Chapter 2 Water management

Objective – to maximise water use efficiency without compromising water quality on-farm and downstream

Water is a valuable resource and in many areas is becoming increasingly scarce. Good irrigation management is essential to maximise yields and control product quality.

Availability of water is increasingly subject to government regulations. These are designed to ensure waterways and groundwater. Extractions are at sustainable levels and protect the health of aquatic environments

Water management considers both the crop's water demand and the amount of water available. It also involves management of irrigation to maximise efficient use of water applied.

Drainage water and run-off also need to be managed to avoid any impact, such as nutrient pollution, on groundwater or waterways and wetlands.

This section is consequently split into the following sections:

- **2a Irrigation efficiency;**
- **2b Water quality;**
- **2c Managing wastewater.**

Further references and resources can be located at the end of this chapter.

Objective
– **uniform application of water to match crop needs**
– **drainage impacts are managed in accordance with environmental, community and regulatory standards**

Irrigation efficiency is a term that helps us define the proportion of irrigation water that is actually taken up and used by the crop. Improvement in irrigation efficiency is normally associated with water savings, production gains and better long-term environmental management.

Irrigation efficiency is determined by irrigation management factors such as:

- Ensuring irrigation systems are operating to design specification and applying water as evenly as possible;
- Ability to time, or schedule irrigation, based upon crop water needs and clear understanding of soils' water holding, infiltration and drainage capacity.

To manage irrigation efficiently a number of management practices need to be considered, starting with an understanding of water availability and crop requirements.

Efficient irrigation management practices

There are nine basic steps involved in the efficient management of irrigation:

Identify

1. Define property goals and implications for water management

Plan

2. Know your soils
3. Design the most suitable irrigation system
4. Develop a farm water budget
5. Know your water supply/ies

Do

6. Determine a basic irrigation schedule
7. Implement strategies to manage nutrient input and salinity

Monitoring and recording

8. Monitor, record and evaluate
9. Check irrigation system performance

See the following two sections for more detail on these steps.

Further references and resources can be located at the end of this chapter.

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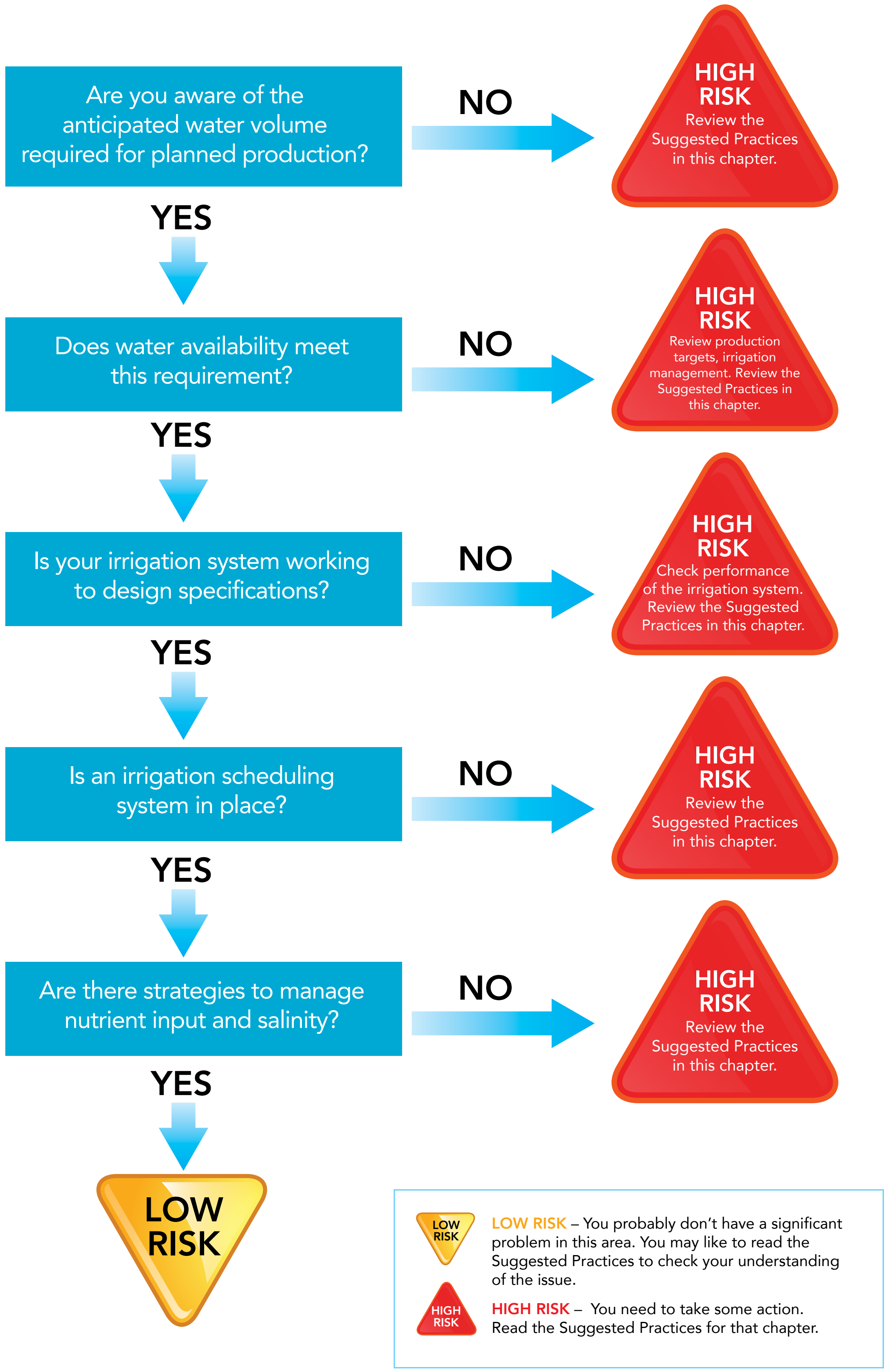
Risk assessment



Further references and resources can be located at the end of this chapter.

Horticulture Australia

Review checklist

To go straight to the worksheet for this chapter click here.

Relevant legislation and regulation

Legal requirements are subject to change. Regularly check with Federal, State and Local authorities for updated requirements. See here for links.

Suggested practices

2a.1 Identify your goals

Your goals will largely depend on the crop(s) you are growing and desired yield and quality. The property goal can be made up of a series of block or paddock goals. Once the goal is defined, you can identify the right irrigation management strategies to help meet your goal, e.g. growing 150 tonnes of Class A onions for the export market, growing 200 tonnes of processing potatoes, or establishing 2 ha of cherry trees and producing 20 tonnes of processing peaches from existing orchard.

The goal may also be influenced by average annual rainfall, capacity of the irrigation water source, regulatory restrictions on water storage or access to surface and underground water. A fairly accurate estimate of expected crop water use will assist in balancing property water supply with yield and quality targets.

2a.2 Know your soils

A soil survey is a fairly comprehensive analysis of soil types and their distribution across your property. Soil surveys establish a better understanding of your soil's ability to hold water and any potential physical and chemical limitations to growing your crops in that soil.

Soil surveys assist in determining if the land is suitable for developing particular crop types and help identify the irrigation system types that may be most suitable, manageable and efficient.

Soil surveys are also useful for identifying:

- Soil structural issues that may result in limited drainage, surface run-off, soil structure decline and root growth problems; and
- Soil chemical and nutritional characteristics that may directly effect plant growth or result in long-term soil quality decline (i.e. soil acidity, salinity and sodicity).

The types of measurement often referred to in a farm soil survey are:

- Readily Available Water (RAW) – this is the water content value most relevant to irrigators. As the name suggests, Readily Available Water is the water component that can be readily used by the crop under ideal growing conditions. It is not the total soil water content. Ideally irrigation should replace water that has been removed by growing crops (there are exceptions to this generalisation but it stands as a sound 'rule of thumb');
- The infiltration rate of soil – another valuable parameter which assists with better matching the application rate of the irrigation system with the soil's capacity to absorb this water without wastage or run-off.

Further references and resources can be located at the end of this chapter.

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Readily Available Water (RAW)

RAW is determined by soil texture and the rooting depth of the crop. Table 2.1 below helps you estimate how many millimetres of readily available water* would be held in a metre of topsoil.

Table 2.1: Readily available water for different soil types. Source: Lovell (2006).

Soil texture	Readily available water (mm/m) between - 8kPa and	
	-40Kpa	-60Kpa
Sand	35	35
Loamy sand	50	55
Sandy loam	60	65
Loam	65	75
Sandy clay loam	60	70
Clay loam	55	65
Clay	45	55

Readily Available Water, is the water available between the soil being at full point (-8kPa) and dried to a tensiometer or gypsum block reading of –40kPa and –60 kPa. More information can be found in Growcom Water for Profit irrigation fact sheets here.

Infiltration rate

Infiltration rate is the speed at which water can move through a soil. Infiltration rate is related to soil texture, bulk density, organic matter, surface soil stability and groundcover.

The infiltration rate of a soil determines the maximum rate at which irrigation should be applied. Applying irrigation at a higher rate results in surface run-off. Table 2.2 below provides indicative irrigation rates.

Table 2.2: Average infiltration rates or some soil types. Source: Wise Watering Irrigation Management Course 2001.

Suggested application rate (mm/hr)			
Soil texture	Average soil structure	Well-structured soil	Infiltration rate range (mm/hr)
Sand	50		20-250
Sandy loam	20	45	10-80
Loam	20	45	1-20
Clay loam	20	40	2-15
Light clay	2		0.3-5
Medium – heavy clay	0.5		0.1-8

(see http://www.dpiw.tas.gov.au/internnsf/Attachments/JMUY-5FP77U/$FILE/IntroductiontoWiseWatering.pdf).

Understanding soil characteristics across the property is vital for determining irrigation frequency and depth of application. It also allows soils with similar characteristics to be grouped into the same irrigation management area, based on the amount and rate at which irrigation water can be applied. It can be used to select representative sites to monitor soil moisture.

Further references and resources can be located at the end of this chapter.

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2a.3 Design irrigation systems

Crop production will suffer if the irrigation design or the irrigation method does not suit your property goals or the soil type. One of the key aspects of design is to match irrigation delivery with water demand.

Consideration should be given to issues such as crop type, variety, harvest dates, soil type, topography and exposure to drying winds. Poor designs reduce irrigation efficiency, cause uneven water application and uneven crop yield and quality. Efficient fertiliser application, particularly fertigation, depends on uniform water application.

Different irrigation system options include:

- Drip irrigation (both surface and sub surface buried tape);
- Micro-sprinklers;
- Capillary bed (for containers);
- Sprinkler irrigation;
- Travelling gun irrigation;
- Centre pivot and linear move irrigation; and
- Surface (flood or furrow) irrigation.

In general, pressurised irrigation systems are a more efficient form of water delivery than surface flood or furrow irrigation. Growers in many irrigation regions are moving away from flood/furrow irrigation systems and changing to pressurised systems that enable more accurate and manageable water delivery. Whatever irrigation method is chosen, the system must be designed to accurately match soil type and plant water demand and protect the environment.

The table below gives some range of expected irrigation application system efficiencies.

Table 2.3: Expected irrigation application system efficiencies. Source: Lovell (2006).

System	% Efficiency
Rain gun (cannon, travelling irrigator)	50 - 75
Fixed Sprinkler	65 - 85
Linear move	75 - 90
Centre pivot	75 - 90
Drip	80 - 90

There are many factors in determining the most suitable irrigation system.
Factors to consider include:

soil types and variation
Readily Available Water (RAW)
yearly water allocation
maximum extractable or stored water supply
markets/end use of crop
the need for frost protection
the option of a cover crop
maintenance and longevity of system
structure
cost to install and maintain system
long-term reliable extractable or stored water supply
topography
maximum crop water demand
water quality
fertigation
allowances for leaching fraction
the need for crop cooling
potential pests and diseases
average annual rainfall recycle
microclimate variation
climate

Using experienced irrigation designers and installers for your crop is important. The Irrigation Association of Australia has a list of certified irrigation designers. See www.irrigation.org.au for more information.

Further references and resources can be located at the end of this chapter.

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2a.4 Developing a farm water budget

A farm water budget is about making sure you have enough water to meet the property goals. Water budgeting helps determine the amount of water you expect to use over the season and attempts to match this with intended irrigated crop area so that the horticultural business can check that planned irrigation needs are within water entitlements.

Water requirements need to be budgeted using measurements of crop water demand at different times of the year, the irrigation system and knowledge of the soil water holding capacity. Individual farm data is best, but in some districts average crop water demands have been calculated and are available from agronomists and irrigation specialists.

Farm water budgets can be refined to crop-specific water budgets and irrigation schedules. There are two main types of irrigation schedule, indirect and direct. These are discussed further below (see 'Determine a basic irrigation schedule' later in this section).

An example of a water budget can be seen below in Table 2.4.

Table 2.4: Example of a water budget. Source: Lovell (2006).

An example of a water budget:

Property name:
Year:
Intended crops:

Crop	Variety	Crop area (ha)		Water requirements / ha
Total water requirement for property				
TOTAL water allocation for property				
Sufficient water available to grow intended crops?				

2a.5 Know your water supply

Understanding your crop water requirements and reliability of water supply is crucial.

The availability of water will affect the choice of crop type, the irrigation system and your irrigation management strategy. For example, drip systems (above ground or sub-surface) require a water supply that allows irrigation at short notice (e.g. within 24 hours) particularly during hot weather. Check with your state water agency to ensure the necessary licences/permits are obtained. In some districts with water allocation schemes, delays in ordering and then receiving water may limit your ability to adopt these practices. On-farm storage will reduce this problem, however, it is advisable to check whether licences/permits are required to construct dams. Interference with a waterway or obstruction of flow may require a licence/permit.

Comparing your crop water requirements against the quantity of water supply available will determine if you have sufficient water. Water may be limiting on an annual basis or sometimes in peak demand periods. If water supplies are limiting or uncertain, more efficient irrigation techniques and drought management strategies need to be considered.

Further references and resources can be located at the end of this chapter.

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Strategies to lessen the impacts of drought include:

- Identify limits to systems and management and investigate crop options by preparing an irrigation and drainage management plan;
- Prepare a risk management strategy for reductions in water availability;
- Maintain soil structure to allow the full root zone to be exploited;
- Retain groundcover for erosion protection and to provide mulch; and
- Seek advice on technical matters, financial matters, and sources of assistance.

Following the drought:

- Reassess your irrigation and drainage management plan;
- Assess the market prospects of various crops and enterprises;
- Determine when water will be available again;
- Assess options for planting crops with or without assured water supply; and
- Watch out for weeds introduced by stock and bought-in fodder.

2a.6 Determine a basic irrigation schedule

Irrigation scheduling includes determining when and how much to irrigate. Growers have traditionally relied on their knowledge and experience to schedule irrigation. However many growers are now using other measures, such as soil moisture monitoring, to fine-tune their irrigation scheduling. Irrigation scheduling can be done by indirect or direct means.

A correct irrigation schedule can optimise yield and crop quality, and reduce the amount of water used. In turn, pumping and water costs may be reduced and drainage minimised. Applying the right amount of water will also avoid leaching of nutrients beyond the root zone. This careful irrigation management helps to achieve production targets and has environmental benefits.

Indirect irrigation scheduling

Crop water demand can be determined by estimating the total loss of water from the crop based upon information such as local evaporation and expected crop water loss through the leaf surface referred to as 'evapotranspiration' (ET). Refer to Growcom Water for Profit – irrigation fact sheets http://www.growcom.com.au/land-water/water-for-profit/resources-water-for-profit/

The Bureau of Meteorology website provides maps of average monthly evaporation for Australia for each month of the year. Example of use: if the monthly map shows that an average evaporation of less than 250 mm during that month (~8mm per day) that represents a monthly water demand of 2.5 ML per hectare.

Some growers use software to develop a daily water budget. An example is shown below. This uses crop coefficients or crop factors to convert daily evaporation readings into estimated crop water use. Refer to Growcom Water for Profit – irrigation fact sheets http://www.growcom.com.au/land-water/water-for-profit/resources-water-for-profit/

Further references and resources can be located at the end of this chapter.

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Table 2.5: Example of an irrigation scheduling spreadsheet. Source: Lovell (2006).

IRRIGATION SCHEDULING SPREADSHEET
SITE: SHEPPARTON
YEAR 2003/04

Volume applied to this crop: 42 ML

Total hectares as entered: 30
Total volume used for year: 42

* Enter data in white squares
* Irrigate when soil moisture deficit is greater than 50 mm

CROP = PEACHES
Hectares 30

Crop Factor 0.9
Effective rainfall 0.8

Date	Evaporation (mm)	Rainfall (mm)	Potential ET (mm)	Effective Rainfall (mm)	Irrigation Applied (mm)	Soil moisture deficit (mm)
23 Nov	5.5		4.95	0	40	0
24 Nov	4.5		4.05	0		4.05
25 Nov	2	10	1.8	8		-2.15
26 Nov	8.8		7.92	0		5.77
27 Nov	6.8		6.12	0		11.89
28 Nov	5.9		5.3	0		17.2
29 Nov	2.5		2.25	0		19.45
30 Nov	5.5		4.95	0		24.4
1 Dec	9.9		8.9	0		33.3
2 Dec	9.9		8.9	0		42.22
3 Dec	7.		6.39	0	50	-1.39
4 Dec	5.5		4.95	0		3.56
5 Dec	9.9		8.9	0		12.47
6 Dec	10.		9.09	0		21.56
7 Dec	12.		10.89	0		32.45
8 Dec	9.9		8.9	0		41.36
9 Dec	9.7		8.73	0	50	0.09
10 Dec	8.8		7.92	0		8.0v
11 Dec	1.	50	0.99	40		3

Direct irrigation scheduling

Direct irrigation scheduling is achieved by measuring soil moisture. Soil moisture monitoring tools can provide information that can be used to check and improve irrigation scheduling. Such tools can help estimate the size of the wetting pattern (particularly depth), the level of plant stress and the additional moisture provided by rainfall. Monitoring soil moisture allows the initial estimates of how much and when to irrigate to be adjusted to suit a specific irrigation system and soil type.

Soil moisture monitoring tools normally measure soil water content or soil water tension.

Examples include tensiometers and resistance blocks (e.g. gypsum blocks) for measuring soil water tension, and neutron probes and capacitance probes for measuring soil water content.

Modern soil moisture systems track and graph soil moisture over time and can be used to help plan future irrigation dates. How much water to apply (hours) per irrigation to fully refill the soil can be calculated from the amount of water held in the soil and the system application rates.

Further references and resources can be located at the end of this chapter.

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The operational and maintenance requirements/costs of each system should be evaluated before making a decision. The nature of the crop may also have a bearing, for example annual crops require a more mobile system.

Regardless of the type of tools used, applying the right amount of water at the right time depends knowing crop water requirements, and stage of growth;

- Consideration of effects of weather;
- Water availability in the root zone (root zone raw);
- Wetting pattern (for micro-irrigation);
- Irrigation system efficiency; and
- Any leaching requirement (for managing high salinity).

Measuring if the volume of irrigation is adequate or excessive can also be achieved using 'wetting- front' detector-type sensors such as the CSIRO FullSTOP™

2a.7 Implement strategies to manage nutrient input and salinity

Manage nutrient inputs

For nutrients to reach the crop roots and to avoid losses from over irrigation, fertiliser should be applied when soils are close to field capacity, i.e. late in the irrigation run. Over-irrigation or application of a leaching fraction will wash the nutrients past the root zone. For more information see Chapter 4 – Nutrient management.

Manage salinity

Soil salinity can potentially reduce production by up to 100% due to reduced plant growth. This is because soil salinity makes it difficult for crops to obtain water and nutrients from the soil. Affected plants show similar symptoms to under-watering or can show visual symptoms such as burning on leaves. Soil salinity can also affect the biological health of the soil, which can have serious long-term effects on soil fertility. There is also a risk to soil structure if the soil becomes sodic. Soil salinity testing should be done regularly to monitor root-zone salinity.

There are a number of possible causes for high soil salinity (saline irrigation water, high water table, poor drainage, inadequate leaching, low rainfall). For more information see Topic 1d – Salinity.

If slightly saline water is used for irrigation, or deficit irrigation practices are used, in low rainfall areas, then it is essential to monitor the build up of salt in the root zone and apply leaching fractions when necessary.

When applying leaching irrigations there needs to be a balance between removing salt and minimising the loss of nutrients. Therefore, specific leaching irrigations should consider the potential for nutrient losses from the rootzone; e.g. avoid leaching when using fertigation or if having recently applied fertilisers.

Checking the salt index of fertilisers

All fertilisers have a salt index, which indicates what the fertiliser contributes to soil salinity.

If your irrigation water or soils are saline, changing to fertilisers with similar nutrients but with a lower salt index may help. For example, potassium chloride has a salt index of 114 but potassium sulphate has a lower salt index of 46.

Information on the salt index of each fertiliser should be available from your local supplier.

Salinity is measured as Total Dissolved Salts (TDS) in eithermilligrams per litre (mg/L) or the equivalent, parts per million (ppm); 100 mg/L = 100 ppm.

Electrical Conductivity (EC) is a good indicator of TDS. It is measured as EC units (equivalent to micro Siemen per centimetre) and can also be expressed as milli Siemen per cm (mS/cm) or the equivalent, desi Siemen per metre (dS/m); 1mS/cm = 1dS/m. NB: 1,000 EC units = 1 mS/cm = 1,000 uS/cm = 1 dS/m = 640 mg/L.

Further references and resources can be located at the end of this chapter.

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Monitoring and recording

2a.8 Monitor, record and evaluate

Monitoring, measuring and recording activities are essential for the overall management of the property. A range of factors should be monitored and evaluated but the following are important:

Monitor crop performance

Keeping records of crop productivity is important to understand the effects of different irrigation practices. Measuring and recording yield, quality and maturity for each crop allows yearly comparisons and evolution against the goal of the property, and helps to refine management decisions.

Document water budget

Record irrigation schedules, amount of water applied, rainfall, soil moisture and crop evapotranspiration.

Assessment of economic yield

One measure of irrigation efficiency is through assessment of economic yield. This can be expressed in gross income per megalitre ($/ML) and/or production water use efficiency (tonnes of produce/ ML). While no definitive figures exist for these criteria, historical on-farm or district comparisons will provide useful benchmarks.

Monitor water quality

Monitoring the quality of your drainage water can give an indication of nutrient loss. See Topic 2b – Water quality.

2a.9 Check irrigation system performance

You need to regularly check and maintain your irrigation system to make sure it is operating correctly and delivering what it should. If the system is not operating at maximum efficiency, irrigation scheduling and management strategies, such as controlling salinity, will not be effective.

Checks that should be undertaken include:

- Visual inspection of irrigation system and crop performance;
- Discharge or flow rate variation;
- Uniformity of water distribution;
- Pressure variation;
- Presence of cuts, blockages, leaks in dripper lines;
- Sprinkler/dripper malfunction;
- Filters; and
- Pumps.

It is also important to measure output uniformity or distribution uniformity. Uneven distribution causes areas of over/under irrigation and has consequences for crop yield and quality. The manufacturer's specifications should be referred to when assessing distribution uniformity and should be within the range specified in the table showing expected irrigation application system efficiencies table earlier in this section.

Further references and resources can be located at the end of this chapter.

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Farm Dam Management – monitoring and mitigation

Conservative estimates suggest that in excess of 8,000 GL is stored in farm dams (i.e., 9% of total stored water) and that there are more than 2 million farms dams across Australia. Reducing this loss using either physical or chemical covers therefore has the potential to significantly increase agricultural water use efficiency in Australia and therefore generate millions of dollars for the Australian economy.

Unlike losses due to evaporation, which will vary based on seasonal variations of evaporative demand, seepage losses will be affected by soil permeability and dam construction.

For some storages it is possible to lose more water from seepage than evaporation. Storages that have excessive seepage losses will require some form of mitigation.

By measuring changes in water depth for periods when there is no inflow, outflow or rainfall, the components of evaporation and seepage can be directly measured as the change in depth. The Evaporation and Seepage Ready Reckoner or technologies such as EvapCalc, Irrimate™ Seepage and Evaporation Meter or 'Pressure Sensitive Transducer' can be used. See Farm Dam Management Resource Kit for more information http://ncea-linux.usq.edu.au/farmdammanagement/

References and further resources

For access to relevant references and further resources click here.

Further references and resources can be located at the end of this chapter.

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Objective – water quality is suitable for its intended use on the property and does not negatively impact downstream water quality

There are two aspects of water quality that need to be considered. The first is to make sure that the quality of water being used is suitable for the intended purpose (e.g. irrigation, agricultural sprays, packing sheds), and the second is to make sure that your operation is protecting the quality of water leaving your farm so it does not negatively impact on downstream users and the environment.

If you are sourcing water from rivers or streams then upstream farms and businesses may impact on you.

Problems caused by using poor quality water on-farm include:

- Salinity (high total soluble salt content);
- Sodicity (high sodium content);
- Toxicity (high concentration of specific salts in the soil);
- Blue-green algae, which may be toxic; clogging of irrigation equipment; and corrosion of pipes and other equipment.

One of the factors that needs to be considered is the proportion of dissolved minerals and salts in your irrigation water.

All groundwater and stream waters contain dissolved minerals. When irrigation water is used, the mineral salts are either taken up by the crop, left in the soil after the crop has used the water, leached down past the root zone, or washed out with run-off. Most of these salts are beneficial, but in some cases they may be harmful to the crops and to the long-term sustainability of the property. See Topic 1d – Salinity.

Other chemical contaminants of water may include heavy metals, and agricultural or industrial chemicals.

The potential impact of poor quality water leaving the farm includes:

- Harm to aquatic species in waterways from water eutrophication due to nutrient and organic matter pollution, and from chemical pollution;
- Sedimentation of waterways and marine environments, causing disruption and damage to these ecosystems; and
- High nutrient levels in waterways contributing to blue-green algae outbreaks.

Further references and resources can be located at the end of this chapter.

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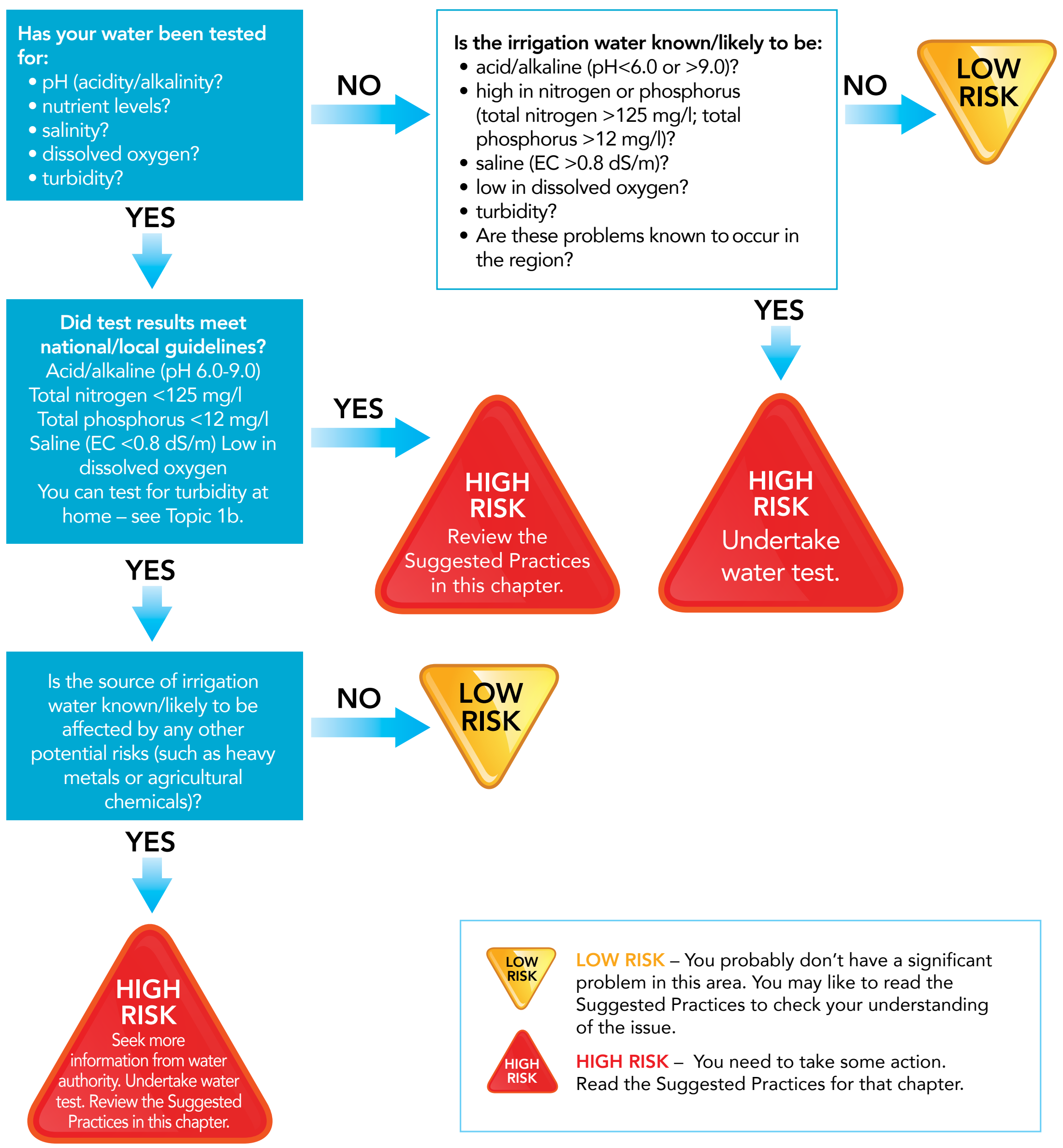
2b Water quality

Risk assessment

IRRIGATION WATER QUALITY



Guideline values should be taken from ANZECC 2000 Australian and New Zealand Guidelines for Fresh and Marine Water Quality National Water Quality Management Strategy, Australian and New Zealand Environment Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand. This source provides detailed information on the water quality required for irrigation.

Further references and resources can be located at the end of this chapter.

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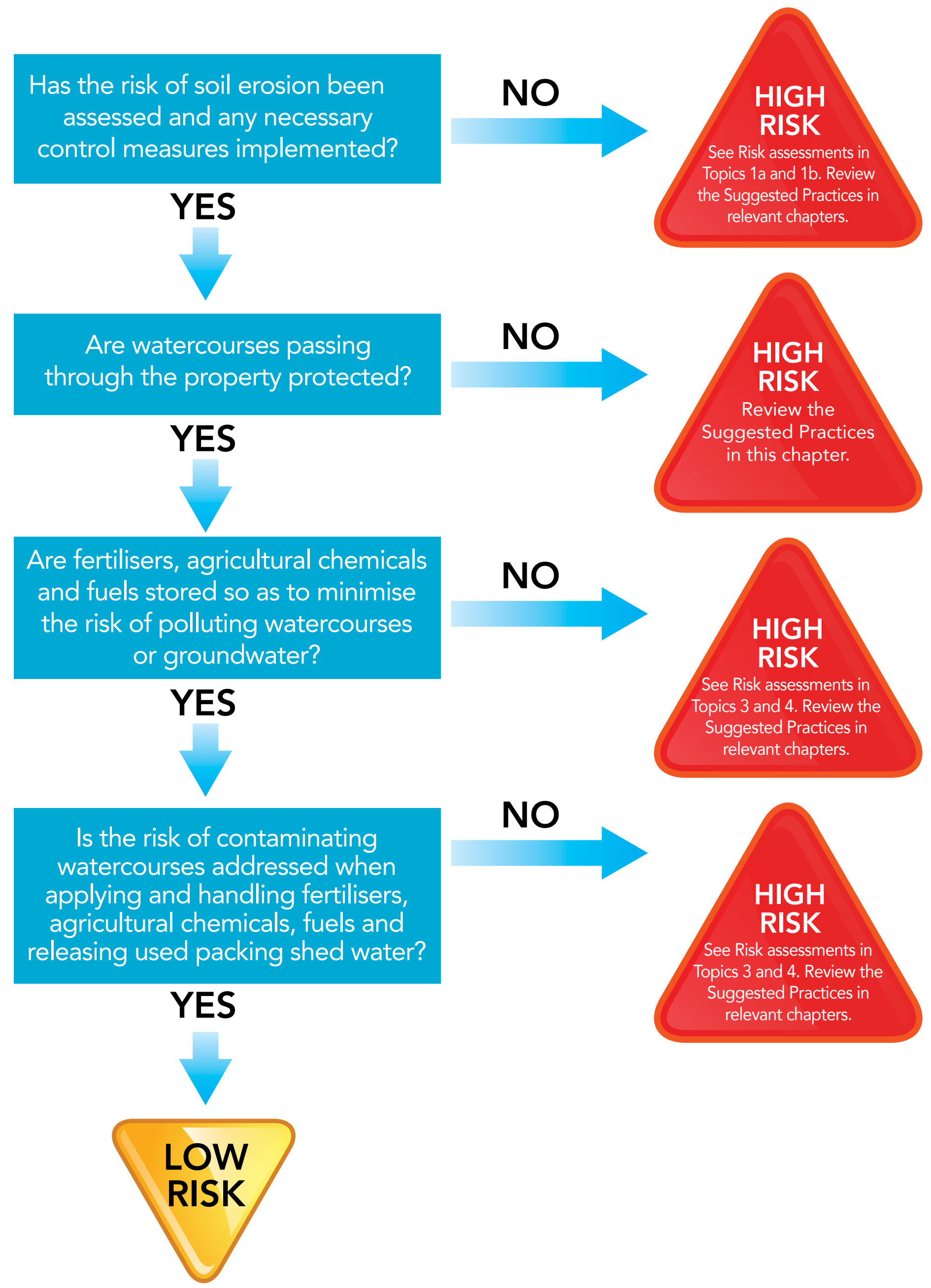
Risk assessment

DOWNSTREAM WATER QUALITY



LOW RISK – You probably don't have a significant problem in this area. You may like to read the Suggested Practices to check your understanding of the issue.

HIGH RISK – You need to take some action. Read the Suggested Practices for that chapter.

Further references and resources can be located at the end of this chapter.

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Review checklist

To go straight to the worksheet for this chapter click here.

Relevant legislation and regulation

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Suggested practices

Check water source quality

This should be a priority when considering new enterprises. Good data is often available from your water supply authority/company/State government agency.

Where use of saline water is unavoidable, regularly check salinity to plan suitable irrigation management options.

It is important to remember that water quality can change from month to month and summer flows in a river system can have quite different water quality to winter/spring periods.

Recycled water can be derived from various wastewater sources and has many uses. Recycled water can be used for a variety of purposes. For each use the water must be treated to a level where it is considered fit-for-purpose. The Environment Protection and Heritage Council, the Natural Resource Management Ministerial Council and the National Health and Medical Research Council developed guidelines for the safe use of recycled water. These guidelines are now stored at http://www.environment.gov.au/resource/national-water-quality-management-strategy-australian-guidelines-water-recycling-managing-0. It is important to check whether your relevant state authorities approved the recycled water for the intended use (e.g. fit for purpose). For more information on using recycled water see http://www.recycledwater.com.au/index.php?id=96

Check quality of water leaving the farm

It is also worth checking the drainage and run-off water leaving your own property. How does it compare with the water upstream or your neighbours? If the water is high in nutrients and turbidity (water cloudiness) then you should consider how fertiliser management, soil erosion, protecting watercourses and agricultural chemical management could be improved. See 1a – Soil erosion caused by water; 1b – Soil erosion caused by wind; 3 – Chemical management; and 4 – Nutrient management.

Your water authority, local catchment authority or Landcare group can usually provide access to water testing laboratories and information on run-off water quality targets.

Protect water quality

Water quality is impacted by activities both on and off farm. It is important to be aware of on-farm activities that can negatively affect water quality as this may impact the suitability of the water for use on the farm as well as having significant environmental impacts. Farm activities may affect water quality by increasing levels of salts, nutrients, suspended sediment, chemicals or organic matter.

Further references and resources can be located at the end of this chapter.

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2b Water quality

Protect watercourses

Watercourses such as rivers, creeks and streams as well as their riparian areas (areas on or near creek and river banks) should be protected. Areas that have significant protected riparian zones have the ability to capture and filter soil sediment and soluble nutrients, improving water quality before it leaves the farm. A strip of undisturbed vegetation should be left to protect waterways.

Revegetate riparian areas with a mixture of native grasses, shrubs and/or trees to provide a buffer and stabilise waterway banks. In some regions there are legislated separation distances (for example 100 m) between sources of groundwater or surface water and obvious pollution sources such as fertiliser or agricultural chemical storage, packing sheds and workshops. It is advisable to check with the relevant government agency.

In known drainage lines or areas where run-off enters waterways install filter strips or buffer strips to minimise sediment and nutrient entering waterways. Seek information regarding design of the buffer strips, particularly in relation to the most appropriate vegetation and width of strip. Fencing waterways to keep stock out and providing off-stream drinking points also help protect watercourses.

Financial assistance may be available to fence riparian zones. Contact your local Landcare, catchment authority or government representatives.

Soil erosion

Soil erosion is an important issue for both soil protection and water quality protection. High turbidity of run-off indicates soil loss is occurring. This is most common after intense rainfall, particularly after a dry spell. Buffer zones or grassed areas can be established to filter run-off and storm water. Often nutrients, especially phosphorus, and farm chemicals are carried attached to soil particles. Controlling soil erosion will help to retain nutrients and reduce nutrient pollution downstream. See Section 1a – Soil erosion caused by water, and 1b – Soil erosion caused by wind, for more details.

Nutrient management

Nutrient management is important to ensure that the nutrients applied are either used by the crop (some of which will be exported off-farm in the harvested product) or safely stored in the soil for the next crop.

Fertiliser or nutrients can be applied through fertiliser or nutrient rich water (e.g. recycled water can have significant concentrations of nitrogen and phosphorus). All nutrient sources should be considered when deciding crop nutrient requirements (nutrient budgeting).

Inaccurate or over-application of fertilisers can contaminate ground and surface water. This can result in the enrichment of water with nitrogen or phosphorus (eutrophication) causing rapid growth of algae and aquatic plants. This disturbs the balance of organisms present in water and the quality of the water within waterways. Nitrogen leaching can also cause soil acidity problems.

There are no blanket answers to reduce nutrient loss. Each farm is different and will require a different response.

A property is more likely to be susceptible to nutrient loss where:

- Soil types are very heavy and there is surface run-off (worse when surface is cultivated);
- Soil types are sandy and there is high leaching;
- High fertiliser inputs are used;
- Crops have high irrigation requirement (more irrigations mean more chances to wash nutrients out);
- A flood or furrow irrigation system is used;

Further references and resources can be located at the end of this chapter.

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- The property is located in a high rainfall area;
- The cultivated area is located close to a watercourse;
- Water is not well managed; and
- Time of nutrient application is not well managed.

Underlying most of the best practices is the need to keep nutrients in the plant root zone and to manage water to minimise irrigation run-off via the surface or into the groundwater.

Good nutrient management involves:

- Deciding what nutrients are needed, e.g. budget nutrients removed in the crop versus nutrients added in fertiliser applications;
- Applying fertilisers the right way;
- Minimising nutrient leaching to groundwater, especially nitrogen, by applying lighter than normal irrigation after fertiliser application or fertigating with lighter irrigations than normal; ensuring any in-line fertiliser injection systems have back flow prevention measures;
- Storing fertilisers properly; and
- Reducing possible harm to the environment by ensuring broadcast application of fertilisers involves leaving a buffer (no fertiliser) zone between the crop and sensitive areas such as watercourses and native vegetation.

For more information on selection and application of fertilisers see Chapter 4 – Nutrient management.

Correct storage and application of fertilisers will reduce environmental harm. Controlling soil erosion and reducing run-off and sediment loss will assist with loss of nutrients from target areas.

Agricultural chemical management

Agricultural chemicals can contaminate waterways through inappropriate application and storage.

Agricultural chemicals should not be applied where they could drift onto water, unless they are specifically approved for use in or near water. Make sure there is a margin between where the spray falls and the bank of any watercourse. For some chemicals, a minimum width for the no-spray zone is specified on the label.

Storage of agricultural chemicals, disposal of waste agricultural chemicals and empty containers must be undertaken with care.

For more information see Chapter 3 – Chemical management.

Prevent pollution from fuels and oils

Oil and fuel spills can pollute waterways and soils, and are a major threat to flora and fauna. State legislation and environmental protection authorities treat the matter very seriously. Theft, vandalism and accidental damage by moving vehicles can cause oil spills and should be guarded against. For more information see Chapter 3 – Chemical management.

Packaging shed water

Some packing sheds use large amounts of water as part of the packing process. Steps should be taken to ensure used water is safe to release back into waterways. This can be achieved through regular monitoring and if necessary filtering or treating water to remove organic material and chemicals. Organic material in water affects the amount of oxygen available and can have significant impact on fish and other aquatic life.

Further references and resources can be located at the end of this chapter.

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2b Water quality

Organic matter

Septic tanks, and manure storage and waste produce dumping areas should be located well away from waterways and from water sources such as bores and dams. Run-off containing leachates from manure storage heaps and dumped piles of waste produce should be contained to prevent entry into waterways.

Ensure sewerage and septic systems are regularly maintained to prevent leakages into surface or groundwater.

Monitoring and recording

Where there is a risk of poor quality irrigation water, testing should be undertaken regularly and at times of greatest risk. For instance, water should be tested for agricultural chemicals (on farm and off farm) when spraying has taken place near the water body. Copies of water tests should be maintained to track changes over time.

Testing parameters will vary with each situation, however the most common tests will be for pH, pesticides (as above), key nutrients (nitrates and phosphates), electrical conductivity (EC) to test salinity, and biological oxygen deficit (BOD) to test for organic matter presence and its potential effect on aquatic species. Accredited commercial testing laboratories are available Australia-wide. Check with your local council or State natural resources or primary industries department for further information.

A regular nutrient stocktake is a cost-effective way of checking fertiliser stocks, storage facilities, purchases and usage. The record should include storage location, type and amount of fertiliser. You may wish to also include details of dates into and out of store, and link usage to the fertiliser application records. A regular chemical stocktake should also be done. The farm map should indicate fertiliser and chemical storage locations and nearest watercourses. Records of weather conditions when applying agricultural chemicals can be used to substantiate minimisation of spray drift.

Records for disposal of unregistered chemicals and chemical containers can also be useful.

Monitoring the use of fuel and oils can detect potential threats to water quality caused by wastage, spills or leaks.

Monitoring any drainage lines for run-off water quality (e.g. nitrate test strips and turbidity tests) is also recommended. This can indicate areas and location of nutrient and soil loss.

References and further resources

For access to relevant references and further resources click here.

Further references and resources can be located at the end of this chapter.

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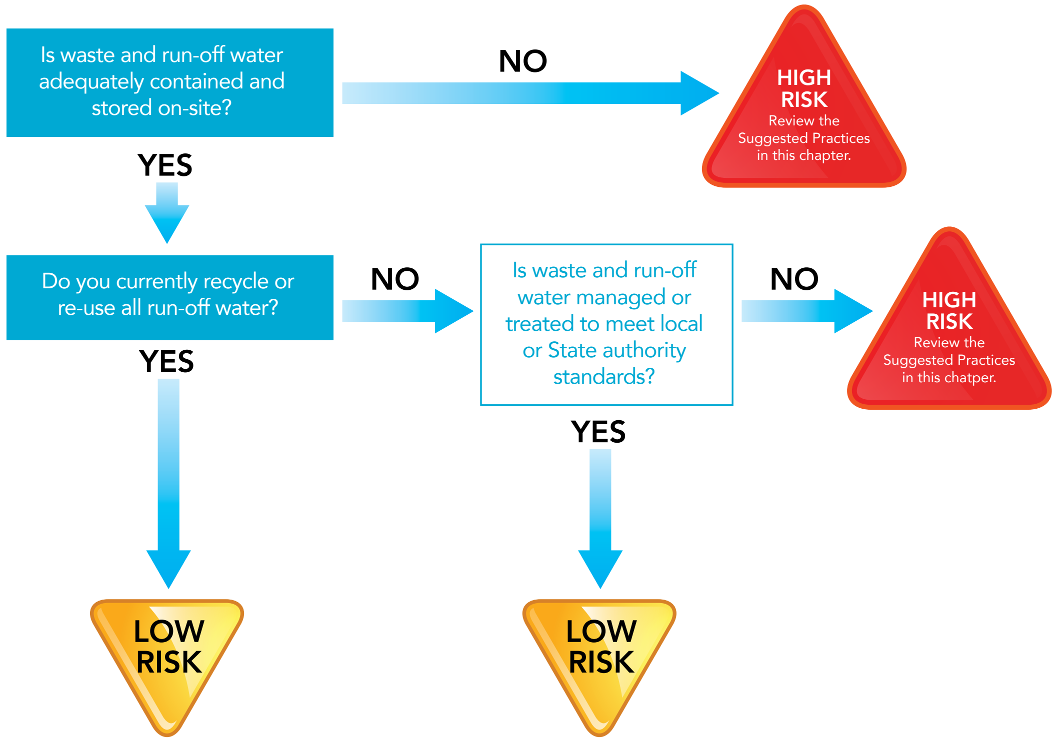
Objective – to manage wastewater and run-off appropriately to minimise or eliminate potential negative environmental impacts

Appropriately managing all waste and run-off water from production areas is important to minimise the release of polluted wastewater into the environment. This is particularly so for containerised nursery operations, where leaching of irrigation water (and rainfall) from containers, and consequent nutrient losses in run-off water, is difficult to avoid. Collecting and recycling it as irrigation water or re-using it in non-production areas such as lawns, gardens and windbreaks also saves on water and fertiliser use, further reducing costs. Wastewater from packing sheds is also addressed in Topic 2b – Water quality and managing water from chemical dips is addressed in Chapter 3 – Chemical management.

Risk assessment



LOW RISK – You probably don't have a significant problem in this area. You may like to read the Suggested Practices to check your understanding of the issue.

HIGH RISK – You need to take some action. Read the Suggested Practices for that chapter.

Further references and resources can be located at the end of this chapter.

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2c Managing wastewater

Review checklist

To go straight to the worksheet for this chapter click here.

Relevant legislation and regulation

Legal requirements are subject to change. Regularly check with Federal, State and Local authorities for updated requirements. See here for links.

Suggested practices

An effective re-cycling/re-use system involves the following activities.

Retain water onsite

Plan layout for drainage and prepare drains to collect run-off water and deliver to a collection dam or tank. Follow local authority or industry guidelines for designing drainage and storage capacity.

Set up filters and treatment systems to remove sediment, litter and undesirable chemicals from run-off water.

Collect run-off water into storage dams/tanks. Storage dams/tanks need to be specially constructed for holding run-off water. Natural wetlands on your property should not be considered as storage for run-off water due to potential pollutants in the water affecting the wetland. Follow local authority or industry guidelines for storage capacity and construction.

Monitor the quality of run-off water to determine effectiveness of treatments. Monitor:

- pH;
- Nutrient levels (particularly nitrates and phosphates); and
- Electrical conductivity (EC), which is an indicator of total salts in the water.

Minimise discharge

Where possible, to minimize the effect of discharge, intercept and divert water from outside your property away from the production area. This reduces the volume of water to be managed and stored, and prevents pollutants and diseases being transferred.

Monitor the quality of discharge water as above.

Seal production areas, if applicable, to minimise infiltration of water into the soil and to direct run-off water to drains. In nurseries, 200 μm thick plastic is commonly laid with at least 75 mm depth of 10-25 mm diameter gravel on top. Other options are concrete or bitumen. Level the growing beds to a minimum grade of 1:70 to ensure movement of run-off water to drains.

Disinfect run-off water to remove pathogens before recycling or reusing

Where applicable, risks associated with pathogens need to be managed (e.g. disinfestation). This is applicable for the nursery industry – see NIASA Best Management. Practice Guidelines section 1.1.1.

Further references and resources can be located at the end of this chapter.

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A useful reference that provides detailed information about setting up a recycling/re-use system is Managing water in plant nurseries – a guide to irrigation, drainage, and water recycling in containerised plant nurseries, 2nd Edition (2002), by NSW Agriculture (now NSW Department of Primary Industries).

Monitoring and recording

Regularly monitor run-off water to determine effectiveness of treatments. Monitor:

- pH;
- Nutrient levels (particularly nitrates); and
- Electrical conductivity (EC), which is an indicator of total salts in the water.

Keep a record of run-off water monitoring results.

References and further resources

For access to relevant references and further resources click here.

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Water management chapter - references and further resources

(web links accurate as at 11 February 2014)

Note: A number of Horticulture Australia Limited (HAL)-funded project final reports have been identified as references within this document. This is by no means representative of all the research & development (R&D) or final reports available in this area. For full list of HAL final reports visit the HAL website www.horticulture.com.au. Alternatively, contact HAL or your peak industry body for more information on research & development outcomes specific to your industry.

NATIONAL ORGANISATIONS

Cooperative Research Centre for Irrigation Futures http://www.irrigationfutures.org.au
This website is an archive of irrigation research, education and training activities between 2003-2010 (active to 2015).

CSIRO Water for a Healthy Country Flagship
http://www.csiro.au/Organisation-Structure/Flagships/Water-for-a-Healthy-Country-Flagship/WIRADA_WFHC_ResearchProfile.aspx
This Flagship provides science and technologies that improve the social, economic and environmental outcomes from water.

Growcom Water for Profit http://www.growcom.com.au/
This website provides access to irrigation fact sheets.

Healthy Waterways http://www.healthywaterways.org/HealthyWaterways/Home.aspx
This website is managed by a not-for-profit community organization focused on protecting and improving waterways in Australia.

Irrigation Association of Australia Ltd www.irrigation.org.au
This is the website for the peak body for urban and rural irrigation industry.

Murray Darling Basin Authority http://www.mdba.gov.au
The Authority provides basin-wide strategy, policies and planning. This website provides links to the Water Quality and Salinity Management Plan, Sustainable Rivers Audit and other publications.

National Program for Sustainable Irrigation (NPSI) http://www.npsi.gov.au
NPSI was the national research program for irrigated agriculture. This program was completed June 2012, but website provides access to research publications.

See also NPSI Knowledge Harvest - Irrigation Essentials
NPSI (2012) Irrigation Essentials Updated – Research and innovation for Australian irrigators. National Program for Sustainable Irrigation. Cotton RDC, NSW. http://npsi.gov.au/files/products/national-program-sustainable-irrigation/npsi06121/npsi06121-irrigation-essentials-updated.pdf

National Water Commission http://www.nwc.gov.au/home
The Commission drives national water reform under the Federal Governments National Water Initiative.

Recycled Water in Australia www.recycledwater.com.au
The national initiative for recycled water in horticulture and wider community. This program was decommissioned, but this website still provides access to relevant information on use of recycled water in horticulture.

STATE-SPECIFIC INFORMATION

New South Wales
NSW Department of Primary Industries – Water and irrigation http://www.dpi.nsw.gov.au/agriculture/resources/water

Northern Territory Government
Department of Land Resource Management – Water http://www.lrm.nt.gov.au/water#.UnjLKaVtx-U

QLD
Queensland Government – Rural water use efficiency http://www.dnrm.qld.gov.au/water/access/rural-water-use-efficiency
Growcom – Water for Profit initiative – Resource centre http://www.growcom.com.au/land-water/water-for-profit/resources-water-for-profit/

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South Australia
Government of South Australia http://www.sardi.sa.gov.au/water/irrigation_management/irrigation_efficiency

Tasmania
Department of Primary Industries, Water and the Environment, Tasmania, (2012) Wise Watering Irrigation Management Course www.dpiwe.tas.gov.au/inter.nsf/WebPages/JMUY-5FJVP7?open

Victoria
Department of Environment and Primary Industries, Victoria http://www.depi.vic.gov.au/water/rural-water-and-irrigation

Western Australia
Department of Agriculture and Food, WA https://www.agric.wa.gov.au/climate-land-water/water/water-management

CHAPTER - SPECIFIC REFERENCES AND RESOURCES

2a Irrigation efficiency

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Boland, AM. (2008) Guidelines for irrigation management (HAL Project Number AP06055). Horticulture Australia Ltd, Sydney, NSW. www.horticulture.com.au

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Wise Water – Irrigation Management Course 2001 – course notes http://www.dpiw.tas.gov.au/internnsf/Attachments/JMUY-5FP77U/$FILE/IntroductiontoWiseWatering.pdf

2b Water quality

Caring for Our Country – Reef Rescue program
http://www.nrm.gov.au/funding/reef-rescue/components.html
This initiative supports projects in the areas of water quality, water quality monitoring and reporting, crown of thorns starfish, systems repair, the land-sea country partnership and the Great Barrier Reef Marine Park Authority.

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1. Background http://nrmonline.nrm.gov.au/downloads/mql:2882/PDF
2. Getting Started: the team, monitoring plan and site http://nrmonline.nrm.gov.au/catalog/mql:2871
3. Biological Parameters http://nrmonline.nrm.gov.au/downloads/mql:2883/PDF
4. Physical and Chemical Parameters http://nrmonline.nrm.gov.au/downloads/mql:2880/PDF
5. Data to Information to Action (could not be sourced online)
6. Groundwater Monitoring http://nrmonline.nrm.gov.au/downloads/mql:2875/PDF
7. Estuarine Monitoring http://nrmonline.nrm.gov.au/downloads/mql:2869/PDF

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2c Wastewater

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