

## 2 Conducting irrigation evaluations

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## **2.1 Introduction**

This section outlines procedures for conducting efficient and reliable irrigation evaluations, and addresses skills and qualifications for irrigation system evaluators.

An irrigation evaluation may be carried out for any of several reasons. In each case, objective information is sought that will allow analysis of performance. This may be used to identify problems, enhance performance, or to demonstrate compliance with regulatory or market requirements.

### **2.1.1 Evaluations and audits**

The words 'evaluation' and 'audit' are often used, but without clear or agreed definitions.

Commonly, an '*audit*' is considered to be an independently conducted comparison of measured performance against some previously specified set of parameters for possible consideration by some third party.

A definition equivalent to Environmental Management System Audit as defined in ISO 14 050 is, "The systematic and documented verification process of objectively obtaining and evaluating audit evidence to determine whether an [irrigation] system conforms to the [irrigation] system audit criteria, and communicating the results of this process to the client."

The implicit intent of an '*evaluation*' is to provide information for management decision making. There is no assumption that findings will be made available to or used by a third party, and as such, an evaluation may be considered a less official exercise.

To the extent that these 'evaluation' procedures objectively measure irrigation systems and management against the Key Performance Indicators established in the (draft) Code of Practice for Irrigation Design, and may be submitted for consideration by some third party, they can be considered outlines for an audit.

### **2.1.2 On-site evaluations**

An on-site evaluation of an irrigation system utilises selected measurements to describe performance of the system and its management, and to identify causes of poor performance and how these may be addressed. Actual measurements are used wherever possible. This ensures that the generated results describe what is happening, not what is supposed to happen.

This section describes the procedures to follow when planning, conducting and reporting on evaluations. Procedures are based on key site measurements and mathematical analyses to generate descriptions of system performance.

In determining some parameters, in particular distribution uniformity, stratified or targeted sampling approaches are used in preference to strict randomised sampling. This allows analysis not only of system performance, but also of the factors contributing to non-performance. In practice, this has been shown to give similar results to randomised sampling, but in any case, limitations and confidence levels should be recognised.

### **2.1.3 Why these schedules were developed**

These schedules were developed to provide guidelines for people undertaking evaluations of irrigation systems as a 'snapshot exercise' under prevailing field conditions. They are intended to promote efficient work practices and informative reporting that facilitates easy comparison of systems.

The schedules have been developed with reference to international practices and standards. Those standards each prescribe different procedures and sampling methods that are not necessarily equivalent. This schedule attempts to encompass all minimum requirements but ensures that procedures are practical for implementation in a cost effective on-site evaluation. Evaluators undertaking assessments for other purposes should be familiar with the relevant international Code or Standard and select that which is appropriate to their intent.

The procedures outlined will provide a satisfactory level of accuracy, identify causes of non-performance and the contribution each makes to the overall performance of the system. Adoption of these guidelines will provide irrigators, regulators and other stakeholders with confidence that findings are valid, repeatable and comparable.

### **2.1.4 Evaluation process**

Irrigation evaluation follows a set of procedures that objectively check an irrigation system and management practices, and allows a system to be benchmarked against established standards. Irrigation maintenance and management plans can then be drawn up to improve the system and save money.

The steps in conducting an evaluation are:

- Decision to conduct an evaluation
- Decision on aspects to be investigated
- Appointment of an Evaluator
- Provision of base information
- Document analysis
- On-farm measurements
- System analysis
- Reporting
- Management decisions
- System and operating changes

### **2.1.5 Planning an evaluation**

The evaluation process will be greatly assisted if appropriate preparations are made prior to visiting the field. These preparations include collection of relevant data about the system and its management, ensuring all required equipment is available, and that the system will be ready for testing when the evaluator arrives at the field.

By following a plan such as that laid out below, evaluations should be carried out as efficiently as possible with a minimum of delays.

#### **2.1.5.1 Typical irrigation evaluation**

A typical Irrigation Evaluation consists of:

- A visual inspection plus a uniformity test on the system to determine the water application efficiency over the site
- A seasonal irrigation efficiency estimation
- Assessment of pump, pipe and filter performance including energy use

Each of these components involves evaluating the system or management practices in their current state. Analysis and reporting of results compares these results to some specified standard, and makes recommendations for improvement.

The evaluation is only the start of the process towards irrigation "best practice". It is important that managers use the generated information to develop irrigation management and maintenance programmes that continuously improve the irrigation system and practice.

## 2.1.6 Information Needs

Assuming this evaluation will be part of a full system analysis, much of the required information can be obtained from a general irrigation questionnaire completed by the irrigator.

Information that should be obtained prior to conducting an evaluation may include:

### 2.1.6.1 General property information

- Owner/Contact name and details
- Property location and address
- Property plan, aerial photos, contour map
- Enterprises

### 2.1.6.2 Climate information

- Long term rainfall data
- Long term ET data
- Current or Last Season rainfall
- Current or Last Season ET

### 2.1.6.3 Soils information

- District/property soil maps
- Soil texture
- Soil water holding capacity data
- Soil limitations

### 2.1.6.4 Farm water supply information

- Water source and quality
- Resource consent limits and conditions
- Overall system layout
- Total flows
- Filtration type

### 2.1.6.5 Irrigation system information

- Permanent system layout
- Movable system positions
- Age and condition
- Connection to farm water supply
- Irrigation machine type
- Motive power and operating speed
- Controller location
- Operating instructions
- Design flow
- Operating pressure
- Sprinkler package
- Whether other water takes influence the system

### 2.1.6.6 Irrigation management information

- Irrigation need monitoring
- Irrigation interval (rotation length)
- Irrigation duration
- Target application depth

## **2.1.7 Visit planning**

The irrigation system owner or manager is needed to confirm that the machine and field visited are the ones intended for evaluation, to identify any hazards or other on-site issues and to clarify or fill in information missing from pre-visit questionnaire(s).

There are benefits in the usual system operator being involved in the evaluation process, to operate the equipment (as usual), and to understand the evaluation process.

Agreements to be obtained prior to the visit include:

### **2.1.7.1 Evaluation date(s)**

- Setting a date, time and meeting place
- Ensuring any required staff will be present and available

### **2.1.7.2 Service and fees**

- Confirming evaluation(s) to be conducted
- Establishing how results will be reported
- Establishing fee for service

### **2.1.7.3 System availability**

- Ensuring the system will be available for evaluation
- Ensuring any system maintenance has been completed
- Ensuring access to irrigation system, equipment and suitable field

## **2.1.8 Equipment needs**

The equipment required to determine distribution uniformity is very similar, regardless of the system being assessed.

Specifications for tools or equipment that may be required are noted in the Appendix 5.3.

## ***2.2 Conducting an evaluation***

### **2.2.1.1 Meet the irrigator**

Ideally the owner/manager should be present during the evaluation, to ensure the equipment is operated correctly, consistent with usual practice. The owner/manager should make adjustments or alterations to the machine, and provide assistance if required. The owner/manager should take responsibility for any jobs that involve tampering with the irrigation system, such as fitting pressure gauges or flow meters.

### **2.2.1.2 Confirm questionnaire responses**

In consultation with owner/manager:

- Review pre-visit questionnaire responses
- Fill in missing details as required
- Review or draft property and system plans

### **2.2.1.3 Confirm evaluation details**

In consultation with owner/manager:

- Confirm purpose of evaluation
- Confirm normal and test operating conditions
- Locate key features and components in the field
- Select test locations and test to be conducted

### **2.2.1.4 Conduct pre-test inspection**

- Observe crop growth patterns and record abnormalities
- Assess soil condition, root depth and estimate water holding capacity
- Assess wheel track condition on moving systems
- Familiarise with system layout and components
- Measure and record topography if variable, focusing on key system points

### **2.2.1.5 Set-up test equipment**

- Install temporary flow meter if used
- Fit pressure test points as required
- Determine location for, and set out, evaporation collectors
- Set out speed test markers
- Establish weather monitoring location and equipment

### **2.2.1.6 Pre-start checks**

- Take water meter readings
- Take power meter readings
- Check headworks components and layout as prescribed
- Assess filter condition and record contaminant type and amount
- Check sprinkler package is correctly installed
- Assess sprinklers or emitters for blockages or wear

**2.2.1.7 Operating checks**

The owner/manager should operate the system, including automatic controllers and motor starting.

- With system operating check flow rates measured by water meter
- Check for correct equipment functioning
- Measure un-irrigated machine or boom lengths
- Record system pressures at prescribed locations
- Assess surface ponding
- Assess for crop interference
- Assess leakages and off-target applications
- Conduct machine speed tests as required

**2.2.1.8 Sprinkler/outlet checks**

- Check sprinkler or other outlet operation and record abnormalities
- Measure outlet flows as prescribed
- Determine wetting radius of sprinkler package and/or end-guns etc

**2.2.1.9 Uniformity testing**

- Record key weather conditions throughout test period
- Lay-out uniformity collectors according to test arrangement
- Collect applied water in collectors
- Charge evaporation collectors as soon as collector volume measurement begins and record volume and time
- Immediately collectors stop receiving water, begin collection measurements, recording the time for each reading
- At completion, record evaporation collector volumes and the time

**2.2.1.10 Specific tests**

- Conduct any tests specific to the irrigation system type or evaluation

Examples may include:

- Alternative pressure/flow tests for micro-irrigation systems
- Specific span tests on pivot or linear systems
- Alternative gun-angle tests on travellers

**2.2.1.11 Post-test checks**

- Take flow meter readings
- Take power meter readings
- Observe system drainage patterns

**2.2.1.12 Pre-leaving checks**

- Ensure all readings have been made and recorded
- Ensure equipment is recovered and the system returned to pre-test condition
- Ensure system is closed down as required ( ideally an owner/manager responsibility)

## **2.3 Data analysis**

Much of the data analysis requires repetitive and relatively complex calculation. For this reason the use of prepared software is recommended.

### **2.3.1.1 Software**

Supporting software packages are available from a variety of sources. These prompt evaluators to make and record particular measurements or assessments, assist with the calculations, and generate reports and recommendations based on inputted values.

The various software packages may not use the same units as those prescribed in these guidelines, and may be based on different procedures of sampling methods. If these factors are noted, most can be adapted to the requirements outlined in this schedule.

In New Zealand, the IRRIG8 Irrigation Evaluation program was developed to support evaluations undertaken in accordance with this Code.

### **2.3.1.2 Determine system performance**

- Process collected data as prescribed to calculate the key performance indicators for the system as tested
- Complete other system analyses as required
- Compare results to benchmark values
- Identify key causes on non-performance
- Assess the contribution of factors to overall performance

### **2.3.1.3 Determine seasonal efficiency**

- Process questionnaire responses to assess the adequacy and efficiency of irrigations for the preceding season
- Estimate the cost savings that may be achieved from system and/or management improvements
- Estimate yield losses and values resulting from inadequate irrigation

## **2.4 Report preparation**

The purpose of reports is to provide the system owner/manager with information to help improve performance.

- Present key performance indicators as prescribed
- Present conclusions and comparisons with established performance benchmarks
- Present recommendations
- Present performance data graphically where appropriate
- Include base data and calculations in appendices



## 2.5 Technical Schedules

The technical schedules provide guidelines for the assessment of both individual irrigation system performance and overall seasonal irrigation efficiency. These are intended to allow irrigators and other stakeholders to determine and benchmark performance, and to identify problem areas and the contribution these make to overall system in-efficiency.

### 2.5.1.1 Key performance indicators

Key performance indicators are presented in the Code of Practice for Irrigation Design (2004). They include:

#### Water Use Efficiency

- Crop irrigation demand
- Management allowable deficit
- Return interval
- Application uniformity
- Application rate
- Application depth
- Adequacy of irrigation
- Application efficiency
- Distribution efficiency
- Headwork efficiency
- Supply reliability
- System capacity

#### Other Efficiency Indicators

- Energy
- Labour
- Capital
  - Capital cost
  - Operating cost
- Effectiveness
- Productivity
- Returns
- Environment
  - Average system efficiency
- Drainage
- Runoff

Indicators selected for this Code relate to estimates of efficiency across an irrigated growing season or year. They provide information relating to economic or environmental implications of in-efficient irrigation systems or management.

### 2.5.2 Seasonal Irrigation Efficiency

Schedule 3 Seasonal Irrigation Efficiency outlines procedures for estimating measures of seasonal irrigation efficiency (SIE).

The indicators estimate the effectiveness and efficiency of irrigation scheduling on a seasonal basis. They are calculated using soil moisture budgets; tracing inputs and outputs from a conceptual reservoir of some set size.

The schedule identifies varying levels of analysis ranging from very simplistic to highly detailed. The simplest is a quick estimate of Seasonal Irrigation Efficiency based on comparing total seasonal irrigation and rainfall with total estimated seasonal evapo-transpiration.

A more detailed process is recommended where information is available. Therefore the schedule outlines a process for more detailed analysis, requiring knowledge of soil water properties, seasonal weather, potential crop water use, and irrigation system performance and management.

### 2.5.3 System performance

Schedule 4 outlines procedures to determine irrigation system performance, on-site, under prevailing crop and weather conditions. The primary focus is to determine distribution uniformity and application rates, and identify the proportional contribution key factors make to non-uniformity.

Additional procedures are presented in some cases. The option(s) selected by an evaluator will depend upon the purpose of the evaluation. This should always be discussed with the system owner and person requesting the evaluation be undertaken.

### 2.5.3.1 Application of schedules

These schedules can be used as standalone guidelines for determining irrigation system performance in the field. They are intended to provide information for inclusion in assessments of irrigation efficiency, and can be combined with other assessments such as energy efficiency and pump performance.

The guidelines describe procedures that ensure:

- evaluations are representative of normal operating conditions
- key in-field system performance observations are recorded
- sampling is undertaken in a way that permits extrapolation and comparison
- key performance indicators are assessed and calculated accurately and correctly
- results are reported in standard units and formats so that comparisons may be made

### 2.5.4 Other performance indicators

Schedule 5.1 Calculations presents guidelines for the assessment of other key performance indicators of irrigation systems and their management. These include hydraulic efficiency, pumping efficiency, and headworks efficiency.

### 2.5.5 List of Schedules

- 3 Seasonal Irrigation Efficiency
- 4.1 Field evaluation of Drip-Micro irrigation systems
- 4.2 Field evaluation of solid set irrigation systems
- 4.3 Field evaluation of sprayline irrigation systems
- 4.3 Field evaluation of sprayline irrigation systems
- 4.5 Field evaluation of traveller irrigation machines
- 4.6 Field evaluation of linear move irrigation machines
- 4.7 Field evaluation of centre pivot irrigation machines