



# Guidelines for land and water management plans

Mackay and Whitsunday region  
May 2006

Reprinted July 2007 with updates to section 2.1



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Reprinted July 2007 with updates to section 2.1

QNRM06059

ISBN 978-1-7417-2862-0

#28319

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## 2. What is a LWMP?

A LWMP provides individual landholders with a practical management plan, which demonstrates that irrigation practices are ecologically sustainable both on and off farm. It gives a landholder the opportunity to plan and review an irrigation enterprise and identify any risks associated with irrigation practices. It can also be a way of recording and measuring continuous improvement.

### 2.1 When is a LWMP required?

The *Water Act 2000* specifies that an approved LWMP is required before using water for irrigation purposes when:

- a new or additional water allocation or interim water allocation is obtained<sup>1</sup>
- a Resource Operations Plan (ROP) specifies a LWMP is necessary for water licences
- an irrigator's land is identified in a Water Use Plan as land where a LWMP is required
- an irrigator intends to use a seasonal assignment of water as their only source of water on the same land in any two of three consecutive water years
- an irrigator intends to use on the same land both a seasonal assignment of water and water taken under a water allocation, or an interim water allocation, in any two of three consecutive water years, and water use will exceed the nominal allocation volume
- an irrigator moves some or all of their existing water allocation from one ROP zone to another ROP zone
- a development permit is required to construct works that capture tail water contaminated runoff.<sup>2</sup>

All irrigators are encouraged to prepare a LWMP for their property. Irrigators who are not required to have an approved LWMP may use these guidelines to prepare a plan for their enterprise to improve water use efficiency or to address other resource management issues.

### 2.2 What land and water does a LWMP cover?

Once water has a LWMP requirement, a LWMP must be prepared for the irrigation and associated development area on which it is to be used. This includes all land that is to be irrigated with the water that initiated the LWMP and all land on which associated infrastructure lies (e.g. storages, sumps and delivery systems). If this water is mixed or used with other irrigation supplies through common associated infrastructure, all land on which the total water supply is to be used needs to be included in the LWMP.

### 2.3 What are the components of a LWMP?

A LWMP consists of a written report and a series of maps.

The written report must address the information you need to provide to satisfy the desired outcomes listed in Section 4 of this document. The level of detail required will depend on the 'risk' associated with the use of the water for irrigation. The written report format should follow the same structured headings in Section 4.

All LWMPs must provide mapping information consisting of a recent aerial photograph or satellite image base map of the property and a series of other maps or overlays that provide the property information requested in the guidelines. This information can be presented as one of the following:

- same scale clear transparent overlays that go over the base map with information neatly recorded on them using waterproof/permanent fine point pens
- a number of aerial photograph or satellite base maps with information neatly printed over the top of the image. If these are produced digitally on a computer it may be possible to combine some overlays onto one map, provided the map does not become cluttered and difficult to interpret.

<sup>1</sup> LWMP requirement does not apply to water and used for stock or domestic purposes, or for existing water entitlements obtained prior to the commencement of Section 73 of the *Water Act 2000*. This exemption also applies if prior existing water entitlements are converted to water allocations, or if they are purchased with land as an ongoing enterprise.

<sup>2</sup> Applies where a Water Resources Plan has declared specific types of works for taking contaminated agriculture runoff and tail water as assessable development.



Figure 2 Irrigation area map

All maps should be A3 paper size or larger. Actual scales will vary depending on the size and complexity of the property. In general, 1:5000 to 1:10 000 will be suitable for areas over 250 hectares and 1:1000 to 1:2000 (i.e. greater detail) for smaller areas. If you need help determining the best scale map or presentation option, discuss the options with your regional LWMP officer at NRW.

In some cases, two scales of mapping may be required depending on whether the whole property represents the irrigation area in sufficient detail. The result will be a:

- whole property map
- map of the development/irrigation area only.

Figure 2 represents an example of an irrigation area map.

Note: If the map of your whole property represents the irrigation area in sufficient detail, separate maps will not be necessary for the irrigation area. All maps can overlay the whole property map.

Map information (see Figure 3) should consist of:

- Three whole property scale maps:
  - base map—prepared from aerial photographs or satellite imagery
  - landform and natural features map
  - vegetation map
- Five irrigation development area scale maps:
  - base map—prepared from aerial photographs or satellite image
  - soils map
  - topography map
  - existing farm design map
  - proposed farm design map



Figure 3 Base maps and overlays

### 3. Who is responsible for preparing a plan?

It is the landholder's responsibility to prepare their LWMP. NRW is not responsible for preparing plans, but can provide information and materials to assist landholders. Information kits can be obtained from NRW outlining departmentally owned data, its type, availability, cost and the areas covered. Information kits are available from your local NRW office.

Prepare the LWMP at your earliest opportunity. Use your own expertise, consultants, industry organisations and other support services to ensure:

- your proposed development will meet the required obligations of a water entitlement holder
- there are no delays in being able to use the water.

Your local NRW office may have a list of consultants who provide technical expertise in soils, water resources, topography, infrastructure design and imagery. The Department of Primary Industries and Fisheries (DPI&F), the Environmental Protection Agency (EPA), local mills, the Bureau of Sugar Experiment Stations (BSES) and other relevant organisations such as Growcom may also be able to provide information to assist with the preparation of a LWMP.

#### 3.1 Will an industry Farm Management System (FMS) be considered?

Industry groups are developing a range of programs and services to assist landholders with planning and management tools that support sustainable natural resource management. These tools, aimed at the property level, are generically known as Farm Management System (FMS) programs. Some existing programs include

- Sugar FMS—CANEGROWERS
- Dairying Better 'n Better for tomorrow—Queensland Dairyfarmers' Organisation
- Australian Cotton Industry's Best Management Practice Program (Cotton BMP)—Cotton Australia
- Steps Towards Effective Management Program (STEM)—Growcom.

The *Water Act 2000* allows NRW to accept a landholder's FMS as the equivalent of a LWMP if certified against a government-accredited industry FMS program. Contact NRW or your industry group representative to see if your industry has an accredited FMS program.

If you have already prepared and/or adopted a property planning and management tool such as an FMS or a property management plan (PMP), contact NRW to see if they meet some or all of the requirements of a LWMP.

#### 3.2 Can preparation of a LWMP be delayed?

Landholders with a genuine need to use their water entitlements before completing their LWMP can apply to NRW for a deferral (see *Mackay and Whitsunday LWMP reference manual*). Deferral applications require supporting information and may be granted for up to twelve months depending on the:

- individual circumstances of the applicant
- level of 'risk' to land and water associated with irrigation practices
- additional information given in relation to the application
- public interest.

## 4. How to prepare your LWMP

Section 4 sets out the information you need to provide in your plan.

### 4.1 Property information

This section covers property location, ownership, contact details, evidence of relevant licences/approvals and an overview of property base map requirements.

#### 4.1.1 Property description and ownership

Information required	Acceptable action
<p>You need to tell us:</p> <ul style="list-style-type: none"> <li>• the name and contact details of the property's owner (include mail address, phone, fax and email)</li> <li>• the name and contact details of the property's manager (include mail address, phone, fax and email)</li> <li>• the name of the property</li> <li>• the lot on plan description from latest rates notice</li> <li>• the rural residential number and road name</li> <li>• the type of land tenure—leasehold or freehold.</li> </ul>	<p>Ownership and contact details for the property are provided for future communication and reporting.</p>

#### 4.1.2 Permits, notices and existing approvals

Information required	Acceptable action
<p>You need to provide evidence of relevant approvals or notices associated with the irrigation development, (e.g. flood plain approval, drainage diversion approval, riverine pump permit, vegetation clearing permit, approved works in a watercourse/lake/spring/easement).</p>	<p>Evidence of notices and approvals, which may affect the irrigation development or approval of the LWMP, are provided.</p>
<p><b>Guide to acceptable practices</b></p> <p><i>See Mackay and Whitsunday LWMP reference manual, section 4.1.2.</i></p>	

### 4.1.3 Base maps

<p><b>Information required</b></p> <p><b>Whole property base map</b> You need to provide recent aerial photography or high-resolution satellite imagery covering your entire property, with the boundaries of both the property and irrigation development area marked.</p> <p><b>Irrigation and associated development area base map</b> You need to provide recent aerial photography or satellite imagery showing a more detailed view of the irrigation development area, with the boundary marked.</p> <p><b>Note</b> If the whole property base map presents the irrigation development area at a suitable scale, then a separate irrigation area base map will not be necessary.</p>	<p><b>Acceptable action</b></p> <p>Suitable base maps that cover both the whole property and irrigation development are provided.</p>
<p><b>Guide to acceptable practices</b></p> <p>See <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.1.3.</p>	

## 4.2 Landscape considerations


This section asks you to identify landscape issues (e.g. salinity, riparian management) that impact on your enterprise, either from outside the property or from within. You are also asked how any actions link with catchment or regional strategies. For example the:

- Mackay Whitsunday Natural Resource Management Plan (refer to [www.mwnrw.org.au](http://www.mwnrw.org.au))
- Great Barrier Reef Water Quality Protection Plan (refer to [www.deh.gov.au/coasts/pollution/reef](http://www.deh.gov.au/coasts/pollution/reef)).


### 4.2.1 Landform and natural features

<p><b>Information required</b></p> <p>You need to provide a landform and natural features map or overlay with clearly marked ridges, gullies, watercourses, lakes, water holes, flood breakout, flood runners, re-entry points, springs and natural wetlands.</p>	<p><b>Acceptable action</b></p> <p>The impact of drainage patterns and natural landform features on the irrigation development are determined.</p>
<p><b>Guide to acceptable practices</b></p> <p>See <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.2.1.</p>	

### 4.2.2 Flood risk and flood plain development impacts

<p><b>Information required</b></p> <p>If areas of your property flood, you need to mark on your landform and natural features map or overlay:</p> <ul style="list-style-type: none"> <li>• the maximum known flood boundary</li> <li>• flow depths and direction</li> <li>• any existing or proposed above-ground works, e.g. levee banks, bund walls, embankments.</li> </ul> <p>Also, describe the flood frequency and your strategies to manage floodwater impacts.</p> <p>If any of your property is located on an active flood plain and you are proposing above-ground works, you need to:</p> <ul style="list-style-type: none"> <li>• discuss the impact of your proposed works on your property, surrounding properties, stream bank stability and soil erosion</li> <li>• provide evidence of communication with neighbours and the local shire council, if relevant.</li> </ul>	<p><b>Desired outcomes</b></p> <p>Flood plain impacts associated with irrigation development are identified and avoided or minimised.</p> 
<p><b>Guide to acceptable practices</b></p> <p>See <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.2.3.</p>	

### 4.2.3 Vegetation and riparian management

<p><b>Information required</b></p> <p>You need to provide a vegetation map or overlay marking the extent of natural vegetation.</p> <p>Describe how the natural values of existing vegetation on your property will be protected or enhanced. Include any proposed vegetation management strategies to improve the connectivity of vegetation corridors with neighbouring properties.</p> <p>If located adjacent to a watercourse or wetland, describe how the irrigation development area and its operation will minimise impacts on the stability and function of the riparian zone. Where new development is to occur, consider both the upstream and downstream impacts of the development.</p> <p>Provide a copy of the latest regional ecosystems map covering the property. If planning to clear native vegetation, provide evidence of vegetation clearing advice or approval from the Department of Natural Resources and Water.</p>	<p><b>Desired outcomes</b></p> <p>Irrigation development has minimal adverse impact on surrounding vegetation and riparian areas, and will not compromise the stability and function of watercourses and/or wetlands.</p> 
<p><b>Guide to acceptable practices</b></p> <p>See:</p> <ul style="list-style-type: none"> <li>• Appendix, Table A: Managing vegetation in and around watercourses</li> <li>• <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.2.2</li> <li>• <i>Mackay and Whitsunday LWMP information kit</i>, section 3.5: Vegetation mapping; section 3.3.1: Drainage mapping.</li> </ul> <p>Discuss acceptable practices with your local NRW Vegetation Management Officer if required.</p>	

#### 4.2.4 Salinity risk and watertables

##### Information required

**Shallow watertables (waterlogging and salinity)**  
 You need to assess the risk of shallow or rising watertables. This may involve obtaining and assessing any existing on-farm groundwater information (e.g. watertable levels and water quality) and/or obtained from NRW, the scheme operator or neighbouring landholders.

You need to mark the location of the bore/s data you have accessed on your landform and natural features map. If there is an identified shallow watertable (water less than 4 m from ground surface) or a rising water table issue, mark the approximate identified area on the same map. Describe the possible contributing factors and their impacts.

##### Soil salinity

If there are any visible signs of salinity in or around your property or any emerging salt problems, you need to mark the identified areas on your landform and natural features map.

Describe the possible contributing factors and their impacts.

##### Desired outcomes

Salinity and shallow watertable issues are identified and avoided or minimised.



##### Guide to acceptable practices

See:

- Appendix, Table B: Suitability of soil types; Table C: Soil salt profile; Table D: Quality of irrigation water
- *Mackay and Whitsunday LWMP reference manual*, section 4.2.4
- *Mackay and Whitsunday LWMP information kit*, section 4.4: Declared catchments and subartesian areas.

## 4.3 Farm resources—land and water


This section covers farm resources. It asks you to provide a series of maps with overlays and descriptions of the land, soils and water resources.

### 4.3.1 Land—soils and topography

<p><b>Information required</b></p> <p>You need to provide:</p> <ul style="list-style-type: none"> <li>• a soils map or overlay of the irrigated area showing soil types and boundaries</li> <li>• a topographic map or overlay of the irrigated area produced from a ground survey showing survey grid and contours. There may also be large scale (&lt;1:25 000) topographic mapping available produced photogrammetrically</li> <li>• a soil classification and profile description for each of the major soil types*.</li> </ul> <p>If the irrigation development is located in a coastal area and proposes disturbance (including de-watering) below 5.0 m Australian Height Datum (AHD), you will also need to provide:</p> <ul style="list-style-type: none"> <li>• an acid sulfate soils (ASS) investigation and management plan in which you outline your strategies to avoid and manage any impact.</li> </ul>	<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• The soils and slopes are suitable for irrigated cropping and pastures and are compatible with the chosen irrigation method.</li> <li>• The release of acid leachate and heavy metal contaminants into nearby watercourses, water bodies and/or estuarine environments is avoided.</li> </ul>
<p><b>Guide to acceptable practices</b></p> <p>See:</p> <ul style="list-style-type: none"> <li>• Appendix, Table B: Suitability of soil types</li> <li>• <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.3.1</li> <li>• <i>Mackay and Whitsunday LWMP information kit</i>, section 3.1: Soil and land suitability studies; section 4.0: Map coverage for the Mackay and Whitsunday region</li> <li>• State Planning Policy 2/02 Guidelines, <i>Planning and managing development involving acid sulfate soils</i> (visit: <a href="http://www.nrw.qld.gov.au/land/ass/">www.nrw.qld.gov.au/land/ass/</a>).</li> </ul>	

\* Generally this information should be provided separately. However, if you have only one or two soil types and they have already been described in detailed soils mapping by NRW, you need only provide the soil type and a brief description as part of the map legend.


### 4.3.2 Water—sources, quantity, quality and suitability for irrigation

<p><b>Information required</b></p> <p>Provide a description of all water sources as outlined below.</p> <p><b>1. Surface and groundwater entitlements</b></p> <p>These include water allocations and water licences. You need to provide the following information:</p> <ul style="list-style-type: none"> <li>• proof of entitlement</li> <li>• nominal volume and/or volumetric limit</li> <li>• water allocation security objective (WASO) group.</li> </ul> <p><b>2. Other irrigation sources</b></p> <p>You need to provide an estimate of long-term annual volume and supply rates for other irrigation sources including overland flow, treated effluent, industrial discharge water, and unregulated sources.</p> <p>If using treated effluent or industrial discharge water, provide evidence of any approvals or permits from the EPA or your local shire council, which describe its quality and any conditions relating to its use.</p> <p><b>3. Electrical conductivity (EC)</b></p> <p>For each irrigation water source you need to provide test results for EC. If using surface water with an EC greater than 1500 <math>\mu\text{S}/\text{cm}</math> (micro-siemens per centimeter) or any underground water, provide a detailed chemical analysis and suitability assessment for irrigation.</p>	<p><b>Desired outcomes</b></p> <p>Quality of irrigation water will not:</p> <ul style="list-style-type: none"> <li>• degrade soils</li> <li>• contribute to salinity in groundwater</li> <li>• impact on adjacent riparian, wetland or natural areas.</li> </ul>
	
<p><b>Guide to acceptable practices</b></p> <p>See:</p> <ul style="list-style-type: none"> <li>• Appendix, Table D: Quality of irrigation water</li> <li>• <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.3.2.</li> </ul>	

## 4.4 Farm design and layout

This section covers farm infrastructure and its design. It asks you to provide detailed information on irrigation infrastructure, field layout, land use and water reliability.

### 4.4.1 Existing crops and infrastructure

<p><b>Information required</b></p> <p>You need to provide an existing farm design map covering the irrigation area. On it:</p> <ul style="list-style-type: none"> <li>• show the boundary of each field or block that is irrigated, the field name or number and area (ha)</li> <li>• show existing infrastructure including buildings, monitoring and irrigation bores, pumps, supply off-takes, irrigation storages (surge and gully dams, sumps, ring tanks and their name or number and storage volumes in ML). If applicable also indicate the capacity and size of water cannons used and their path of travel</li> <li>• locate pipelines (stand pipes, gated pipes lay flat, hydrant points, etc.), channels, check or drop structures, inverted siphons, surface and subsurface drains (open and buried), silt traps, power lines, main access tracks, and storage sites for pesticide, fertiliser and fuel.</li> </ul> <p>If there is space on the map, describe the irrigation method/s and the crop type/s generally grown. Otherwise, provide this information separately.</p> <p>Include a brief history of the irrigation development on the property.</p>	<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• Existing irrigation development including the current field layout and irrigation infrastructure is provided.</li> <li>• Current land use and infrastructure does not lead to degradation of watercourses and wetlands or contribute to watertable rise.</li> </ul> 
<p><b>Guide to acceptable practices</b></p> <p>See Mackay and Whitsunday LWMP reference manual, section 4.4.1.</p>	

### 4.4.2 Proposed crops and infrastructure

<p><b>Information required</b></p> <p>You need to provide a proposed farm design map for the irrigation area, showing details of all proposed development (as for section 4.4.1).</p>	<p><b>Desired outcomes</b></p> <p>Proposed field layout and irrigation infrastructure is designed and located to avoid land or water degradation.</p>
<p><b>Guide to acceptable practices</b></p> <p>See Mackay and Whitsunday LWMP reference manual, section 4.4.2.</p>	


### 4.4.3 Crop water requirement and reliability of supply

<p><b>Information required</b></p> <p>You need to provide:</p> <ul style="list-style-type: none"> <li>• an estimate of the long-term total water requirement, which includes total crop water requirement plus all losses</li> <li>• the water reliability of supply in satisfying the total irrigation requirement, if using unregulated supplies</li> <li>• an indication of long-term reliability of supply for each bore, if using groundwater in conjunction with surface water. Include evidence of any pump/flow rate tests and the method by which the tests were conducted.</li> </ul>	<p><b>Desired outcomes</b></p> <p>The reliability of irrigation water and water supply infrastructure requirements has been determined.</p>
<p><b>Guide to acceptable practices</b></p> <p>See <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.4.3.</p>	


### 4.4.4 Suitability of irrigation system

<p><b>Information required</b></p> <p>You need to:</p> <ul style="list-style-type: none"> <li>• identify which irrigation systems are suitable for your soil types, topography, water quality and crop choice</li> <li>• describe why you have chosen your current and proposed irrigation system over other methods.</li> </ul>	<p><b>Desired outcomes</b></p> <p>Current and proposed irrigation systems are designed and located to minimise the potential for adverse effects on groundwater and/or surface water.</p>
<p><b>Guide to acceptable practices</b></p> <p>See:</p> <ul style="list-style-type: none"> <li>• Appendix, Table E: Suitability of irrigation in parts of the landscape</li> <li>• <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.4.4</li> <li>• BSES (2003), <i>Irrigation guide for the Central District</i>.</li> </ul>	


#### 4.4.5 Pumping, storage and distribution

<p><b>Information required</b></p> <p>You need to provide authorisation details (development permits) and the range of designed pumping duties (litres per second per metre of head) for each of your authorised supply pumps (existing and proposed).</p> <p>For pumps that are located on or within a stream, you need to describe how any impact to the riparian zone caused by your pump installations and associated access tracks will be minimised.</p> <p>If proposing a new dam or ring tank, you need to provide investigation, design and construction details including maximum storage capacity. Describe how construction will minimise the risk of failure, seepage and deep drainage losses, prevent by-wash erosion, and not cause adverse impacts to natural overland flows.</p> <p>If using earthen distribution channels, you need to discuss how seepage losses will be minimised.</p> <p>Describe erosion protection around any channel structures such as, bubblers, check structures and inverted syphons.</p>	<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• Pump installations do not cause erosion or stream bank degradation.</li> <li>• Storages, channels and pipelines have been designed and constructed to reduce the risk of seepage and deep drainage.</li> </ul> 
<p><b>Guide to acceptable practices</b></p> <p>See:</p> <ul style="list-style-type: none"> <li>• Appendix, Table E: Suitability of irrigation in parts of the landscape</li> <li>• <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.4.5.</li> </ul>	

#### 4.4.6 Irrigation design and erosion control

<p><b>Information required</b></p> <p>You need to mark on your existing and/or proposed farm design map:</p> <ul style="list-style-type: none"> <li>• your irrigation layout (i.e. head ditches, tail drains, furrow direction and grades)</li> <li>• existing and proposed sediment traps and buffers (detention basins, grass filters, artificial wetlands).</li> </ul> <p>Describe how your irrigation layout design will minimise erosion and achieve uniform water application.</p> <p>Describe how existing and proposed sediment traps and buffers filter and capture sediment.</p>	<p><b>Desired outcomes</b></p> <p>Irrigation and sediment buffer system design and management minimise the risk of erosion and run-off, which may contribute to poor water quality.</p> 
<p><b>Guide to acceptable practices</b></p> <p>See:</p> <ul style="list-style-type: none"> <li>• Appendix, Table F: Standard of infrastructure and its design</li> <li>• <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.4.6.</li> </ul>	

#### 4.4.7 Drainage and stormwater run-off

<p><b>Information required</b></p> <p>For all irrigation methods, you need to:</p> <ul style="list-style-type: none"> <li>• mark all surface and subsurface drainage works, both inside and outside the irrigation area (e.g. contour banks, drains and outfalls) on your existing and/or proposed farm design map</li> <li>• provide the volume in mm or ML intended to be contained on-farm by your tail water and stormwater management system, or in a shared scheme with others</li> <li>• if proposing new or modified stormwater or tail water infrastructure (storages, sumps or drains), provide calculations of frequency and volume of run-off to be captured.</li> </ul>	<p><b>Desired outcomes</b></p> <p>Drainage works, tail water and stormwater management systems are designed to minimise the risk of potentially poor quality water leaving the farm.</p> 
<p><b>Guide to acceptable practices</b></p> <p>See:</p> <ul style="list-style-type: none"> <li>• Appendix 1, Table G: Managing drainage and stormwater runoff from irrigated land</li> <li>• <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.4.7.</li> </ul>	

## 4.5 Farm management, monitoring and reporting

This section covers farm management issues that can impact on natural resources. It asks you to provide:

- your management and monitoring strategies
- evidence of your record keeping and monitoring practices
- assurance of your ability to report on conditions and trends.


### 4.5.1 Irrigation system performance

<p><b>Information required</b></p> <p>You need to describe how you will monitor your irrigation system performance (volume supplied to farm, storage losses, delivery, application and deep drainage losses).</p> <p>Provide details for, and describe how you will record:</p> <ul style="list-style-type: none"> <li>• field monitoring tools used to schedule water applications and ensure irrigation rates are matched to soil type and crop requirement</li> <li>• field assessment of water application uniformity</li> <li>• field assessment of on-farm storage losses resulting from deep drainage or seepage</li> <li>• changes to reconfigure irrigation layout to improve performance.</li> </ul>	<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• Irrigation system achieves an even distribution and is operated so that water applied does not exceed what the crop requires or soil infiltration rates.</li> <li>• Records are kept and reports are completed for the life of the approved plan.</li> </ul>
<p><b>Guide to acceptable practices</b></p> <p>See <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.5.1.</p>	

## 4.5.2 Soil and erosion management

<p><b>Information required</b></p> <p>You need to show that your soil and erosion management practices conform with industry codes of practice or best management practices.</p> <p>Describe how:</p> <ul style="list-style-type: none"> <li>• your in-field cropping practices (e.g. green cane harvesting, crop rotation, fallow management, furrow shape, end of furrow banking, soil compaction avoidance strategy, tillage and ground cover target levels) are used where appropriate to minimise erosion risk</li> <li>• your in-field measures such as contour banks and grassed filter strips have been designed to minimise soil erosion and trash or stubble movement</li> <li>• your sediment traps, drains and buffer systems are managed (including frequency of cleaning, slashing, de-silting and where silt is relocated)</li> <li>• your in-field soil and erosion management does not increase the risk of pollutants associated with fertiliser and chemical use entering aquifers or adjacent riparian areas</li> <li>• you will maintain ground cover levels to avoid land degradation potential when irrigation water is unavailable if your long-term annual water supply reliability precludes an annual irrigated crop.</li> </ul>	<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• Farm management practices minimise soil erosion.</li> <li>• Sediment traps and buffer systems are regularly inspected and maintained.</li> <li>• Records are kept and reports are completed for the life of the approved plan.</li> <li>• Chemical management techniques minimise risk of pollutants entering aquifers or adjacent riparian areas.</li> </ul>
<p><b>Guide to acceptable practices</b></p> <p>See:</p> <ul style="list-style-type: none"> <li>• Appendix, Table F: Standard of infrastructure and its design</li> <li>• <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.5.2.</li> </ul>	

### 4.5.3 Farm run-off and water quality

<p><b>Information required</b></p> <p>You need to describe:</p> <ul style="list-style-type: none"> <li>• how you manage your irrigation and drainage system to minimise, capture and recycle tail water, if your irrigation method has the potential to generate tail water</li> <li>• how you manage your irrigation and drainage system to minimise, capture and recycle stormwater</li> <li>• how you capture and contain agricultural effluent produced from system cleaning and back flushing procedures if you use drip or micro spray systems, including subsurface</li> <li>• how you monitor and/or keep records of:             <ul style="list-style-type: none"> <li>- irrigation tail water and stormwater systems (including storages)</li> <li>- flushing and system cleaning procedures (end flush, back flush, frequency of flushing, volume discharged, and method of treatment or disposal)</li> <li>- the quality of water leaving your property or in the immediate subcatchment (including turbidity, Electrical Conductivity (EC), pH, nitrates, phosphates and pesticide levels)</li> <li>- the application of agricultural chemicals and fertilisers</li> <li>- farming practices such as tillage operations</li> <li>- rainfall</li> </ul> </li> <li>• how you either:             <ul style="list-style-type: none"> <li>- collect and analyse water quality samples for water leaving your property</li> <li>- collect and analyse water quality samples if involved in or undertaking water quality monitoring within the immediate subcatchment of your property.</li> </ul> </li> </ul>	<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• Irrigation tail water and stormwater run-off do not adversely affect water bodies or water resources on or off the property.</li> <li>• The condition of run-off water leaving the property or within the immediate subcatchment is monitored and managed to ensure quality is not degrading.</li> <li>• Records are kept and reports are completed for the life of the approved plan.</li> </ul>
	
<p><b>Guide to acceptable practices</b></p> <p>See:</p> <ul style="list-style-type: none"> <li>• Appendix, Table G: Managing drainage and stormwater run-off from irrigated land</li> <li>• <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.5.3.</li> </ul>	

#### 4.5.4 Pesticide, fertiliser and fuel management

<p><b>Information required</b></p> <p>You need to describe how your method of storage, handling and disposal of pesticides and empty containers conforms to industry codes of practice.</p> <p>Give details of:</p> <ul style="list-style-type: none"> <li>• how agricultural chemicals and empty containers are stored and, if applicable, disposed of (storage location, security and bunding)</li> <li>• where and how fuel and oil associated with any pumps are stored</li> <li>• where wash down sites, refill points and disposal sites of used containers are located</li> <li>• how your in-field fertiliser and chemical management, such as matching application rates to crop requirements, controls the risk of pollutants entering aquifers or adjacent riparian areas.</li> </ul>	<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• Storage and use of agricultural chemicals do not contaminate surface water, groundwater or soil resources on or off site.</li> <li>• Records are kept and reports are completed for the life of the approved plan.</li> </ul>
<p><b>Guide to acceptable practices</b></p> <p>See <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.5.4.</p>	

#### 4.5.5 Salinity and watertables

<p><b>Information required</b></p> <p>Describe how you will avoid the potential for the development of salinity and shallow watertables and how you will monitor this.</p>	<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• Irrigation and farm management avoids the development of salinity and shallow watertable problems.</li> <li>• A monitoring program is in place, records are kept and reports are completed for the life of the approved plan.</li> </ul>
<p><b>Guide to acceptable practices</b></p> <p>See:</p> <ul style="list-style-type: none"> <li>• Appendix, Table C: Soil salt profile</li> <li>• <i>Mackay and Whitsunday LWMP reference manual</i>, section 4.5.5.</li> </ul>	

## 5.0 How will your LWMP be assessed?

Submit two copies of your completed LWMP, with an assessment application form, and the appropriate fee, at your local NRW office. Application forms are available on the NRW website at <[www.nrw.qld.gov.au](http://www.nrw.qld.gov.au)> (click on 'Land management' in the 'Topics' menu on the home page). When assessing your plan, we will consider recommended industry best practice and, if necessary, negotiate any changes with you before approving the LWMP. A copy of the approved plan will be returned to you. Where changes in farm layout or farming practices are necessary as a result of the assessment of your LWMP, we will negotiate a reasonable implementation period so that your enterprise is not disadvantaged.

Once approved, you must comply with your LWMP. The plan will be approved for a set period (maximum of ten years). The approval may be for a lesser period, depending on the risk to land and water resources resulting from the use of the water. Before the approved period expires, you must resubmit your LWMP for assessment and approval for a further period. To support a renewal application, you will need to provide evidence that the existing plan and management practices are meeting the desired outcomes. This means you will need to provide evidence of any record keeping and monitoring requirements to which your initial approval was subject. Changes to the initial LWMP may be required as a result of condition and trend monitoring.

During the life of the plan, NRW has a responsibility to see that the LWMP is implemented and that desired outcomes are being achieved. We will therefore visit your property and conduct audits to verify that strategies or actions identified in the plan are in place.

### 5.1 What if you vary your LWMP?

Farming practices are likely to change over time as a result of evolving technology, priorities, research and experience. As a result, landholders will make ongoing improvements that may modify their LWMP.

If you make a significant change to your LWMP, you must advise NRW as you may require an approved amendment.

Examples of a significant change include:

- a change in irrigation or cropping practice that leads to a significant change in irrigation management strategies
- a change in land use, irrigation method or irrigation infrastructure
- using the water with a LWMP requirement on additional land or different land.

An example of a change that would not be seen as 'significant' and therefore not require a formal amendment would be:

- a change in crop use that does not significantly alter irrigation practices or the area irrigated.

If you plan to make a change to your LWMP, contact your local NRW office first.

## 6.0 Other considerations

There may be other approvals and obligations required as part of an irrigation development that are not 'core elements' of a LWMP.

These include, but are not limited to:

- responsibility for control of declared plants under the *Land Protection (Pest and Stock Route Management) Act 2002*
- development impacting on state land
- referable dams
- works in or adjacent to a declared fish habitat area
- vegetation management.

NRW may require evidence that other approvals and obligations have been or are in the process of being addressed before approving your LWMP. Check with your local NRW office to determine whether any such approvals will delay approval of your LWMP.

Irrespective of these approvals being obtained, landholders have a general environmental duty of care under the *Environmental Protection Act 1994* to conduct their activities in such a way that prevents environmental harm. To assist you to comply with the provisions of the *Environmental Protection Act 1994*, industry codes of practice and best management practices along with environmental protection policies have been developed. As a landholder, you should familiarise yourself with these documents.

### 6.1 Flood plain management

The placement of structures on the flood plain, such as storages, banks and channels, can alter natural flood flows, which may have adverse impacts on properties and landholders upstream and/or downstream. Landholders have always had a common law duty of care not to cause nuisance or harm to neighbour/s through their actions. As a landholder, it is in your best interest to consider the consequences of any proposed activities.

Your local NRW office can advise whether your property is covered by a plan dealing with flood plain management issues. This may include provisions under the *Water Act 2000* that deal with flood plain management issues, or a policy, local law or flood plain management plan prepared by local government. Primary producers must consider any relevant provisions when contemplating new developments and obtain permits or similar authorities for works as applicable.

If you want to construct significant works on your property and there are no flood plain management provisions, you need to address your common law obligations and assess the impact of those works on run-off volumes, concentrations and flow directions. Depending on the location of the property and the relative size of the works, you may have to undertake hydraulic modelling of flows. NRW recommends that the advice of an appropriate consultant be sought first.

## 6.2 Native vegetation management

The *Vegetation Management Act 1999* regulates the clearing of native vegetation in Queensland to prevent the loss of biodiversity, avoid land degradation, and maintain ecological processes. If you wish to clear remnant vegetation as part of your property development, you need a current development permit from NRW.

For more information, consult your local NRW Vegetation Management Officer.

## 6.3 Cultural heritage, environmental protection and biodiversity conservation

Individuals should comply with the provisions relating to cultural heritage under the *Aboriginal Cultural Heritage Act 2003* and the *Torres Strait Islander Cultural Heritage Act 2003*. Take all reasonable and practicable measures to ensure your activities do not harm Aboriginal or Torres Strait Islander cultural heritage. This is the 'cultural heritage duty of care'.

Your activities should comply with:

- cultural heritage duty of care guidelines under the Aboriginal Cultural Heritage Act
- any agreement with Aboriginal or Torres Strait Islander parties for the area
- any approved cultural heritage management plan under Part 7 of the Aboriginal or Torres Strait Islander cultural heritage legislation.

The Cultural Heritage Coordination Unit in NRW can assist you on these matters through its cultural heritage database and register. Your property details can be searched on the database/register.

The EPA is responsible for administering historic cultural heritage requirements. It is also responsible for approvals, compliance and negotiated outcomes relating to rare and threatened flora and fauna, and can provide information on impact assessment of environmentally sensitive places such as wetlands or endangered plant communities.

Proposed developments must avoid adverse impacts in the following areas:

- areas of national or international significance such as:
  - World Heritage properties
  - Ramsar listed wetlands
  - areas involving internationally protected migratory species or nationally threatened animal or plant species
  - ecological communities listed under the *Environment Protection and Biodiversity Conservation Act 1999*. One such threatened animal species in the Mackay and Whitsunday Region is the Proserpine Rock Wallaby (*Petrogale persephone*)
- areas of state significance such as protected areas, critical habitat or areas containing rare or threatened animal or plant species either under the *Nature Conservation Act 1992* or as identified in the *CQC Bioregion Biodiversity Planning Assessment April 2005*
- areas containing important wetlands or significant coastal dune systems as listed in:
  - *A directory of important wetlands* (Young et al. 2001)
  - regional coastal management plans prepared in accordance with the State Coastal Management Plan (Queensland's Coastal Policy 2001).
  - any other recognised plan.

## 7.0 Glossary

Development permit	An approval for a development as defined under the <i>Integrated Planning Act 1997</i>
Active flood plain	The level area of alluvial soils adjacent to a stream, which is flooded by stream water on a periodic basis
Irrigation	The application of water for the purpose of sustaining plant growth and/or enhancing primary production
Irrigation requirement	The water that must be applied through the irrigation system to ensure the plant receives its full water requirement
Riparian vegetation	Vegetation within or bordering a river, stream or gully
Seasonal water assignment	The assignment by the holder of a water entitlement (water allocation or interim water allocation) to another person, for a water year, or part of the water year of all or part of the water
Sediment trap	An excavation, natural depression or small storage located in return drains or outfalls designed to collect suspended sediment
Sump	Excavation, natural depression or storage designed to capture tail water or agricultural effluent run-off from cultivated land under gravity often for later pumping into on-farm storages
Surge dam	Large capacity gravity fed storage that captures overland flow water for later pumping into on-farm storages
Tail water	Applied water that exits the edge of an irrigated field
Water allocation	An authority granted under section 121 or 122 of the <i>Water Act 2000</i> , issued under an approved Water Resource Operations Plan. The authority to construct works associated with the allocation is given under the <i>Integrated Planning Act 1997</i> .
Water entitlement	A water allocation, interim water allocation or water licence.
Water licence	A licence granted under the <i>Water Act 2000</i> , chapter 2, part 6, division 2 that enables the taking of and use of water or interfering with the flow of water. The authority to construct works associated with the water licence is given under the <i>Integrated Planning Act 1997</i> .

## 8.0 Further reading

### Codes of practice and best practice manuals

- Bureau of Sugar Experiment stations (Queensland) 2001, *Sustainability in sugar: a self-assessment workbook*, Bureau of Sugar Experiment Stations, Indooroopilly, Qld.
- CANEGROWERS 1998, *Code of practice: sustainable cane growing in Queensland*, CANEGROWERS, Brisbane.
- Cotton Research and Development Corporation (Australia) 2000, *Best management practices manual—Australian Cotton Industry*, 2nd edn, Cotton Research and Development Corporation, Narrabri, NSW.
- Hogarth, M & Allsop, P 2000, *Manual of cane growing*, Bureau of sugar experiment stations Brisbane, Qld.
- Queensland Farmers' Federation 1995, *The environmental code of practice for agriculture*, Queensland Farmers' Federation, Brisbane.
- Queensland Fruit and Vegetable Growers 1998, *Farmcare—cultivating a better future: code of practice for sustainable fruit and vegetable production in Queensland*, Queensland Fruit and Vegetable Growers, Brisbane.

### Directories

- Young, S, Larmour, G, Eyles, K, Environment Australia, National Heritage Trust, National Wetlands Program 2001, *A directory of important wetlands*, 3rd edn, Environment Australia, Canberra.

### Land suitability and soil maps and reports

- Department of Primary Industries (Land Resources) 1990, *Guidelines for agricultural land evaluation in Queensland*, Information series (Department of Primary Industries), Queensland Government, Brisbane.
- Department of Primary Industries & Department of Housing, Local Government and Housing 1993, *Planning guidelines: the identification of good quality agricultural land*, Queensland Government, Brisbane.
- Hardy, S & Whitsunday Shire Council 2003, *Soils and land suitability of the Whitsunday coast area, central Queensland*, Whitsunday Shire Council, Proserpine, Qld.
- Holz, Gk, Shields PG & Department of Primary Industries (Qld) 1985, *Mackay sugar can land suitability study*, 2 vols, Land Resources Bulletin, Queensland Government, Brisbane.
- Muller, PG & Department of Natural Resources and Mines 2002, *Assessment of Mackay and Sarina district soils for spray and furrow irrigation of sugar cane*, Queensland Government, Brisbane.
- Thompson, WP, Baker DE, Cannon, MG & Department of Primary Industries (Qld) 1981, *Soils of the Proserpine lowland, north Queensland*, Technical report (Agricultural Chemistry Branch) no. 18, Queensland Government, Brisbane.
- Wills, AK, Baker, DE & Department of Primary Industries (Qld) 1988, *Plane Creek sugar cane land suitability study*, Land Resources Bulletin, Queensland Government, Brisbane.

### Monitoring

- Department of Natural Resources 1998, *Natural resource monitoring guide: a practical guide for detecting changes occurring at the property or catchment level*, Queensland Government, Brisbane.

### Riparian zone management

- Abernethy, B & Rutherford, ID 1999, *Guidelines for stabilising streambanks with riparian vegetation*, Technical report (Cooperative Research Centre for Catchment Hydrology—Australia), no. 10, CRC for Catchment Hydrology, Clayton, Vic.
- Karssies, LE & Prosser, IP 1999, *Guidelines for riparian filter strips for Queensland irrigation*, Technical report (CSIRO Land and Water), no. 32, CSIRO, Canberra.

### Salinity

- Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australian and New Zealand, 2000, *Australian and New Zealand guidelines for fresh and marine water quality*, National Water Quality Management Strategy, vol.1, no.4, Australian Government, Canberra.
- Department of Natural Resources 1997, *Salinity management handbook*, Queensland Government, Indooroopilly, Qld.

### Soil classification

- McDonald RC, National Landcare Program (Australia), Australian Collaborative Land Evaluation Program & CSIRO (Land and Water) 1998, *Australian soil and land survey: field handbook*, 2nd edn, Australian Collaborative Land Evaluation Program, Canberra.

### Use of chemicals

- Department of Employment, Vocational Education, Training and Industrial Relations 1994, *Code of practice for the storage and use of chemicals at rural workplaces*, Queensland Government, Brisbane.

### Water infrastructure and irrigation design

- Horton, AJ, Jobling, GA & Queensland Water Resources Commission 1984, *Farm water supplies design manual*, Queensland Government, Brisbane.
- Irrigation Association of Australia (Design Guidelines Committee) 1991, *Whole farm planning for irrigation: design guidelines*, Irrigation Association of Australia, Melbourne.
- Peterson, C & Sander 2003, E, *Irrigation guide—Central District (Mackay, Plane Creek and Proserpine)*. Bureau of Sugar Experimentation Stations, Queensland.

## Appendix

### Cases where development is high risk, unsuitable, or prohibited under current legislation

In the Mackay and Whitsunday district, some management activities, when coupled with particular landscape feature attributes, are considered high risk or unsuitable for sustainable irrigation, or are prohibited under current legislation. Where activities and/or situations are considered unsuitable or high risk, the onus is on you to demonstrate to NRW how you will successfully manage the identified risk.

Prohibited, unsuitable or high risk activities and situations are outlined in the following tables:

Table A Managing vegetation in and around watercourses

Table B Suitability of soil types

Table C Soil salt profile

Table D Quality of irrigation water

Table E Suitability of irrigation in parts of the landscape

Table F Standard of infrastructure and its design

Table G Managing drainage and stormwater run-off from irrigated land

Use the reference link at the top of each table to refer back to the relevant section of the guidelines.

**Table A Managing vegetation in and around watercourses**

<p>Adequate vegetation corridors are in place to minimise adverse impacts on riparian areas and protect or maintain the stability and function of watercourses.</p> <p>(Refer to: 4.2.3 Vegetation and riparian management)</p>	
<p><b>Prohibited</b></p> <p>No new development involving the clearing of remnant vegetation can occur without a current development permit from the Department of Natural Resources and Water. Regional vegetation management codes for the central Queensland Coast bioregion do not allow clearing and development within the following distances of watercourses.</p> <p><b>Coastal streams</b> (SE coast bioregion and CQ coast bioregion)</p> <ul style="list-style-type: none"> <li>• gullies 25 m either side of the high bank</li> <li>• creeks 25 m either side of the high bank</li> <li>• rivers 50 m either side of the high bank</li> </ul> <p>Gullies = stream orders 1 and 2; creeks = stream orders 3 and 4; rivers = stream orders 5 and 6. Refer to the <i>Mackay and Whitsunday information kit</i> to determine stream orders.</p>	<p><b>Reason</b></p> <p>This is required under the <i>Vegetation Management Act 1999</i>.</p>
<p><b>High risk or unsuitable</b></p> <p>Stream bank stability and function is generally reduced when the horizontal width of native vegetation extending from the top of the high bank away from the watercourse is less than the height from the bed of the watercourse to the top of high bank (metres) plus an additional five metres horizontally.</p> <p>However, minimum required buffer widths may be affected by factors such as:</p> <ul style="list-style-type: none"> <li>• the buffer strip performing the dual role of filtering sediments, nutrients and pesticides as well as maintaining stream banks stability</li> <li>• the adjoining land slopes/drains away from the watercourse</li> <li>• location along the stream, e.g. inside or outside bend, straight section</li> <li>• stream bank instability is not evident</li> <li>• direct stock access to stream is restricted or limited</li> <li>• tail drain systems, which satisfactorily manage and control run-off water from the irrigated area before entering the riparian zone.</li> </ul> <p>See <i>Mackay and Whitsunday LWMP reference manual</i> for further information.</p>	<p><b>Reason</b></p> <p>The purpose of these buffer width requirements is to maintain and/or improve biodiversity values and stream bank stability and to provide a buffer area capable of filtering sediments, nutrients and/or chemicals.</p>

**Table B Suitability of soil types**

Only those soils that are suitable for irrigation should be developed. (Refer to: 4.3.1 Land—soils and topography)	
<b>Unsuitable or high risk</b>	<b>Reason</b>
<p>1. Soils that have known inherent limitations or landscape position problems such as salinisation on lower slopes or adjacent land are considered unsuitable or high risk for irrigation.</p> <p>2. Development that involves excavation, exposure or subsurface drainage to or below 5 m AHD without an acid sulfate soils (ASS) investigation and management plan that complies with the Queensland ASS technical manual, <i>Soil management guidelines</i>, is considered unsuitable or high risk for irrigation.</p> <p>3. The following soils are considered high risk for any irrigation method:</p> <ul style="list-style-type: none"> <li>• Chromosol: shallow, brown or grey, mottled, acid duplex (e.g. Moffat soils)</li> <li>• Dermosol: moderate to deep duplex or gradational soil with a sandy loam to clay loam topsoil over alkaline heavy clay loam subsoil. (e.g. Luce, Nilotica)</li> <li>• Hydrosol: moderate to very deep cracking or non-cracking clays usually with clay topsoils over acid or alkaline subsoils often with pyrite present. (e.g. Dundula, Glen Isla, Goorganga, Hillsborough, Wilmington)</li> <li>• Lithosols: shallow stony soils on steep hills with slopes usually greater than 10% (e.g. Breen, Chenola, Urannah, and some of Samourgassi soils)</li> <li>• Rudisol: uniform sandy to gradational soils with a thick sandy loam topsoil that can be gravelly (e.g. Caley, Debella and Debella-cobbly variant, Dittmer, Drakon, Exmoor and Julian). Slopes often exceed 10% (e.g. frontal dunes and Septimus soils)</li> <li>• Sodosol: yellow, grey or brown sodic duplex soil with a bleached subsurface horizon overlying a tough clay subsoil (e.g. Allandale soils—strongly sodic variant, Billy Creek, Buckley, Campbell Plains, Conder, Grasstree, Kangaroo, Lascelles).</li> </ul>	<p>Development to irrigated agriculture may add to the salinity problem.</p> <p>Development of this kind could lead to the release of acid leachate and heavy metal contaminants into nearby watercourses, water bodies and/or estuarine environments.</p> <p>Steep slopes</p> <p>Subsoils high in sodicity and salinity, low plant available water capacity (PAWC), poor drainage</p> <p>Risks associated with exposure of ASS. Subsoils high in sodicity and salinity, low PAWC, poor drainage</p> <p>Steep slopes, low PAWC</p> <p>Low PAWC, low nutrient retention, highly permeable, steep slopes, soil erosion risk</p> <p>Rooting depth limited by tough, extremely sodic subsoil (ESP up to 70%), highly impermeable subsoil, very low PAWC. Iron-manganese pan can limit root depth in Lascelles soils. Campbell Plains soils have high subsoil salinity. Buckley soils can be affected by secondary salinity.</p>

<p>4. The following soils are considered high risk for flood irrigation method only:</p> <ul style="list-style-type: none"> <li>• Chromosol (including yellow, red, grey, brown, black or gleyed): duplex soils, often mottled which can be acidic and/or sodic (in the deeper subsoil) with a bleached subsurface horizon. Some of these soils can have a thick sandy topsoil with high permeability (e.g. Edgecumbe, Farleigh, Finley, Freddy, Gargett, Kinchant (coarse sandy variant), Koumala, Kuttabul, Louisa, Malin, Marwood, Mirani, Munbura, Neils, Pioneer, Preston, Riordanvale and Uruba soils)</li> <li>• Dermosol: brown or yellow structured, gradational, sandy to loamy textured non-cracking clay soils with high permeability and sometimes with a self-mulching surface (e.g. Bode, Campwyn, Gargett, Glenella, Hector, Martin, Mookara, Nabilla, Pring, Quandong, Royston, St Helens, Strathdickie, Swayneville, Tannalo, Wagoora, Wagoora—basic parent material—and Wandarra soils).</li> <li>• Ferrosol: red, acid structured non-cracking clay soil (e.g. Pinnacle soils)</li> <li>• Kandosol: very permeable yellow or grey massive gradational textured soils sometimes with an acid subsoil (e.g. Dingo, Kowari, Mulei, Sunter and Up River soils).</li> <li>• Rudosol: uniform or gradational sandy and/or loamy soils with high permeability (e.g. Andergrove, Cameron, Hannan, Leichardt, Murray and Neils soils)</li> <li>• Sodosol—undulating to hilly: yellow, red, grey or brown duplex soils usually with a bleached horizon. Often mottled in appearance these soils are acidic and can be strongly sodic (e.g. Belberra, Dryander, Dunwold, Gillibin, Glenroc, Jumper, Kaila, Kinchant, Lillypool, Mentmore, Ossa, Palmyra, Pindi, Pluto, Seaforth, Slater and Whiptail soils)</li> <li>• Sodosol—flat to undulating: grey or yellow often mottled, sodic duplex soil sometimes with a silty or sandy bleached surface and/or a bleached subsurface horizon (e.g. Alligator, Anakey, Carmila, Etowrie, Goodbye, Hillrise, Koolachu, Kunipipi, Mentmore, Redfern, Roundback, Shinfein, Splitter, Tenmile and Wollingford soils)</li> <li>• Tenosol: very permeable, grey, uniform sandy soils (e.g. Turpad soils)</li> <li>• Vertosol: deep, uniform, cracking, clay soil with a self mulching clay topsoil over alkaline clay subsoil. (e.g. Abbot, Armstrong, Silent Grove and Wygong soils)</li> <li>• Miscellaneous soil types include Belmunda, Cliftonville, Finch Hatton, Habana, Kungurri, Netherdale, Saddle and Uruba (sandy topsoil variant) soils.</li> </ul>	<p>Slopes often exceed 2%. Thick sandy topsoil can preclude flood irrigation due to high permeability and drainage losses. Some potential exists for furrow irrigation of Pioneer soils with high inflow rates, short row lengths, steeper row slopes, modified furrow shape and hill size to avoid deep drainage losses.</p> <p>Slopes usually exceed 2%. Deep drainage losses due to high permeability. Some potential for furrow irrigation of St Helens soils, with high inflow rates, short row lengths, steeper row slopes, modified furrow shape and hill size to avoid deep drainage losses.</p> <p>Slopes exceed 2%.</p> <p>Slopes exceed 2%.</p> <p>High potential for deep drainage losses; too sandy; often poor landform for flood irrigation; slopes exceed 2% in some areas. Murray soils often have high levels of surface rock.</p> <p>Slopes often exceed 2%. Topsoil is often too thick and/or sandy for furrow irrigation. High subsoil sodicity can limit effective plant rooting depth. Dryander soils can be affected by secondary salinity.</p> <p>Slopes can exceed 2%. Areas with a sandy or silty topsoil greater than 0.3 m deep are unsuitable for flood irrigation. Rooting depth can be limited by strongly sodic and alkaline soils. Kinipipi, Etowrie, Roundback, Hillrise, Anakey and Goodbye soils may be affected by secondary salinisation.</p> <p>High permeability and deep drainage losses</p> <p>Slopes greater than 2% prone to erosion</p> <p>Slopes exceed 2%.</p>
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**Table C Soil salt profile**

<p>The assessment of soil salinity is complex. It cannot be assessed independently of irrigation water quality, method of irrigation, management practices, choice of crop and rainfall. Salt in the root zone of the soil profile can be natural or induced. More often than not, it has been induced as a result of shallow watertables bringing salt closer to the soil surface through capillary rise. In these situations the cause of the shallow watertable problem needs to be addressed. Given adequate drainage, naturally occurring salt levels in the root zone can generally be reduced through irrigation, which leaches the salt downwards. However, the shifting of this salt downwards may cause problems elsewhere on the property or landscape.</p> <p>The following criteria provide a general guide to what might be considered a likely problem. If high levels of salt exist within the top two metres of the soil profile, the plan must outline management options that will maintain soil profile conditions suitable for agricultural activity, and prevent salt mobilisation contributing to salinity impacts elsewhere.</p> <p><i>(Refer to 4.3.1 Land—soils and topography)</i></p>	
<p><b>Unsuitable or high risk</b></p> <ol style="list-style-type: none"> <li>1. Soils with an existing high salt accumulation somewhere within two metres of the soil surface.</li> <li>2. Land visibly affected by salt such as: <ul style="list-style-type: none"> <li>• land showing a reduction or loss of non salt-tolerant plants</li> <li>• failed or reduced crop establishment or vigour</li> <li>• bare areas</li> <li>• 'fluffy' structureless surface soils</li> <li>• seasonally or permanently shallow watertable.</li> </ul> </li> <li>3. High soil salinity levels (EC1:5 soil water suspension) that exceed: <ul style="list-style-type: none"> <li>• 300 <math>\mu\text{S}/\text{cm}</math> on sandy soils (&lt;10% clay)</li> <li>• 400 <math>\mu\text{S}/\text{cm}</math> on sandy loams (10–20% clay)</li> <li>• 600 <math>\mu\text{S}/\text{cm}</math> on clay loams (20–35% clay)</li> <li>• 800 <math>\mu\text{S}/\text{cm}</math> on light clays (35–50% clay)</li> <li>• 1000 <math>\mu\text{S}/\text{cm}</math> on medium clays to heavy clays (&gt;50% clay).</li> </ul> </li> </ol>	<p><b>Reason</b></p> <p>High soil salt loads will limit or prevent plant growth and may lead to salinity development.</p>

**Table D Quality of irrigation water**

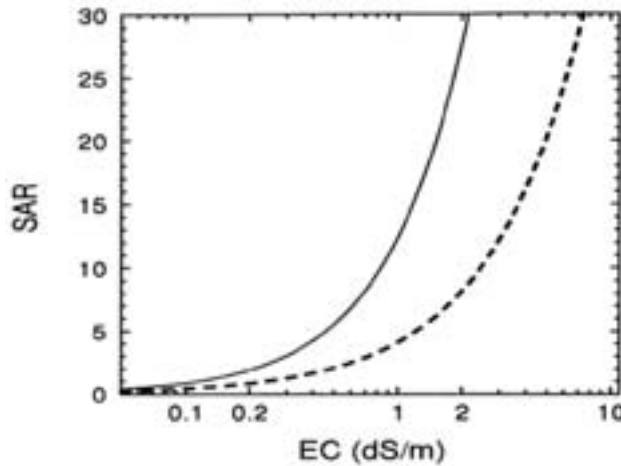
Irrigation water quality should not degrade soils; contribute to salinity in groundwater; or impact on adjacent riparian or natural areas.

Assessment of water quality and its suitability for irrigation can be complex. Water suitability for irrigation cannot be assessed independently of soil properties, irrigation system, crop type, rainfall and management practices. The following criteria provide a general guide to what might be marginal water quality using two criteria—sodicity and salinity. Sodicity is the presence of a high proportion of sodium ions relative to calcium and magnesium. Salinity is the presence of soluble salts. In the Mackay and Whitsunday area, these parameters are more likely to be a problem with water derived from groundwater sources.

(Refer to: 4.3.2 Water sources—quantity and quality)

**Unsuitable or high risk**

1. Excess sodium will degrade the physical properties of a soil by breaking down clay aggregates. The diagram below illustrates the relationship between the sodium adsorption ratio (SAR) and electrical conductivity (EC) of irrigation water and its likely impact on soil structural stability. Water quality falling to the left of the solid curve is unsuitable.



See the *Mackay and Whitsunday reference manual* for information on how to calculate SAR from your water analysis report. Unit conversion: 1 dS/m = 1000  $\mu$ S/cm

2. As a general guideline the salinity level of irrigation water should not exceed EC 1500 ( $\mu$ S/cm).

If using surface water with an EC greater than 1500  $\mu$ S/cm (micro-siemens per centimeter) or any underground water, provide a detailed chemical analysis and suitability assessment for irrigation.

Consider:

- water quality, including residual alkali (RA) and sodium absorption ratio (SAR)
- soil types
- proposed crops
- irrigation method
- climate.

**Reason**

The use of poor quality irrigation water (sodic, saline or both) may lead to soil structural degradation or an increased risk of salinisation.

If this water is used undiluted, sensitive crops and plant species will suffer. There is also the potential for salt accumulation over time and subsequent plant toxicity. You need to assess soil type, drainage and irrigation management practice. Spray irrigation will be less suitable than other methods that apply water to the root zone as the foliage of sensitive crops will burn.

**Table E Suitability of irrigation in parts of the landscape**

Some landscape positions and land slopes can preclude irrigation development. (Refer to: 4.3.1 Land—soils and topography; 4.4.4 Suitability of irrigation system)	
<b>Prohibited</b>	<b>Reason</b>
No ponded pasture development is permitted below the highest astronomical tide, in or adjacent to natural wetlands or in areas of high conservation value or fish habitat value.	For consistency with state government Ponded Pasture Policy 2001
<p><b>Unsuitable or high risk</b></p> <p>Certain slopes are considered unsuitable for specific combinations of crop and irrigation method, irrespective of location within the Mackay and Whitsunday area.</p> <p>1. Cane</p> <ul style="list-style-type: none"> <li>• Flood irrigation methods (siphons, lay flat and gated pipe) <ul style="list-style-type: none"> <li>- Land slope is less than 1 in 1500 (0.07%)</li> <li>- Land slope is greater than 1 in 50 (2%).</li> </ul> </li> <li>• Spray irrigation methods (pivots and lateral moves) <ul style="list-style-type: none"> <li>- Land slope is greater than 1 in 25 (4%).</li> </ul> </li> <li>• Travelling guns and hand shift <ul style="list-style-type: none"> <li>- Land slope is greater than 1 in 14 (10%).</li> </ul> </li> <li>• Drip irrigation methods (permanent and temporary subsurface drip) <ul style="list-style-type: none"> <li>- Land slope is greater than 1 in 50 (10%).</li> </ul> </li> </ul> <p>2. Forage and grain crops</p> <ul style="list-style-type: none"> <li>• Flood irrigation methods (siphons, lay flat and gated pipe) <ul style="list-style-type: none"> <li>- Land slope is less than 1 in 1500 (0.07%)</li> <li>- Land slope is greater than 1 in 50 (2%).</li> </ul> </li> <li>• Spray irrigation methods (pivots, lateral moves and travelling guns) <ul style="list-style-type: none"> <li>- Land slope is greater than 1 in 30 (3%).</li> </ul> </li> <li>• Drip irrigation methods (permanent and temporary subsurface drip) <ul style="list-style-type: none"> <li>- Land slope is greater than 1 in 50 (2%).</li> </ul> </li> </ul> <p>3. Intensive small crops</p> <ul style="list-style-type: none"> <li>• Spray and drip irrigation methods (hand shift, solid set, travelling gun, micro systems, and drip) <ul style="list-style-type: none"> <li>- Land slope is greater than 1 in 25 (4%).</li> </ul> </li> </ul> <p>4. Perennial tree and vine crops</p> <ul style="list-style-type: none"> <li>• Spray and drip irrigation methods (hand shift, solid set, travelling gun, micro systems, and drip) <ul style="list-style-type: none"> <li>- Land slope is greater than 1 in 15 (7%).</li> </ul> </li> </ul>	<p>Waterlogging, drainage Erosion</p> <p>Operating inefficiencies</p> <p>Erosion</p> <p>Erosion</p> <p>Waterlogging, drainage Erosion</p> <p>Erosion</p> <p>Erosion</p> <p>Erosion</p>

**Table F Standard of infrastructure and its design**

<p>Certain design and construction standards should be adhered to, to reduce the risk of failure of irrigation works and decrease the risk of erosion or development of localised high watertables.</p> <p><i>(Refer to: 4.4.5 Pumping, storage and distribution; 4.4.6 Irrigation layout and erosion control; 4.4.4 Suitability of irrigation system)</i></p>	
<b>Unsuitable or high risk</b>	<b>Reason</b>
<p>1. Flood irrigation—field design</p> <ul style="list-style-type: none"> <li>• A direct drop, of bare or cultivated soil, from end of furrow into tail drain that is greater than 0.15 m (measured from end of furrow to floor of tail drain)</li> <li>• Tail drains with flow velocities below 0.1 m/s</li> <li>• Tail drains with flow velocities greater than 0.45 m/s</li> <li>• Furrow cross-fall that exceeds 0.5%</li> </ul>	<p>Increased erosion</p> <p>Flow inadequate resulting in siltation</p> <p>Increased erosion</p> <p>Furrow failure in large storm events</p>
<p>2. Storages</p> <ul style="list-style-type: none"> <li>• Embankment batters that are 3:1 or steeper (i.e. 1 m vertical rise for every 3 m horizontal)</li> <li>• Embankment batters that are 4:1 or steeper for any part of the embankment located below flood level on a flood plain</li> <li>• Embankment crests that are not 3 m wide or <math>\sqrt{\text{height}}</math> of the embankment + 1 m wide, whichever is the larger width</li> </ul>	<p>Erosion</p> <p>Erosion and embankment failure</p> <p>Embankment failure</p>

**Table G Managing drainage and stormwater run-off from irrigated land**

<p>Drainage and stormwater run-off from irrigated land or irrigated infrastructure should be managed and directed away from susceptible water bodies, over vegetated land, and through a containment system. A stormwater management system should take into account the combination of soil type, irrigation method and crop.</p> <p><i>(Refer to: 4.4.7 Drainage and stormwater run-off; 4.5.3 Farm run-off and water quality)</i></p>	
<p><b>Unsuitable or high risk</b></p> <p>1. Annual crops (e.g. cereals, legumes, peanuts, strawberries and melons)</p> <p>In well-structured cracking and non-cracking clay soils, flood, spray (lateral move, pivot, travelling gun, hand shift, solid set) and/or subsurface (drip) irrigation methods are unsuitable or high risk if:</p> <ul style="list-style-type: none"> <li>• they are unable to contain and recycle all tail water generated</li> <li>• they are unable to contain <b>25 mm</b> of stormwater run-off from irrigated land from a rainfall event, either in on-farm or shared group scheme</li> <li>• all drains, waterways and outfall areas not well grassed</li> <li>• discharge from the back flushing filtration system or the cleaning of drip lines (end flushing) is not contained or disposed of in a manner that minimises the risk of potentially poor water quality leaving the farm.</li> </ul> <p>In permeable soils (sandy loams to clay loams), spray (lateral move, pivot, travelling gun, hand shift, solid set) irrigation methods are unsuitable or high risk if:</p> <ul style="list-style-type: none"> <li>• they are unable to contain and recycle all tail water generated</li> <li>• they are unable to contain <b>10 mm</b> of stormwater run-off from a rainfall event off irrigated land, either in on-farm or shared group scheme</li> <li>• all drains, waterways and outfall areas not well grassed.</li> </ul> <p>2. Perennial crops (e.g. cane, hay and tree crops)</p> <p>In well-structured cracking and non-cracking clay soils, flood, spray (lateral move, pivot, travelling gun, hand shift, solid set) and/or subsurface (drip) irrigation methods are unsuitable or high risk if:</p> <ul style="list-style-type: none"> <li>• they are unable to contain and recycle all tail water generated</li> <li>• they are unable to contain <b>15 mm</b> of stormwater run-off from irrigated land from a rainfall event, either on-farm or in shared group scheme</li> <li>• all drains, waterways and outfall areas not well grassed</li> <li>• discharge from the back flushing filtration system or the cleaning of drip lines (end flushing) is not contained or disposed of in a manner that minimises the risk of potentially poor water quality leaving the farm.</li> </ul>	<p><b>Reason</b></p> <p>Contaminated stormwater run-off may pollute water bodies.</p>

<p>In permeable soils, spray (lateral move, pivot, travelling gun, hand shift, solid set) and/or subsurface (drip systems) irrigation methods are unsuitable or high risk if:</p> <ul style="list-style-type: none"><li>• they are unable to contain 5 mm of stormwater run-off from irrigated land area from a rainfall event, either in on-farm or hared group scheme</li><li>• inter-row and outfall areas are not well grassed</li><li>• discharge from the back flushing filtration system or the cleaning of drip lines (end flushing) is not be contained or disposed of in a manner that minimises the risk of potentially poor water quality leaving the farm.</li></ul>	
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