation efficiencies which are important for a range of reasons.

Aligning the irrigation method to the characteristics of the property is an important factor in achieving high levels of irrigation efficiency. However for a given method, there is a range of efficiencies that are achievable depending on the design improvements and technologies adopted. Adoption of multiple technologies may provide incremental improvements in efficiencies (e.g. target reduced evaporation losses or reduced rootzone drainage losses). Some technologies are alternative ways of achieving similar outcomes (e.g. alternative ways of reducing tailwater losses).

Achieving high levels of WUE are important for profitable and sustainable irrigation across all irrigated industries and irrigation landscapes.

Table 6-4: Water use efficiency checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Managing infiltration and rootzone drainage	Is the soil type suited to the irrigation method?	☐	☐	☐	Seek advice from irrigation designer or contact AgVic	
	Does the design account for variability in soil type?	☐	☐	☐		
	Does the design account for changes in land elevation?	☐	☐	☐		
	Does the design allow for leaching of accumulated salts from rootzone?	☐	☐	☐		
Managing evaporative losses	Can the surface area of channels and storages be minimised?	☐	☐	☐		
Reducing seepage and leakage losses?	Are channel loses factored into decisions on the merits of channel vs pipeline distribution?	☐	☐	☐		
	Are property soil types understood so heavy clays can be sourced for construction of new channel pads, or line existing channels?	☐	☐	☐		
	Are channels fenced to avoid stock damage?	☐	☐	☐	Discuss with AgVic	

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
	Is routine maintenance of channels undertaken, including weed control to avoid overtopping and erosion of banks?	☐	☐	☐		
Managing the timing of irrigations	What options are available for water savings in the approach to scheduling irrigations?	☐	☐	☐		
Water saving technologies for flood and furrow irrigation						
Re-use	Are there impediments to construction of a below groundwater storage. For example, excavating into sands with poor stability that would be prone to losses or inflow of saline groundwater?	☐	☐	☐	Consider development of an Irrigation Farm Plan Discuss technical issues with AgVic	
	Can tailwater be captured, stored and re-used across a large portion of the property?	☐	☐	☐		
	Are there potential benefits of integrating farm drainage design and re-use between neighbouring properties?	☐	☐	☐		
	Is the tailwater storage volume less than or equal to the volume that will trigger a requirement for licensing as a farm dam?	☐	☐	☐		
	Is there potential to integrate opportunistic drainage diversion into the re-use outfall structure?	☐	☐	☐		
	Is there potential to take over an SRW drain as a tailwater re-use system?	☐	☐	☐	Discuss with SRW and if potential, consider in development of an Irrigation Farm Plan	

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
	Is there potential for harvesting neighbour's drainage that is not currently routed to a re-use system?	☐	☐	☐	Discuss with neighbour and if potential, consider in development of an Irrigation Farm Plan	
Slope & length	Is the design and length of bays and furrows appropriate to the soil type?	☐	☐	☐	Consider development of an Irrigation Farm Plan. Discuss technical issues with AgVic	
Automatic irrigation	Does design include high technology automatic irrigation options linked to soil moisture monitoring?	☐	☐	☐		
Fast flow	Are irrigation application rates designed to achieve uniform watering depths for the prevailing soil type by optimising delivery to the paddock with length, width and slope of the bays/furrows.	☐	☐	☐		
Water saving technologies for centre pivot – linear move						
Automatic Irrigation	Is the system equipped with sensor technology to cease irrigation?	☐	☐	☐	Discuss options with irrigation designer and equipment supplier	
Emitters that deliver uniform distribution	Is the system equipped with the latest technology providing low pressure precision applications minimising potential for evaporation? e.g. efficient droppers, or moving plate sprinklers?	☐	☐	☐		
Irrigator alignment control	Are sensors fitted and working to ensure irrigation cut-off if irrigator bogged or misaligned?	☐	☐	☐		
Water saving technologies for fixed pressurised impact sprinklers						

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Automatic irrigation	Does design include high technology automatic irrigation options linked to soil moisture monitoring?	☐	☐	☐	Discuss options with irrigation designer and/or equipment supplier	
Variable speed drive	Has a variable speed pump been considered to enable the pump to change speeds in response to a drop-in pressure between irrigation shifts?	☐	☐	☐		
Water saving technologies for pressurised surface micro-irrigation						
Automatic irrigation	Does design include high technology automatic irrigation options linked to soil moisture monitoring?	☐	☐	☐	Discuss options with irrigation designer and/or equipment supplier	
Pressure compensating drippers	Have pressure compensating drippers been considered so that flows from emitters can be maintained irrespective of changes in pressure?	☐	☐	☐		
Variable speed drive	Has a variable speed pump been considered to enable the pump to change speeds in response to a drop-in pressure between irrigation shifts?	☐	☐	☐		
Water saving technologies for pressurised sub-surface drip						
Filtration	Is the system equipped with a well-maintained filter to avoid clogging of emitters?	☐	☐	☐	Discuss options with irrigation designer and/or equipment supplier	
Pressure regulation	Have pressure regulator valves been considered so that pressures maintained across the system and so achieve uniformity of application?	☐	☐	☐		

6.6 Energy use efficiency

Energy is a critical input to irrigated agriculture both in the distribution of water, and because modern agricultural practices are highly mechanised. Energy related risks are to:

- Profitable agriculture – high operating costs threaten financial viability
- Healthy environment – energy sourced from fossil fuels generate greenhouse gasses
- Rising energy costs contribute to the cost price squeeze on farming. More efficient energy usage reduces costs without compromising productivity
- Greenhouse gas emissions contribute to climate change, which is already significantly impacting upon agriculture systems in south-eastern Australia
- Individuals and communities are increasingly seeking opportunities to reduce their energy costs, reduce their emissions and if possible, achieve carbon neutral outcomes.

All modern irrigation systems consume energy and hence incur costs and generate emissions. However, irrigation systems that are not gravity based and involve significant lift, incur the greatest financial and environmental energy costs.

Table 6-5: Energy use efficiency checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Understanding risks	What farm activities consume the most energy and so impose the highest cost?	☐	☐	☐	Discuss with irrigation designer or irrigation equipment supplier	
	What are the expected long term trends in energy costs?	☐	☐	☐	Discuss with power supply company	
Opportunities for improved energy efficiencies	Have I factored energy costs/benefits into the choice of irrigation method?	☐	☐	☐	Discuss with irrigation designer or irrigation equipment supplier	
	In my chosen irrigation system, have I investigated reducing future energy consumption, by investing in more efficient components (three phase power, pump size, pipeline sizes)?	☐	☐	☐	Discuss with irrigation equipment supplier and power supply company	

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
	The viability of pumping systems operated by renewable energy sources continues to improve. Have I considered renewable energy options to satisfy part of farm needs?	☐	☐	☐		
	Is there potential to share in the development of renewable sources in partnership with others in the community?	☐	☐	☐	Consider development of an irrigation farm plan where all management options should be considered	
	If there are currently no viable renewable energy options, is it possible for my design to take into account the potential adoption to renewables in the future?	☐	☐	☐		
Exploring alternative power supply options	Is there potential for neighbours or the wider community to come together to develop renewable energy sources?	☐	☐	☐	Discuss with neighbours and if shared interest, discuss with Power supply company	
	Is there potential (and value) for neighbours to share capital cost of access to three-phase power or renewable energy generation?	☐	☐	☐		
Implementation	Are there immediate actions available to reduce energy consumption?	☐	☐	☐	Discuss with irrigation designer or irrigation equipment supplier	
	What opportunities are there to be more energy efficient over the longer term?	☐	☐	☐		

7 Community and environmental considerations

7.1 Overview

Everyone lives in a catchment with both the farm and the broader environment benefiting when on farm operations support and protect the surrounding environment. These benefits are most effectively and efficiently achieved when farmers work collaboratively with agencies and communities.

This section covers the following modules:

- Cultural heritage
- Waterlogging (shallow watertables) and salinity
- Flooding
- Nutrient management
- Native vegetation and biodiversity.

Each module contains an easy-to-use checklist to guide irrigator best practice.

7.2 cultural heritage

Traditional Owners have a strong connection with country and Indigenous artefacts, cultural sites and traditions are part of Australia's heritage.

As stewards of the land, landholders have an opportunity to support Traditional Owners in maintaining or renewing this spiritual connection and developing their own understanding and protection of the cultural heritage values specific to their property.

Table 7-1: Cultural heritage checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Linkages & regulations	Further information & resources
Protection of cultural heritage values	Are there opportunities to improve understanding and sharing of cultural heritage values on the property?	☐	☐	☐	Seek advice from the CMA's Aboriginal Cultural Heritage Officer	
Strengthening connection to country	Are there other opportunities to strengthen spiritual connection between Traditional Owners and country?	☐	☐	☐		

7.3 Waterlogging (Shallow Watertables) and salinity

Waterlogging is the prolonged saturation of the soil which decreases the oxygen available in the rootzone. Salinity is the accumulation of salt in the rootzone from capillary rise from a shallow watertable.

Waterlogging and salinity both impact upon plant growth and hence productivity.

The effects of waterlogging from a rising watertable may be very quickly apparent whereas salinisation of the soil progressively occurs over time. The rate of salt accumulation depends upon depth to watertable and other factors such as salinity of groundwater and soil type.

If accumulated salt is not periodically leached from the rootzone, a threshold level of soil salinity will eventually be reached beyond which increasing salinity leads to reduced yields. The threshold salinity varies from crop to crop with some crops being significantly more sensitive than others. In low lying areas, there is potential for the land to be salinized to the extent that it becomes unsuited to agricultural uses.

Shallow watertables arise most commonly in irrigated riverine plain or floodplain landscapes where there is intensive irrigation and the watertable is relatively flat. In these situations, groundwater gradients are low and so do not provide lateral drainage sufficient to offset accessions to the aquifer. During extended wet periods when cool season rainfall on the irrigated landscape exceeds plant water use, drainage losses below the rootzone induce the development of shallow watertables. Productivity is particularly threatened when the watertable lies within 2 metres of the surface.

Table 7-2: Waterlogging and salinity risk checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Action	Further information & resources
Which parts of my farm are at risk from shallow watertables?	What do I recall from historic prolonged wet periods during the 1980s and 1990s?	☐	☐	☐	The CMA and AgVic have access to bore data, salinity and depth to watertable mapping for most of the region Data is also available on-line Contact the CMA or AgVic for further information	https://www.vvg.org.au
	What do soil tests indicate is the current salinity status? Is EM38 salinity mapping warranted?	☐	☐	☐		
	If new to the area, what do my neighbours or agencies know about the salinity risk to my property?	☐	☐	☐		
	Are there monitoring bores near these low-lying areas? Is there historic data that shows long term trends and levels during wetter years?	☐	☐	☐		
Land use options	Are areas with a history of salinization fenced off, vegetated with salt tolerant species, and excluded from the irrigation?	☐	☐	☐	Discuss options with AgVic or Independent Farm Consultant and consider completing an Irrigation Farm Plan	
	If agricultural use, what are the most salt tolerant pasture/crop species?	☐	☐	☐		
	If biodiversity use, what are the most salt tolerant trees, shrubs and grasses?	☐	☐	☐		
Surface drainage options	Is there potential to improve surface drainage?	☐	☐	☐	Review "Surface drainage" checklist (Section 6.4)	
	If surface drainage can be improved, how do avoid mobilising salt off-farm	☐	☐	☐		

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Action	Further information & resources
Sub-surface drainage options	Is there an individual or broader community interest in shallow groundwater pumping for salinity control, supplementary water, or both?	☐	☐	☐	Seek advice from SRW	
	Are there any constraints on the issue of licences to pump shallow groundwater?	☐	☐	☐		
	Has a desktop assessment based upon readily available data identified potential for groundwater of a suitable yield and salinity?	☐	☐	☐		
Sub-surface drainage field investigations	Has an electromagnetic survey been conducted to identify potential drilling targets?	☐	☐	☐	Discuss with SRW and potentially engage a geophysics contractor	
	Has a bore construction licence been obtained?	☐	☐	☐	Contact SRW	
	Does drilling indicate high yielding sands and useable quality and hence justify test pumping?	☐	☐	☐	Engage and discuss with licensed driller	
	Does test pumping indicate a viable irrigation supply (yield and salinity) and what is the area likely to benefit from salinity control?	☐	☐	☐		
	If field investigations indicate a viable groundwater pumping site, what is the best option – low volume tube wells or spearpoint system? Is solar power an option?	☐	☐	☐		

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Action	Further information & resources
	If the desktop assessment or field investigations indicate groundwater pumping site is not viable, is tube drainage a viable alternative to a groundwater pump?	☐	☐	☐		
	What the risk from use of the groundwater?	☐	☐	☐	Review "Water Quality of Applied Irrigation Water (Section 0) and discuss with AgVic	
Approval to take and use groundwater	Has a licence application been submitted and approved?	☐	☐	☐	Seek advice from SRW	
	What are the conditions on the licence with respect to entitlement and maximum flow rate?	☐	☐	☐		

7.4 Flooding

Flooding is the inundation of land as a consequence of local rainfall, overland flow and/or stream breakouts. Most flooding is caused by natural events and is contained within the floodplain. Due to the construction of large storages in most catchments, floods are less frequent and of smaller magnitude than they were historically.

Flood events are natural occurrences critical to the function of many environmental, social, cultural and economic values. Flooding replenishes paleo-channels and wetlands that fringe river systems and plays a critical role in flushing of rivers and lakes. Natural flooding also has geomorphological and cultural significance.

Benefits extend to the farm; rehydrating the floodplain, replenishing depleted groundwater resources and delivering natural nutrients to the soil. However, flooding also poses risks to physical infrastructure and without adequate drainage, extended inundation of farmland can lead to significant agricultural losses.

In planning and responding to flooding events, property owners should balance the important role that inundation and natural flow pathways play in environmental health, whilst ensuring farming systems are designed to cope with such events.

Table 7-3: Flooding risk checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Linkages & regulations	Further information & resources
Understanding risk and opportunities	What parts of my property (if any) are at risk from flooding? What do I recall from historic flooding events in the area? If new to the area, can neighbours offer any advice?	☐	☐	☐	The CMA has detailed flood mapping for most of the region. Contact the CMA for further information	
	How often do these areas flood?	☐	☐	☐		
Managing risk and opportunities	Could on-farm drainage be improved and would earthworks require a permit?	☐	☐	☐	Consider the issues on surface drainage (Section 6.4) and discuss with AgVic or an irrigation designer	
	Could off-farm drainage be improved?	☐	☐	☐		
	What are the implications of flooding risk to irrigation layout?	☐	☐	☐		
	What are the opportunities to enhance biodiversity outcomes from flooding events?	☐	☐	☐	Discuss with the CMA and an irrigation designer	

7.5 Nutrient management

Nutrient management is the application of fertiliser and other organic amendments (e.g. animal waste) in a way that meets the crop needs without having detrimental impacts on beneficial uses of surface and groundwaters, the health of soils, or aquatic or terrestrial ecosystems. High concentrations of phosphorus, nitrogen, micronutrients, pathogens and pesticide residues can all contribute to risks to catchment health. This is a significant risk for Lake Wellington and other Gippsland Lakes, and in some catchments is also a threat to potable water supply.

Effective nutrient management includes:

- Ensuring sufficient nutrients to meet crop needs
- Avoiding application of excess quantities that then pose a pollution risk to waterways, lakes and groundwater
- Understanding the connectivity between intensively farmed agricultural land and drainage lines which can be a significant pathway for sediments, animal waste and applied fertiliser to migrate to waterways.

Table 7-4: Nutrient and water quality management checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Understanding risks	What areas of the farm are both a source of nutrients and have connection to waterways? Areas prone to erosion Areas prone to concentration of waste (e.g. laneways and feed pads) Areas used for distribution of effluent Fertilised areas.	☐	☐	☐	Develop a nutrient management plan with advice from AgVic, an industry bodies (e.g. GippsDairy or AUSVEG) or an independent consultant	
Applying the right amount of fertiliser	What are the nutrient needs of the crop?	☐	☐	☐		
	What are the types and quantities of fertilisers you currently apply?	☐	☐	☐		
	Do you apply other sources of nutrients (e.g. waste or wastewater, compost)?	☐	☐	☐		

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
	What do the most recent soil tests indicate is the status of your soil fertility relative to the nutrient needs of your crop?	☐	☐	☐		
	What is the estimated removal of nutrients and other soil additives by the crop?	☐	☐	☐		
	What is the net shortfall in nutrients required to maintain a nutrient budget?	☐	☐	☐		
Reducing losses in runoff	What options are there to reduce nutrient losses due to erosion?	☐	☐	☐		
	What options are there to reduce nutrient rich runoff from both irrigation and rainfall?	☐	☐	☐		
Meeting regulatory expectations	Have all of the water quality risks and management measures been documented in a new or updated soils and nutrient management plan?	☐	☐	☐	Contact the EPA for advice on regulatory obligations on the management of off-farm nutrient risks	
	For new irrigation developments, does this plan include approved monitoring of the nutrient balance and movement (including in relation to groundwater depth and quality) as is required under standard water-use conditions?	☐	☐	☐	Contact the SRW on nutrient management planning necessary to meet standard water-use conditions	

7.6 Native vegetation and biodiversity

Biodiversity contributes to a healthy ecosystem, provides benefits to the natural environment and supports profitable and sustainable agriculture. These benefits include:

- Fungi, worms and bacteria transforming sunlight, carbon and nitrogen into fertile soil
- Pollination from insects
- Creation of micro-climates
- Provision of shade and shelter for livestock
- Waste absorption and breakdown
- Integrated Pest Management (IPM).

These benefits are applicable across all agricultural landscapes including plant and animal based industries and, in both irrigation and rainfed systems.

Table 7-5: Native vegetation and biodiversity checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Protection and enhancement of biodiversity	Have the on-farm location and importance of environmental assets (e.g. native vegetation, natural waterways, wetlands and billabongs) been identified?	☐	☐	☐	Contact the CMA and Landcare for advice on species, riparian plantings and shelter belt design	
	Have the off-farm location and importance of local or linked environmental assets been identified?	☐	☐	☐		
	Are neighbours interested in planning native vegetation corridors and works to protect shared waterways, wetlands or remnant bushland for the mutual benefits of both properties, and the catchment at large?	☐	☐	☐		

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
	Have I engaged with Landcare or other environmental groups to ensure that my planning is aligned with the environmental priorities of the local area and that I build upon diversity in the surrounding landscape?	☐	☐	☐	Contact the CMA and Landcare for advice on species, riparian plantings and shelter belt design	
	Is local advice available on recommended vegetation species to maximise biodiversity and ecosystem services for the area?	☐	☐	☐		
	Are buffers planned to protect native vegetation from irrigation induced waterlogging?	☐	☐	☐		
	Are buffers planned to protect waterways from sediments and nutrients mobilised in overland flow and tailwater?	☐	☐	☐		
Removal of native vegetation	Does proposed development on the property impact native vegetation? If so, have alternative irrigation methods been considered that would reduce the impact?	☐	☐	☐	Review Irrigation methods module (Section 5.2) Seek advice from Local Government on required permits	
	What are the options for offsets?	☐	☐	☐		
	Have I applied for a permit, and received approval?	☐	☐	☐		
Livestock benefits	Have the shade and wind shelter benefits to reduce the impact of heat stress and cold spells on livestock been considered?	☐	☐	☐		

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Cropping benefits	Does the plan utilise the potential pollination benefits of biodiversity?	☐	☐	☐	Seek advice from AgVic	
	Does the plan utilise potential integrated pest management benefits of biodiversity?	☐	☐	☐		
	What are the potential benefits of a cover crop as a habitat for pest predators vs habitat for pests? Are there other complementary benefits to soils?	☐	☐	☐		
	Does planning seek to develop microclimate benefits from vegetation corridors?	☐	☐	☐		

8 Farm operations

8.1 Overview

Sustainable irrigation management is not just about the type of system and infrastructure. It is also dependent on good management. This section covers the following regular and re-occurring irrigation management issues that warrant regular consideration:

- Farm safety
- Managing through drought
- Maintenance measures for energy and water use efficiency
- Irrigation scheduling
- Soil management
- Quality of applied water.

Each module contains an easy-to-use checklist to guide irrigator best practice.

8.2 On-farm safety

Under Occupational Health and Safety (OH&S) legislation, farms, as with all workplaces, must provide a safe work environment for the farm owner/operator, lessee, employees, contractors, family and visitors.

The statistics show that farms are one of the most dangerous workplaces in Australia. Safety must therefore be front and centre to farm operations and farm development.

Table 8-1: On-farm safety risk checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Understanding risks	Are my obligations for the safe operation of my farm understood?	☐	☐	☐	Seek advice from Farmsafe Australia on best practice safety management and OH&S obligations	https://www.farmsafe.org.au
	Have most current available farm safety documentation and checklists been obtained applicable the industry?	☐	☐	☐		
	Have risks been identified and documented?	☐	☐	☐		
Mitigating risks	Have appropriate control measures been put it place to protect workers, contractors, families and visitors?	☐	☐	☐		

8.3 Managing through drought

In Gippsland, and elsewhere in south-eastern Australian, the climate is highly variable. Climatic trends and predictions suggest south-eastern Australia is becoming warmer with less winter season rainfall, and so drought management will be increasingly important.

Building resilience to cope with years of water shortage is therefore an important part of farm operations to maintain sustainable productive irrigated agriculture.

Table 8-2: Drought management checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Understanding risk	For each of my water sources, how regularly do I expect to get my full entitlement? e.g. 7 in 10 years? More? Less?	☐	☐	☐	Develop a drought management plan. Advice available from AgVic, and industry bodies or an independent consultant	
	Do my current sources of water meet my water needs in dry years to-date?	☐	☐	☐		
Managing risk	Are there other possible sources worth investigating?	☐	☐	☐		
	Can I improve my water use efficiency to make better use of the water available each year?	☐	☐	☐		
	What are the relative costs of purchasing additional water sources (entitlement or allocation) compared with fodder purchase?	☐	☐	☐		
	What are the pros and cons of destocking now and restocking post dry spell?	☐	☐	☐		

8.4 Maintenance measures for energy and water use efficiency

When considering the potential to transition to a more energy or water use efficient operations, it helps to understand existing inefficiencies which could be rectified promptly. This means that you can:

- Save water
- Save on energy costs.

Table 8-3: Checklist for immediate opportunities to improve energy use efficiency

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Understanding current system	What design information is there on the current setup?	☐	☐	☐	With advice from AgVic, collate readily available data Seek advice from irrigation designer and irrigation system supplier on options for operational improvements	
	Taking into account the type of system, what are the general attributes of the current setup that are most likely to contribute to water losses?	☐	☐	☐		
	For non-gravitation systems, what are the general attributes of the current setup – elevation head, pump/motor size, pipeline size, direct coupled/belt coupled pump/motor drive, outlet locations and sizes, that may contribute to energy inefficiencies?	☐	☐	☐		
	What is the annual volume pumped/delivered?	☐	☐	☐		
	What is the irrigation season energy consumption?	☐	☐	☐		
	What is the operating pressure?	☐	☐	☐		
	What is the flow rate through outlets/sprinklers/emitters?	☐	☐	☐		

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
	What does available data indicate as to performance? – ML/kWh?	☐	☐	☐		
	How do the energy use records compare with readily available regional data or estimates of power consumption?	☐	☐	☐		
	Is the setup and operating performance consistent with available information on design?	☐	☐	☐		
Clogging	Are supply bores, pipelines and outlets/tapes/emitters maintained and clear of mineral deposits (e.g. iron), algae or other blockages?	☐	☐	☐	Seek advice from Bore servicing contractors	
	Should filtration be considered?	☐	☐	☐		
Opportunities for improvement in pump operations and delivery pipelines	Are there cost effective options for reducing operating pressure? For example, a variable speed pump that adjusts to changes in pressure across irrigation shifts? Removal of restrictions in segments of pipeline?	☐	☐	☐	Seek advice from irrigation designer and irrigation system supplier on options for operational improvements	
	Are there simple/low cost opportunities to reduce energy losses? e.g. losses in motor pump couplings?	☐	☐	☐		
	Is there opportunities to operating at lower tariff rates (e.g. off-peak)?	☐	☐	☐		
	Are there leaks in mains and laterals?	☐	☐	☐		
	Are there leaks in risers and around sprinkler bearings?	☐	☐	☐	Seek advice from irrigation designer and irrigation system	

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Opportunities for improvement in fixed-point impact sprinklers	What is the condition of sprinklers - frequency of knocker operations and rotations?	☐	☐	☐	supplier on options for operational improvements	
	Are sprinkler stakes straight (not tilted)?	☐	☐	☐		
	Is distribution uniformity confirmed against standards?	☐	☐	☐		
Opportunities for improvement in CPLM systems	Are there leaks in span pipes at towers?	☐	☐	☐	Seek advice from irrigation designer and irrigation system supplier on options for operational improvements	
	What is the condition of sprinklers - frequency of knocker operations and rotations?	☐	☐	☐		
	Is there potential for upgrade to Low Energy Precision Application (LEPA) emitters?	☐	☐	☐		
	Are the sprinklers/emitters clean – unblocked?	☐	☐	☐		
	If there are blockages, should filtration be considered?	☐	☐	☐		
Opportunities for improvement in Border check systems	Are weeds controlled in channels?	☐	☐	☐	Seek advice from irrigation designers and irrigation system suppliers on options for operational improvements	
	Are bay outlets sealed when closed?	☐	☐	☐		
	Are stock excluded from channels?	☐	☐	☐		
Overall assessment	Taking into account the above, how does the available information compare with the original design? What measures can be taken to address differences that are likely to be contributing to poor energy or water use efficiencies?	☐	☐	☐		

8.5 Irrigation scheduling

Irrigation scheduling is the timing of irrigation and the amount of water applied. It is an important management tool because excessive water deficit or over irrigation can result in waterlogging, reduced irrigation efficiency and reduced crop productivity.

The aim of irrigation scheduling is to optimise soil water availability so that the crop is not stressed or managed to an optimal level of stress.

Table 8-4: Irrigation scheduling checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Action	Further information & resources
General information required	How do the soil types vary across the property?	☐	☐	☐	Use a Concept Plan (Section 5.2.3) and Farm Irrigation Plan (if available) to collate relevant information Seek advice on scheduling options from a specialist irrigation consultant or AgVic irrigation officer	
	What are the different crop types to be irrigated and where are they located on the property?	☐	☐	☐		
	What is the readily available water holding capacity of the rootzone?	☐	☐	☐		
Soil moisture monitoring	What soil moisture monitoring options are there suited to property crop types?	☐	☐	☐		
	What is the right sensor distribution (density and depth) to provide measurements representative of rootzone soil moisture?	☐	☐	☐		
	Where should sensors be placed to provide an indication of average water application?	☐	☐	☐		
	What options are there to link soil moisture monitoring probes to the office computer system?	☐	☐	☐		

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Action	Further information & resources
Crop water demand	Is satellite imagery based estimates of water demand available for the farm?	☐	☐	☐		
	Are there opportunities to use Bureau of Meteorology forecasts to support water orders?	☐	☐	☐		

8.6 Soil management

Healthy soils are one of most important property assets. Heathy soil is biologically active, chemically balanced and well structured, with maximum potential to retain moisture. Effective soil management means maintaining a healthy soil and managing the risks arising from erosion, salinity, sodicity and a poor nutrient balance.

A healthy soil is important because:

- Retaining soil and nutrients is conducive to productive and profitable farming
- Avoiding the development of saline and sodic soils
- Managing saline and sodic conditions when they arise to avoid further productivity losses and downstream impacts
- Minimising soil and nutrient losses, reduce fertiliser inputs and hence operating costs
- Reducing export of sediments, nutrients, chemicals and pathogens contributes to improved catchment water quality and waterway health.

Table 8-5: Soil management checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Soil types and soil chemistry	What are the major soil types and how are they distributed?	☐	☐	☐	Use a Concept Plan (Section 5.2.3) and Farm Irrigation Plan (if available) to collate relevant information Seek advice on best practice soil management from a specialist agronomist or AgVic irrigation officer	
	What are the results of recent soil tests/mapping of fertility, salinity, sodicity?	☐	☐	☐		
Managing soil fertility and structure?	How do soil test results inform nutrient management?	☐	☐	☐	Discuss options for monitoring and management implications with AgVic or an agronomist	
	How do soil test results inform soil structure management?	☐	☐	☐		
Avoiding soil loss	Which parts of the farm are most at risk of soils erosion? Why – soil type? Slope? Floodplain?	☐	☐	☐	Discuss with AgVic or an agronomist	

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
	Does the erosion risk increase significantly if cultivated?	☐	☐	☐		
	Is minimum tillage an option to reduce risk of soil loss?	☐	☐	☐		
	Would a ripper mulcher have application for annual cropping on steep slopes?	☐	☐	☐		
	Do cover crops have application? Are there disbenefits that need consideration e.g. increased frost risk, or provide habitat for pests?	☐	☐	☐		
	Are natural drainage lines buffered or otherwise protected by sediment traps, from the impacts of erosion?	☐	☐	☐		
	Is there evidence that off farm impacts are being managed?	☐	☐	☐		
Is my property likely to be at risk?	Is there current or historic evidence of a shallow watertable in my area?	☐	☐	☐	Discuss with CMA and SRW Consider "Waterlogging (shallow watertables) and Salinity" checklist (Section 7.3)	

8.7 Quality of applied water

All water contains salts which at higher concentrations pose a risk to crop productivity and soil health.

It is important to understand the water quality of applied water because:

- The water may be brackish and/or sodic, particularly if the source is groundwater, wastewater, or surface drainage from saline areas
- Applying brackish or sodic water increases both the potential for soil salinisation and/or soil sodicity (a high concentration of sodium relative to calcium and magnesium)
- These risks require careful management to avoid toxic effects on crops, and soil structure decline.

Table 8-6: Quality of applied water checklist

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
Salinity of water source	Are one or more of my water sources brackish?	☐	☐	☐	Discuss with SRW	https://salinitywatch.gbcma.vic.gov.au/salinity-benefits-and-risks/irrigation-with-groundwater.html
Chemistry of water	If using water sources other than surface supplies, has the chemistry and salinity been assessed?	☐	☐	☐	Laboratory analysis	
	If groundwater, has the risk of iron clogging problems been assessed?	☐	☐	☐	Seek advice from bore pump equipment suppliers	
	If micro or spray irrigation, has the Langlier Saturation Index (LSI) been assessed to ensure that the water chemistry (e.g. pH and concentration of calcium carbonate) does not pose a risk of clogging?	☐	☐	☐	Seek from a specialist agronomist	
Irrigation system design	Does my irrigation system design maximise the opportunity to spread my use of brackish water over a large area of the farm?	☐	☐	☐	Discuss with Irrigation designer	
	Does the delivery system design provide the opportunity to mix brackish water sources with fresher water sources?	☐	☐	☐		

Issue	Checklist	Under control / not relevant	Relevant / explore further	Critical and /or regulatory issue (action req'd)	Actions	Further information & resources
	Has the volume of irrigation water (+ rainfall) necessary to leach salts from the rootzone been estimated for the primary soil types, and considered in the application rates?	☐	☐	☐	Seek from a specialist agronomist	
	Is the irrigation system designed to avoid over canopy application with brackish water?	☐	☐	☐	Review canopy risk impacts in "Irrigation method" checklist (Section 5.2)	
Using brackish water	Are the preferred crops, suited to the available water quality?	☐	☐	☐	Seek advice on monitoring and managing use of poor quality water from a specialist agronomist	
	Do I regularly monitor the salinity of applied water?	☐	☐	☐		
	Are soil tests on areas regularly irrigated with brackish water undertaken and compared with threshold soil salinity/sodicity data?	☐	☐	☐		
	Does the shandying ratio (volume and salinity of fresh water relative to brackish water) keep the applied salinity below recommended thresholds?	☐	☐	☐	Seek from a specialist agronomist	
	Are the risks to soil structure of alternating between brackish and fresh water sources understood?	☐	☐	☐		
	Have options to manage soil salinity and sodicity problems arising from using brackish water been considered?	☐	☐	☐		

Appendix 1: Examples of useful farm scale data

Understanding of the farm and its performance benefits from both hands on experience, and good farm records.

The following provides a summary of opportunities for record keeping that will provide an improved understanding of irrigation performance and so inform future decision making.

Theme	Useful Data Sets
Water use	Monitoring of water taken from all sources, and water for key areas of the farm so as to understand water use variability
	Water use/ha and water use/production unit
	Water use compared with rainfall records
Energy use	Energy use and partition various contributions to different operational components?
Water quality	Salinity and water chemistry of water source
	Salinity of applied water
Biodiversity status	Arial photographs of native vegetation
	Encourage farm sites to be the focus of environmental group/research biodiversity studies?
Watertable and soil salinity	Installation and monitor of observation wells in areas at risk of shallow watertables
	Farm salinity surveys (perhaps every 5 years?)
Soil fertility	Soil tests undertaken at least every 2 years
	Records on areas fertilised with effluent
	Records kept on areas fertilised with inorganic fertiliser
Production	Records maintained on production on different parts of the farm

Appendix 2: Actions for Extension Officer

Module	Issue	Action

Appendix 3: Actions for Landholder

Module	Issue	Action

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