Pressurised Irrigation Best Management Practice Guidelines

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Environment

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TABLE OF CONTENTS

1	INTRODUCTION	4
2	DEFINITION OF TERMS	5
3	SPECIFICATIONS FOR PRESSURISED IRRIGATION	7
	3.1 Soil Survey Report Specifications	7
	3.2 Irrigated Crop Survey	8
	3.3 Irrigation System Design	9
	3.4 Irrigation System Evaluation	9
	3.5 Scheduling	13
	3.6 Irrigation System Operation	14
4	ACKNOWLEDGEMENTS	14
5	REFERENCES	15

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1 INTRODUCTION

This pressurised irrigation best management practice guidelines is essentially a standard that assesses irrigation performance at the farm level. Its purpose is to define the minimum information required to determine where irrigation efficiency improvements can be made for pressurised irrigation systems. The code of practice divides on farm irrigation management into 6 key topics:

- Soil survey report
- Irrigated crop survey
- Irrigation system design
- Irrigation system evaluation
- Scheduling
- Irrigation system operation

Voluntary implementation of this code of practice ensures that best management practice is achieved and demonstrates a commitment to minimising the environmental impacts of irrigation drainage.

The pressurised irrigation best management practice guideline is part of a broader project to develop a pressurised irrigation code of practice for the Riverland in South Australia. The products of this project include:

- Pressurised Irrigation Best Management Practice Guidelines
- Pressurised Irrigation System Auditing
- Guidelines for the development of a District Irrigation Code of Practice

All of these publications are focused on water use efficiency at the farm level and are primarily concerned with irrigation best management practices to minimise the environmental impacts of irrigation drainage.

Underlined terms found in paragraphs throughout the document are defined in Section 2: Definition of Terms.

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2 DEFINITION OF TERMS

Amelioration/Soil Amelioration	Actions taken to physically, chemically or biologically alter the properties of a soil profile.
Field Application Efficiency (Ea)	Field Application Efficiency (Ea) refers to the amount of water directly available to the crop for evapotranspiration relative to irrigation water applied. Soil type, crop selection, irrigation system design, application uniformity and irrigation management practices affect the field application efficiency (Irrigated Crop Management Service 2000). Field application efficiency is difficult to measure due to the wide range of variables required in the calculation. IRES software provides an estimation of field application efficiency based on a simulated soil water balance for the crop Rootzone. Field Application Efficiency estimates from IRES can only be accurate if all data used in the software is without error.
Headworks	Headworks are defined to include components delivering water supply directly to an irrigation system that an irrigator has direct responsibility for. This may simply be the valve that connects the irrigation system to a shared pipeline operated by a trust or similar organisation. In other situations this may include all infrastructure from the water supply to the outflow pipe of the filtration system.
Impeding Layer	A layer in the soil that restricts plant roots from penetrating deeper into the soil profile. Impeding layers may be physical, chemical or biological in nature and will restrict root penetration to varying degrees dependant on plant species and variety. For this reason, impeding layers need to be considered with respect to the specific plant roots exposed to the layer.
Irrigation Requirement (Ir)	The depth of irrigation water required for meeting evapotranspiration minus contribution by effective precipitation, groundwater, stored soil water, required for normal crop production plus leaching requirement and application losses. (1977, FAO 24, 1988 FAO 56)
Land Management Units	Defined areas of land that have similar limitations and management requirements considering soil profile and rootzone characteristics.
MAD	'Managed Allowable Depletion' (MAD) is the percentage of TAW that is allowed to be used before refill should occur to maintain desired crop vigour and yields. It is typically expressed in millimetres per metre and is often referred to as the Refill Point
PAW	'Plant Available Water' (PAW) essentially has the same meaning as RAW but is typically determining using strategically placed soil water monitoring devices after a soil survey to determine the amount of water available to the crop.
Property	The area of irrigated land to which the water license applies.

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Patch	Defined to be the area of ground containing plants of the same species, variety, age, and rootstock.
RAW	Readily Available Water' (RAW) is the amount of water stored in the soil that can easily be extracted by plants before the onset of any water stress. Typically, RAW is determined between field capacity (-8 kPa) and a refill point of –60kPa but may involve other ranges depending on crop, soil type and circumstance
Shift	A group of valves that are grouped together and operated simultaneously.
Spreading Emitters	Spreading Emitters refers to all emitters that spread or distribute water out over a given area. This includes all emitters other than drip emitters – eg sprinklers.
TAW	'Total Available Water' (TAW) is the amount of water held in the soil between field capacity (–8kPa), and permanent wilting point (-1500kPa). TAW is typically expressed in millimetres per metre.
Valve runtimes	The duration of time that a valve unit irrigates for.

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3 SPECIFICATIONS FOR PRESSURISED IRRIGATION

3.1 SOIL SURVEY REPORT SPECIFICATIONS

A soil survey report needs to contain the following essential specifications for the irrigated area of the property:

- The date of the soil survey
- The person responsible for the soil survey and resultant report
- The location of the property (Hundred / Section / Lot or GPS coordinates using GDA-1994 datum)
- Soil profile descriptions and the method(s) used to make descriptions
- A map locating the soil profile sampling sites, using a recognised coordinate system. Please note that detailed explanation will be required to justify sampling pit spacing of less than 2 pits per hectare.
- The thickness of layers and depth to any impeding layer at each survey site
- An estimation of the soil water holding capacity. Provide details to clearly identify:
  - The method used in determination: For example: Readily Available Water (RAW), Plant Available Water (PAW) or Total Available Water (TAW) with Managed Allowable Depletion (MAD).
  - The zone for which calculations are representative (i.e. topsoil layer only, or an identified crop rootzone, or potential rootzone depth)
- A map depicting Land Management Units including areas not suitable for irrigation
- A rationale on the method used to generate land management units
- Soil chemical analysis for at least 10% of sampling sites

In addition to the essential specifications listed above, the following points are considered to be desirable in a soil survey report:

- A statement clearly disclosing that the soil survey report has been prepared in accordance with The Code of Conduct for Commercial Soil Surveyors
- A statement disclosing that the Soil Surveyor, upon commencing the Soil Survey and report, was aware of:
  - The intended future land use/s
  - The current land use/s and management practices
  - Previous land use and management practices (if available)
- A Capability Statement from the soil surveyor
- A statement confirming the independence of the soil surveyor
- Surface elevation contours at 1 metre or less contour interval
- A soil profile description map
- A readily available water map

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- A rationale for the method of soil profile description used
- Soil profile root score and / or rootzone depth
- Appropriate conclusions and recommendations
- If conducted, a preliminary reconnaissance survey of the property using remote sensing techniques such as an Electro Magnetic Survey.

3.1.1 Soil Survey Record Keeping Requirements

Record and maintain a history of any soil survey related documents.

A log of soil amelioration activities including the date, description of the activity and affected area need to be recorded.

3.2 IRRIGATED CROP SURVEY

Record the following information for each irrigated patch on the property:

- **Crop Type**

  A broad description of the crop e.g.: Citrus

- **Patch Identification**

  A unique identification name

- **Rootstock**

  (If Applicable)

- **Crop Variety**

  e.g: Navel

- **Plant Spacing**

  The spacing between plants within a row

- **Row Spacing**

  The spacing between planted rows

- **Planting Date**

- **Inter-row crop or cover-crop details**

- **Crop Area**

  The recommended method to calculate crop area is to use a computer based Geographic Information System (GIS) to construct a polygon around each crop area as displayed within an ortho-corrected aerial photograph.

  If this technology is not available then the following calculation is acceptable:

  Row Spacing x Plant Spacing x Total Number of Plants

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3.3 IRRIGATION SYSTEM DESIGN

A scaled design or at least a map of the irrigation system needs to be provided displaying the location of:

- Head works
- Pipe works
- Valves
- The area covered by valves

(Please include a North reference and identifiable landmarks to clearly identify the location of map.)

For the irrigated area, provide a contour map displaying 1m elevation intervals.

Irrigation system specifications for head works, filtration system, emitters and recommended shift configurations need to be provided.

3.4 IRRIGATION SYSTEM EVALUATION

3.4.1 Head works Specifications

Measure and record Head works pressure at least twice per year.

Document the method used to routinely measure head works pressure as a Standard Procedure for Measuring Head works Pressure.

Measure the pressure and flow of the headworks under standard operating conditions as defined in the Standard Procedure. NOTE: Headworks pressure needs to be measured at the discharge pipe prior to a master valve or any other flow-obstructing device.

Measure and record Headworks flow rate at least weekly during weeks when irrigation has been scheduled.

Headworks flow needs to be measured using a flow meter that is installed and operates in compliance with respective water authority regulation.

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3.4.2 Emitter Specifications

Measure the pressure and flow rate for a selection of emitters over each valve area on establishment of a new irrigation system.

Measure the pressure and flow rate for a selection of emitters for selected valve units annually to strategically check that valves are operating at design specifications.

Record specifications for all emitter products used in the irrigation system. Specifications to be recorded include:

- Reference location (valve number)
- Brand / Type
- Model
- Nominal Flow rate (from manufacturers specifications or as stamped on emitter or tubing)
- Spacing between emitters
- Spacing between rows

Pressure variation between emitters within each valve unit should not exceed ± 10% of the midpoint. It is recommended that the mean pressure be close to the design specification of the irrigation system. Pressure compensated drip emitters are exempted from this requirement but must operate within manufacturer operation parameters.

Flow variation for emitters within each valve unit should not exceed ± 5% of the midpoint. It is recommended that the mean flow rate be close to the design specification of the irrigation system.

Measure flow rates and pressures for at least 9 locations within each valve unit. The recommended method for measuring flow rate and pressure is described in IAA, 2006.

Calculate the mean application rate for each valve unit in the irrigation system.

Measure the Distribution Uniformity (DU) for Spreading Emitters, at least every second year for various selected valve units throughout the irrigation system. A minimum of one valve needs to be selected to represent each category of sprinkler configuration operating in the irrigation system. A category of sprinkler configuration is defined as valve units that contain the same emitter type, row spacing, emitter spacing and operating pressure and flow.

Implement and maintain a standard testing procedure document to ensure that emitters are maintained, and operate within designed or identified system specifications for flow and operating pressure.

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3.4.3 Centre Pivot Specifications

Maintain a record of specifications for the centre pivot and its emitter package. Minimum specifications include:

- Pivot Brand & Model
- Nominal flow rate required to operate pivot
- Inline pressures for the centre and terminal end of pivot required to operate pivot
- Emitter Brand / Type
- Emitter Model
- Nozzle/jet sizes and colours (as stamped on each emitter)
- Regulator size / pressure
- Nominal flow rates for each emitter
- Distance of each emitter from centre of pivot
- Operating ground clearance height of emitters

Measure at least annually, the Application rate per pass and full rotation time at 100% operating speed.

Measure the maximum instantaneous application rate along the pivot boom.

Measure the Distribution Uniformity of the centre pivot annually.

The minimum option for measuring distribution uniformity is the lowest quarter weighted average method. The recommended testing procedure can be found in IAA, 2006.

$$DU = \frac{Lowest_Quarter_Weighted_Average}{System_Weighted_Average} \times 100$$

For shallow rooted annual crops achievement of > 85% is required using this calculation, and for deep rooted perennials > 75% is required.

The modified Heerman and Hein coefficient of uniformity formula is the international standard [ISO11545:2001(E)] for testing distribution uniformity of centre pivots. This formula may be used alternatively:

$$C_{uH} = 100\left[1 - \frac{\sum_{i=1}^{n}\left|V_i - \overline{V_w}\right|S_i}{\sum_{i=1}^{n}\left|V_i S_i\right|}\right]$$

Interpretation of C_{UH} results are provided below:

Result	C_{UH}
Excellent	95-100
Very Good	90-95
Good	85-90
Fair	80-85
Poor	<80

Greater than 90 is the target using this method.

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Standard procedural documents need to be implemented and maintained that describe the annual measurement procedure for calculating:

- Distribution uniformity,
- The instantaneous application rate,
- The application rate per pass,
- The inlet pressure and flow rate.

A maintenance log and schedule needs to be implemented and maintained outlining a program to inspect and monitor centre pivot infrastructure and operation. Regular inspections and maintenance need to cover:

- Pump Efficiency
- Tower and pipe work leakage,
- Line flushing,
- Emitter and regulators (Look for blockages, restrictions or damage.),
- Drop tubes (if fitted),

3.4.4 Specifications for Furrow Irrigation

Maintained irrigation furrows to be clean and well formed, for the duration of the irrigation season.

For each riser or water inlet, the following information is required:

- Flow rate from the water inlet or riser per shift or valve combination
- Length of each furrow
- Slope of each furrow
- Soil Type
- Type of furrows used (typically Broad based or 'V' shaped furrows)

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3.5 SCHEDULING

3.5.1 Specifications for Assigning Valve Runtimes

For each valve on the property, assign an appropriate runtime by using the following method.

Irrigation runtimes are calculated using:

- The Soil Water Deficit (SWD) below a given full point (or given reference point in the case of a deficit irrigation regime) expressed in millimetres (mm)
- Additional Leaching Requirement (LR) if necessary expressed in millimetres (mm).

  NB: See specifications on leaching requirements below.
- The mean valve Application Rate (AR) measured in mm/hr

$$\frac{\text{SWD (mm)} + \text{LR (mm}}{\text{AR (mm/hr)}} = \text{Valve Runtime (hours)}$$

A documented standard procedure needs to be used routinely for calculating valve runtimes.

3.5.2 Leaching Requirements

Where the leaching percentage exceeds application losses, the leaching percentage is to be used and replace application losses in calculating total irrigation requirements.

If applicable, a rationale for irrigation leaching requirements needs to be documented with guidelines for applying leaching irrigations.

Measure and record the EC of the irrigation water

3.5.3 Specifications for When to Irrigate – Scheduling Technology

Scheduling technology must be continually used to determine when irrigations should occur to meet Irrigation Requirement.

For whatever scheduling device or technique is used, there needs to be a demonstrated, quantitative and indicative link between the scheduling device or technique and the soil water content of the crop rootzone.

Scheduling devices must be installed such that information derived from the device can be demonstrated to be relevant to the crop for which the device is used to schedule irrigations.

Record all irrigation events with the date, duration and the valves opened.

Read the flow meter at least weekly during weeks where irrigation is occurring.

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3.6 IRRIGATION SYSTEM OPERATION

The following units of competency have been identified to assess the skills required to autonomously operate a pressurised irrigation system in a consistent and nationally recognised manner. Formal assessment of any of these units is not mandatory or obligatory for this code of practice. These units may be formally assessed to contribute towards obtaining certificate qualifications if desirable for those implementing this code of practice.

Key irrigation management staff need to be able to demonstrate the skills identified in the following nationally recognised units of competency:

Unit Code	Name of Competency
AHCIRG306A	Troubleshoot irrigation systems
AHCIRG303A	Measure irrigation delivery system performance
AHCIRG305A	Operate pressurised irrigation systems
AHCIRG308A	Monitor soils under irrigation
AHCIRG325A	Operate irrigation technology
AHCIRG313A	Implement and monitor environmentally sustainable work practices
AHCIRG301A	Implement a maintenance program for an irrigation system
AHCIRG408A	Schedule Irrigations
AHCIRG327A	Implement and adjust irrigation schedule

Reference: TGA, Agriculture, Horticulture and Conservation and Land Management Training Package, AHC10. http://training.gov.au/Training/Details/AHC10

Industry skill council: http://www.agrifoodskills.net.au

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- Simon Knowles (Irrigation Consultant - Systems)
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- Tony Wilson (Irrigation Consultant - Soils)

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5 REFERENCES

- IAA (Irrigation Association of Australia) 2006 *Draft Certified Irrigation Auditor – Ag Pressurised Irrigation Systems Resource Manual*, eds M. Jessen & G. Giddings, Irrigation Association of Australia, Hornsby Westfield, New South Wales.
- Australian National Training Authority, Agriculture, Horticulture and conservation and land management Training Package, AHC10 http://training.gov.au/
- Irrigated Crop Management Service, 2000, *Annual Irrigation Requirement for Horticultural Crops*, South Australian Government, Loxton.
- Doorenbos, J. & Pruitt, W.O., 1992, *Crop Water Requirements*, FAO Irrigation and Drainage Paper 24, Food and Agriculture Organization of the United Nations, Rome
- Allen R, Pereira L, Raes D, Smith M, 1998, Crop evapotranspiration, Guidelines for computing *crop water requirements*, FAO, Irrigation and Drainage Paper 56, Food and Agriculture Organization of the United Nations, Rome

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