Milestone 5 Report

**Development of a Water Use Efficiency Reporting Structure**

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April 2003

Thanks to Matt Book and Renee Fielke
Central Irrigation Trust
Barmera
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DEVELOPMENT OF A WATER USE EFFICIENCY REPORTING STRUCTURE

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1. INTRODUCTION

The Murray-Darling Basin Commission (MDBC) has supported this project in order to develop a set of tools to facilitate practical and reliable Water Use Efficiency (WUE) monitoring, assessment and reporting at a range of scales. The scope of the project is to focus upon WUE where irrigation is effected by pressurised delivery of water to horticultural land uses. In this arena, differences in monitoring, assessment and reporting needs have been detected and can be grouped as factors of the following drivers:

- Water Management Agencies need to report on salinity and water management targets
- Irrigators are under increasing pressure to report their irrigation management to Agencies and Processors
- Water Use Efficiency is seen as a prime indicator of sustainable water management, with targets incorporated into recent policy and regulation
- Irrigators do not have a convenient method of reporting WUE

1.1. Tools, Data Capture and Data Analysis

In response to these needs, the project partners have undertaken to develop the following prototype tools:

- Irrigation Inventory Tool (IIT):
  A Geographic Information Systems (GIS) based tool for facilitating consistent, standardised capture of several of the key data sets necessary for WUE calculation (Meldrum, Rhodes & Argus, 2002)
  Output: District Irrigation Database

- Water Use Efficiency Module (WUEM):
  A GIS-based module, which increases the functionality of a commonly used proprietary software package to enable WUE assessment and reporting to take place using standardised inputs
  Output: Outlet/Licence, Property and District Level WUE Report
• Farm Level Water Management Module (FLWMM): A Visual Basic application which will use Microsoft Access tables and customised algorithms for on-farm monitoring and assessment of water use


This report focuses on the development of a WUE reporting structure to be implemented through the ultimate development and delivery of the WUE and FLWM modules.

The prototype Irrigation Inventory Tool (IIT) and its resulting District Irrigation Database depicted in figure one establishes the baseline data necessary for WUE calculation. The IIT standardises the way that these baseline data sets are captured. As a bare minimum, the IIT enables spatial capture of crop composition to type level (e.g. Citrus, Vines, Stonefruit etc.) with qualification made as to the age of the plantings. In the trial phase of this project, this information is captured from a base of highly accurate digital Orthophotography and irrigator interview. Using this approach, the GIS is able to calculate highly accurate areas for crop plantings, a key factor in ensuring WUE calculations.
performed using the data are accurate enough to support informed decision making.

The prototype IIT has been designed with flexibility and adaptation in mind. It has the capacity to increase the detail of crop mapping to rootstock level while also facilitating the capture of supporting data sets such as irrigation management techniques, drainage capabilities and training participation. In offering this flexibility, the IIT enables continual improvement in the WUE knowledge base to be applied broadly, while providing the data sets enabling rigorous analysis of the results. This can be achieved through investigation of the relationships between the results themselves and management techniques and impediments.

At whichever level of detail is selected for formulation of the District Irrigation Database, it is imperative that water use is tied very closely to each homogeneous crop unit. The IIT provides a means of doing this in a manner which matches the scale of inventory conducted. Water can be linked to crops at any level from the individual irrigation system valve unit, through metered areas, licensed properties, up to bulk water delivery at the district scale.

![Diagram of Water Use Efficiency Tool](image)

**Figure 2: Water Use Efficiency Tool - Basic Principles**
Figure two outlines the basic operation of the proposed WUE reporting structure. The calculation of Natural Resource Management (NRM) focussed WUE indicators involves linking crop factor tables and evaporation data to crop data to generate a theoretical crop water use or crop water requirement. This becomes the numerator in an Annual Water Balance Evaluation equation, the denominator being the crop water application, derived from a sum of rainfall and consumption. A detailed description of the proposed calculation process is outlined later in this report along with brief discussion of other indicators that the IIT/WUEM combination will have the capacity to deliver.

1.2. Tools and Users

Section two of this report outlines the scoping process that was undertaken to identify potential users of the tools and the scale of inquiry they are likely to conduct in employing them. A summary of the concepts derived during this process is depicted in figure three and discussed in more detail later.

Tools and Users

![Tools and Users Diagram](image)

Information Users and Pathways

- MDB via Irrigation Management Information and Reporting System (IMIRS)
- State Governments/Catchment Boards via Water Allocation Plan performance monitoring
- Irrigation Authorities/Community Groups via Land and Water Mgmt Plan monitoring
- Processor Groups via purpose built tools (e.g. Crop Forecasting, QA Programmes, EMS Accreditation)

Figure 3: Water Use Efficiency Tools - Tools and Users
Figure three defines the boundaries between organisational query of WUE performance and query conducted by individuals in the form of self-assessment. While the FLWMM proposes a model for highly detailed investigation geared towards improvement based on direct action, the IIT/WUEM combination provides a mechanism for data capture and analysis that facilitates:

- Community ownership of the issue
- Targeted resource allocation and education
- Multi-scale reporting
- Regulation

The proposed reporting structure, while making the definition between information relevant at these different scales, allows for transfer of information between all levels with individual irrigators able to access district held data and, in turn, feed value added information generated on-farm up the tree to assist with better decision making. Figure three also alludes to the possibility of interfacing other secondary tools through establishment of partnerships between communities, natural resource managers and industry groups.
2. WUE REPORTING STRUCTURE

In proposing the establishment of the WUE reporting structure outlined in this report, the key goals for this project are:

- To provide standardised yet flexible methodologies for calculation of a broad range of WUE indicators
- Ensure the indicators considered cater for the needs of the major users of the information
- Ensure the indicators calculated are appropriate for use at the scale of the data sources used to calculate them
- Generate a series of outputs that facilitate management of the water resource by reporting WUE indicators transparently, consistently and concisely

These goals are guided by the principle that the data capture tools developed in this project form, not only the basis for WUE calculation for NRM purposes, but generate a significant community resource which may be used for collective approaches to tackling a range of irrigation related issues. As such, the IIT and FLWMM are seen as primary tools, crucial in establishing the data resource, and the WUEM is seen as a secondary tool that will interface with this data resource in a way that will engage the entire irrigation community.

2.1. SCOPING STUDY

In order to develop a picture of WUE activities currently being undertaken in the horticultural regions of the Basin, a series of meetings has been conducted from Griffith to Adelaide with consideration also given to activities in and around Toowoomba in QLD. The following summarises the findings of those meetings and defines the scope under which such a reporting structure should seek to add value. Several of the key points arising in the interview series are listed while table one groups the responses of participants into a matrix that focuses on three key themes:
DEVELOPMENT OF A WATER USE EFFICIENCY REPORTING STRUCTURE

IIT TRIAL PHASE 2

- Data Capture and Storage
- Monitoring, Assessment and Resource Allocation
- Indicators

Agriculture NSW, Griffith (NSW)
Iva Quarisa & Michael Grabham

- WUE Benchmarking project (funded through the Murrumbidgee Horticultural Council) involved flying 1:30,000 aerial photos for horticulture - plan to re-fly every 5 years. Rice is mapped from 1:50,000 photos.
- WUE Benchmarking project involved 25 irrigators recording irrigation events on a card system on a voluntary basis. Some used the cards others did not record all the necessary information. Results were stored in a spreadsheet.
- Results of WUE Benchmarking project used for LWMP reporting and to feedback to the irrigator.
- There are no reporting requirements for horticulture at present, however most properties in gazetted horticulture areas are allocated 12 ML/ha.
- Rice is restricted to 6 ML/ha for all land suitable for rice production, however the irrigator is only allowed to grow 1/3 of the rice suitable land to rice (therefore the 6 ML/ha allocated to the remaining 2/3 can be applied to the area grown to rice).
- NSW Ag employ Farm Planning Officers to assist irrigators attending Farmwise courses and develop irrigated property plans. The target is to assist 850 irrigator's complete plans.
- NSW Ag interested in indicators such as ML/ha, $/ha, T/ML and $/ML for the project area.

Murrumbidgee Irrigation, Griffith (NSW)
Sigrid Tijs & Leander Wiseman

- Murrumbidgee Horticultural Council conducts an annual paper survey for crops of 50 -100 irrigators. MI obtains this data and stores it in an Access database.
WUE indicators include ML/ha, tonnes/ML, $/ML (personal use only), and Annual Water Balance (AWB) calculations performed using locally collected $E_T$ and crop coefficients (from CSIRO Land and Water).

Workshops are held for the growers on how to calculate $$/ML - arbitrary values are used for $ for the different crop types and qualities. Difficult to obtain accurate prices from irrigators, so district average values for crop types are obtained from industry marketing boards (eg Wine Marketing Board).

MI has spatial data for rice, horticulture, channels, outlets, etc and produce maps using ESRI ArcMap software.

CSIRO Land and Water, Griffith (NSW)
Dr Shahbaz Khan & Dr Evan Christen

Concerns raised over how the WUE indicator values would be interpreted and used for policy decisions. Emphasised the need to highlight the accuracy of the WUE calculation.

Recharge from rainfall is entirely dependent on the management of the crops, eg. the presence of winter crops between rows.

Found that deep drainage caused by excessive irrigation is highest in Spring, during the first few irrigations, due to the full soil profile after winter rains.

Some suggestions on using testwell data to estimate water use efficiency and felt contribution from ground water should be included in the daily water balance calculation.

CSIRO provide accurate local crop coefficients and $E_T$ for daily water balance calculations.

Department of Land and Water Conservation (DLWC), Leeton (NSW)
Allan Brink

Rice is the only crop with specific reporting requirements under LWMP. There are no reporting requirements for horticulture.
It is a condition of licence that rice growers complete and return a grower survey, however it is not a regulatory requirement - if it is not returned the grower receives no licence the following year (100% return rate).

Water consumption records are vague due to additional water supply from up to 2 or 3 bores, and difficulty in mapping water distribution within the property.

LWMPs specify a maximum of 16ML/ha to be applied to rice (this can change according to seasonal change). 12ML to grow the crop + 2ML to wet the paddock + 2ML of drainage (surface runoff). If 16ML/ha is exceeded the land is then classed as unsuitable for rice.

Department of Land and Water Conservation (DLWC), Deniliquin (NSW)

Tod Spencer

New Act coming soon (Water Management Act). The Act will include efficiency rates for different crops (ML/ha).

Efficiency in tonnes of rice/ML of water delivered is calculated at a regional scale.

Assessment of the irrigation district efficiency rather than individual property efficiencies.

Rice is mapped from SPOT satellite images (20 metre pixels).

Murray Irrigation manages LWMPs and DLWC audit the LWMP funding.

Murray Irrigation Ltd, Deniliquin (NSW)

David Watts

The SWAGMAN Series of models was developed jointly by CSIRO and Murray Irrigation Ltd. This is similar to the IIT and FLWMM (crop mapping from orthophoto and grower survey).

LWMPs have targets and initiatives set out, eg. 12mm of rain must be retained on-farm, total farm plan guidelines require water to be quality tested before being released into stormwater.

Murray Irrigation undertakes on-farm WUE calculation.
Primary Industries (formally NRE), Tatura (VIC)

David Lawler, Andy McAllister, Chris Nicholson & Greg Richards

- Seasonal variation (ie. drought) can cause large variations in irrigation
- Tatura region has more annual crops than perennials, therefore the variability on a property within each year is difficult to account for.
- Satellite imagery was used to map broad-acre crops.
- There are no set requirements to report on WUE in Victoria, but there are limits to the quantity of water an irrigator can apply to a property (usually about 10 ML/ha).
- Whole Farm Planning encourages irrigators to use water more efficiently through providing incentives for assistance and information. Assistance includes re-use systems, laser grading, channel improvements and irrigation system design.
- Canneries conduct surveys of horticultural growers (only those supplying fruit to the cannery) for crop forecasting and production planning purposes (called a Fruit Census).
- Primary Industries conducts an Irrigated Culture Census for Goulburn-Murray Water (GMW) every 4 years (1997 & 2001 completed). This involves collecting crop information on a property basis down to the variety level.
- Whole Farm Planning is the emphasis for Primary Industries, looking at biodiversity, drainage issues and WUE.

Primary Industries (formally NRE), Irymple (VIC)

Dr Mark Kristic, Maxine Schake, Yasmin Chalmers, Jenny Treeby, Deanne Burrows & Louise?

- It was suggested that it would be beneficial for the water ordering system to have images of property, outlet and value boundaries on screen so the irrigator to select which patches they wanted to order water for. An incentive scheme exists in Victoria where irrigators who receive assistance through the scheme must record their irrigation information on data sheets for 2 years. This is to
prove that they are using the resources they received efficiently. This information includes similar information to that collected through the FLWMM.

- Primary Industries in Tatura are studying the potential use of effective canopy area to adjust the crop coefficients instead of age and cope with different canopy management. Suggested investigation of effective canopy area in comparison to the age adjustment factor currently used in our WUE methods.
- Primary Industries was interested in looking at developing a common set of farm level irrigation record sheets for horticulture.

**Western Murray Irrigation, Dareton (NSW)**

*Anthony Couroupis*

- Western Murray Irrigation produce an Annual Licence Report (for their bulk licence) which reports on WUE using a similar method to that in the IIT.
- Suggested including an option in the IIT WUE module to substitute \( E_{T0} \) data into the WUE calculation rather than using the LTAA data from the WAP.
2.2. WUE Module PROPOSAL

Figure four depicts the range of options available when calculating an Annual Water Balance type WUE indicators for NRM purposes. The range WUE related management techniques identified in the consultation process outlined in the previous section means that the proposed WUE Module needs to be able to calculate WUE at:

- Different scales
- Different temporal resolutions
- Using a variety of methodologies

Figure 4: WUE Calculation for NRM - The options
The proposed WUE module will be developed as a customised menu (Figure 5) within ESRI ArcMap software using the Visual Basic (VB) programming language and ArcObjects. This menu will activate a series of forms allowing the user to set the parameters for the WUE calculation.

![WUE Module Customised Menu](image)

**Figure 5**  WUE Module Customised Menu

The first form to appear in the WUE calculation process will ask the user to select the State, District and Irrigation Season for which WUE will be calculated. These parameters will be selected from a series of pick lists, as shown in Figure 6.

![Settings Form](image)

**Figure 6**  Settings Form

The user will then be prompted to select the District Irrigation Database (Figure 7), as created by the IIT.
The name of this database will be crosschecked with the District and Season selected on the previous form. If the variables do not match, the user will be asked to re-select these parameters before continuing. If the district and season match the selected database, a message will confirm the database to be used in the calculation (Figure 8).

The WUE reporting level will need to be selected. There will be options to calculate WUE at outlet or licence, property, district or bulk licence levels (see Figure 9); the smallest unit being the outlet or licence, up to the largest level at district scale. The WUE of a valve unit is not calculated within the WUE module. The Valve Unit Level Report option is available for collating and reporting valve unit indicators calculated through the Farm Level Water Management Module (FLWMM).

In most cases, the consumption information is recorded at outlet or licence level. For a calculation at this scale, the crop water use information for each
homogeneous patch is summed to the outlet level. WUE is then calculated for this outlet or licence. At the property level, there may be more than one outlet within a property. In this case, the crop water use and the outlet consumption are summed for each homogeneous patch prior to WUE calculation. The same procedure is used for the District scale calculation, with the crop water use summed for each homogeneous patch, and the consumption for every outlet in the district being tallied. The WUE is then calculated using these two summed figures, giving a district level WUE result.

Figure 9 Report Level

A number of different WUE indicators will be able to be calculated within the WUE module. Figure 10 displays the proposed form for selecting the various WUE indicators.
Figure 10  WUE Indicators

Under the *Water Allocation Plan for the River Murray Prescribed Watercourse* (WAP), the method for calculating WUE is defined as:

\[
\text{Crop factors} \times \text{evaporation} \quad \frac{\text{Water applied} + \text{rainfall}}{X 100}
\]

This calculation uses long-term effective rainfall and Epan evaporation information, and crop factors with age adjustments. This option is available from the pick lists on the Calculation Method form, as shown in Figure 10. \( \text{ET}_0 \) evaporation data and crop coefficients can also be used to calculate WUE. Both these methods of calculation can be done using either long-term rainfall and evaporation information or actual measured data.

Figure 11  Select Rain Station
There is an option on this form asking the user whether or not to include vegetable crops. The crop factors available in the WAP for vegetables assume all vegetable crops are planted in a particular month. This assumption is not always correct and as a result, a WUE calculation that excludes vegetables may be the most accurate. If a user has access to more accurate crop factors for vegetables they may wish to include this crop in the calculation.

Yield based indicators will also be available within the WUE module. This option will allow WUE to be calculated based on tonnes of crop yield per mega litre of water used, or dollars obtained per mega litre.

The next form to appear will ask the user to select the rainfall station nearest to the chosen district to be used for the calculation (Figure 11).

WUE will be able to be calculated either annually or quarterly (Figure 12). The ability to calculate WUE quarterly may be beneficial when attempting to monitor the progress of one’s WUE throughout the year. This will assist irrigators in identifying problems and improving irrigation practises in order to achieve higher WUE.

![Report Period](image)

**Figure 12**  
Report Period

The rainfall, evaporation, crop factors/coefficients, age adjustment factors and consumption tables can be selected using the form in Figure 13. These tables
can be imported from anywhere on the user's system and will be subsequently stored in either the District Irrigation Database or the WUE_Tool.mdb.

It is proposed to set up a database (called WUE_Tool.mdb) to store tables used in the WUE calculation, but not directly related to the individual District Irrigation Databases. For example, the rainfall, evaporation, crop factor and age adjustment tables may be used for the WUE calculation in more than one district. It is these tables that will be stored in the WUE_Tool.mdb. Tables relating only to one District Irrigation Database, such as consumption information, will be stored within the district database.

![Select Tables](image)

*NOTE: The names of the tables in this form are working names only. More meaningful names are to be generated.*

**Figure 13** Table Selection form

Once all the parameters and tables required for the WUE calculation have been selected, the WUE module will compile the results. A message will appear asking the user if they would like to see a table of results (Figure 14).

![Display Table Query](image)

**Figure 14** Display Table Query
If 'Yes' is chosen, a table similar to that in Figure 15 will be displayed on the screen. An option button will appear allowing the user to print the table to a chosen printer.

![Figure 15: Results Table](image)

The user will also have the option of generating a map of the chosen district. A message box will prompt the user for a response to the question 'Do you want to view a map of the results?' (Figure 16).

![Figure 16: Display Map Query](image)

If the users choses 'Yes', a map, such as the one displayed in Figure 17, will be displayed on the screen.
3. IIT TRIAL PHASE 2

3.1. Cobdogla Irrigation district

In order to establish a baseline set of data for use in validation of the results calculated using the WUE module, it has been required that generation of the proposed indicators should take place using the relatively manual process of Arc Macro Language (AML). This section outlines the analysis conducted on data captured using the IIT using AML methodologies and will be used to ensure that results calculated using the WUE module are correct.

3.1.1. Background

The total irrigated area mapped along the River Murray in South Australia has increased over the last 15 years. The Murray-Darling Basin Commission (MDBC) imposed a cap on water diversions from the River Murray in 1994. This cap may have led to the expansion of irrigation areas along the River, which has most likely been driven by:

- uptake of unused allocations,
- enhanced water supply infrastructure,
- increased efficiency of water use,
- water traded from interstate.

In addition to this, there has been replanting of irrigated crops and upgrading of their associated infrastructure in the past decade. Rehabilitation of irrigation supply systems in Government irrigation districts commenced in 1992 in the Cobdogla and Moorook irrigation districts, followed by Cadell and Mypolonga in 1994. This involved the conversion of supply infrastructure from open channels and gates to pressurised pipes and metered outlets, allowing more reliable, accurate and efficient delivery of irrigation water to irrigators.

A Geographic Information System (GIS) was set up to monitor the land use change within these districts via a series of indicators. These included grower surveys to collect crop type and irrigation system information, as well as
monitoring groundwater levels and grower participation in training courses. The indicators recorded substantial change in all four irrigation districts relating primarily to types of crops grown and methods of irrigation application. This period of change also coincided with an increase in the demand for grapes for wine production. Rehabilitation provided a catalyst for change to more efficient production.

The methodology used to conduct the 2001/02 survey was vastly different to that used in the four previous surveys (1993/94, 1995/96, 1996/97 and 1998/99). The earlier surveys involved mapping cropped areas from aerial photography at 1:10 000 scale, using drive-by surveys and local knowledge to identify the crop type and year planted. The irrigation system information was acquired from SA Water and correlated to the crop information. The crop and irrigation surveys were integrated, allowing the drive-by surveys to assist in identifying the irrigation systems from the road.

The 2001/02 base data was mapped at a scale of 1:2 000 using digital orthophotography. On-ground surveyors from Central Irrigation Trust (CIT) collected the crop and irrigation system information through grower interviews, using a standardised survey form. This data was subsequently entered into a District Irrigation Database using the IIT.

These five data sets have formed the basis of, and allowed, a number of change detection processes to be undertaken. The water use efficiency (WUE) of several variables within the district will also be examined.

### 3.1.2. Crop Types

Cobdogla Irrigation District has experienced vigorous growth and significant change since rehabilitation of the irrigation supply systems commenced. Time-series analyses of the five crop surveys have detected an increase in total area planted for Cobdogla by 409 hectares to 3,095 hectares in 2001/02.
The expansion of the wine industry in South Australia has led to land use changes and crop expansion in Riverland districts. This is evident in the Cobdogla Irrigation District where the expansion of vine plantings has led to the crop continuing to dominate horticulture in the area. Figure 18 shows the continued growth of vines in the district with decreased plantings of citrus, stonefruit and vegetables. In the 2001/02 irrigation season, vines constituted over 85% of the planted area in Cobdogla, up from 70% in 1993/94. Vegetable crops experienced the most significant decline with a 10% reduction in planted area since 1993/94.

![Figure 18 Major Crop Types for Cobdogla Irrigation District 1993/94 - 2001/02](image)

The age profile for the major crop types in Cobdogla reflects the recent expansion of vine plantings in the district (Table 1). Surveys conducted in 1993/94, 1998/99 and 2001/02 have been used for this analysis. Since 1994, 1 916 hectares of vines have been planted, representing 72% of the area under vines in 2001/02. The addition of over 1 594 hectares of young vines between 1994 and 1998 indicates a period of rapid growth in the region, with the 2001/02 survey data recording a reduced rate of expansion. In comparison to vines, the net increase in citrus and stonefruit crops is relatively insignificant, with only 27 hectares and 39 hectares of new plantings respectively between 1994 and 2001.
Table 1 Major Crop Type by Age for Cobdogla 1993/94 - 2001/02

<table>
<thead>
<tr>
<th>Ages</th>
<th>Citrus</th>
<th>Vines</th>
<th>Stonefruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ages</td>
<td>93/94</td>
<td>98/99</td>
<td>01/02</td>
</tr>
<tr>
<td>0 - 1 years</td>
<td>7</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>2 - 4 years</td>
<td>96</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>5 years and over</td>
<td>65</td>
<td>60</td>
<td>65</td>
</tr>
<tr>
<td>Total Hectares</td>
<td>168</td>
<td>83</td>
<td>75</td>
</tr>
</tbody>
</table>

For the 2001/02 survey, crop water use efficiency was calculated based on the crop age and type. Figure 19 displays the water use efficiency of the major crop types. The results indicate that at the time of survey, the majority of citrus crops were between 61% and 80% efficient. Vine grower efficiency tended to be evenly distributed across two categories, making them between 61% and 100% efficient. Of all the properties growing stonefruit, the majority were over 150% water use efficient. This is an excessively high WUE result and may be attributed to the grower applying less water than is usually required for crop production, due to the reduced demand for fruit.

Figure 19 Crop Type by Water Use Efficiency for 2001/02

Although the majority of the stonefruit irrigators are over 150% efficient, a general pattern of water use efficiency exists among the three major crop types.
There are a few irrigators in the lower efficiency categories, the majority between 61% and 100% and a few irrigators in the higher WUE groups. The results indicate that only a small percentage of crops are over irrigated, and that most plantings are being efficiently managed.

3.1.3. On-farm Irrigation Systems

Five on-farm irrigation system surveys have been conducted for Cobdogla Irrigation District, representing the 1993/94, 1995/96, 1996/97, 1998/99 and the 2001/02 seasons. These data indicate that changes to irrigation systems have also occurred as a result of the rehabilitation process.

The trend in on-farm irrigation system types in the Cobdogla Irrigation District persists with properties continuing to adopt drip, overhead and under tree sprinklers. The number of properties under furrow irrigation has declined further; the 2001/02 survey indicating furrow represents less than 4% of the total area with systems. This change can be attributed to the rehabilitation process with the improved method of water delivery to properties providing an incentive for irrigators to adopt more efficient irrigation systems.

![Figure 20: On-Farm Irrigation Systems 1993/94 - 2001/02](image-url)
Figure 21 illustrates a common distribution of WUE amongst the major irrigation systems in the Cobdogla Irrigation District in 2001/02. The majority of irrigators with flood/furrow irrigation, and overhead or under canopy sprinklers are irrigating between 61% and 100% efficiency. However, most of those with drip irrigation tend to be distributed across three WUE categories; 61-80%, 81-100% and 121-150%. The relatively uniform distribution of different irrigation systems in WUE categories indicates that perhaps there are other factors, aside from irrigation system type, that influence WUE. Irrigation management techniques are likely to play a pivotal role in determining the WUE of a property.

*NOTE: Water Use Efficiency is measured using long-term annual average Epan evaporation and effective rainfall.

Figure 21 Irrigation System by Water Use Efficiency for 2001/02

3.1.4. Property Size Profile

The size of properties in relation to WUE was examined for the 2001/02 survey. Figure 22 illustrates that the majority of properties with 2 or more hectares are between 61% and 100% efficient. Those properties of less than 2 hectares are more evenly distributed across all seven categories of WUE. The analysis also shows that as the area of a property decreases, the distribution of properties in the WUE categories increases.
3.1.5. Participants in Irrigation Management Training

Of all irrigators who responded to the question regarding irrigation management training in the Cobdogla Irrigation District, approximately 20% had participated in some form of irrigation management training. Figure 23 compares the WUE of irrigators who did and did not participate in irrigation management training. The curve that represents those irrigators who did receive some training reveals a dip around the 61 - 80% category. However, the results indicate a relative similarity between the two groups.
The chart in Figure 24 illustrates that although the WUE of irrigators who did and did not participate in irrigation management training is relatively similar, the median WUE value of those who did receive some training is higher. This shows that irrigation management training lifts the performance of many irrigators.
3.1.6. Water Use Efficiency

Using the method outlined in the Water Allocation Plan for the River Murray Prescribed Watercourse (and described in section X.X), the WUE of the Cobdogla district in 1997/98 was 85%. Since then, the WUE of the district has decreased to 80%. Due to the rehabilitation of the supply systems and the consequent replacement of furrow irrigation with more efficient systems, we would expect to see an increase in WUE. The reduction in WUE can be attributed to the altered crop and irrigation system mapping techniques employed for the 2001/02 survey. The increased accuracy of the patch mapping in 2001/02 has resulted in a decrease in the amount of irrigated area mapped. This reduction in area significantly affects the results of the WUE calculation, implying that the same amount of water is applied to a smaller area. In fact, the area mapped using the previous method was not a true representation of the irrigated area. The 2001/02 data and WUE results therefore more accurately reflect the WUE of the district.
3.2. Secondary IIT Trials

Having the IIT installed in the latter part of 2002, CIT have undertaken to survey all of the district they operate using the methodologies proposed by this project. Two of these districts are formally involved in this project, Kingston-on-Murray near Overland Corner and Chaffey (Cooltong and Rai Rai) north of the Renmark Irrigation Trust.

3.2.1. Kingston

Kingston is a small district comprising some 181 hectares. Patching and property identification was completed in 1 day. Crop surveying took 10 days to complete and data entry into the IIT District Irrigation Database took 1.5 days. Data is about to be used to calculate Water Use Efficiency using the prototype WUE module as part of a target under Milestone six.

3.2.2. Cooltong and Rai Rai

Collectively, these two districts form the District of Chaffey. As a whole it is larger than Kingston. It is slightly different from other districts in that it has a history of this type of data collection and, as such has existing GIS databases, the most up-to-date being 2000. However, these databases are not immediately compatible with the IIT.

The 2000 crop survey data was imported into ArcMap to overlay the 2002 aerial photo image of the district. Maps were printed showing the 2000 survey data on the 2002 map and posted to growers. CIT are now following up on corrections and changes made to properties since the 2000 survey, with 18% of the district completed so far. Once collected, the new information will then be entered into the IIT, and then new maps (2003 aerial photo and 2002-2003 irrigation season data) will be printed and posted to the irrigators. So far, map set up, printing and postage has taken six days while follow-up surveys have taken three.
4. RECOMMENDATIONS FOR COST SHARING

Cost sharing can be considered in three sections. Firstly there are those costs related directly to production of WUE results. These are the operational costs. Secondly, there are costs associated with software maintenance and update that can be referred to as management costs. The third group of costs can be referred to as tangential costs and can be associated with spin-off activities initiated as a result of the establishment of a community data resource. Splitting potential costs into these three groups reflects the potential for distinct groups or organisations to take responsibility for them. However, while these distinct groups have been given some consideration in the following section, the situation, in reality, is quite dynamic and management structures put in place to deal with the costs of implementation should recognise this. It may actually be the case that the best method of cost sharing sees individual organisations contributing to each of these cost classes.

4.1. Operational Costs

The magnitude of operational costs will be directly related to frequency of survey and/or reporting requirement. The key components include:

- Software & Hardware acquisition
- Production of Orthophotography
- Production of Property Plans
- Irrigator Survey and Data Entry
- Secondary Data Acquisition (e.g. Climatic Information)
- Report Generation

It is recommended that those requiring the information to be collected should bear the bulk of these costs. Partnerships may be struck to reduce this burden especially if certain tangential costs are foreseen. It is recommended that widespread consultation take place prior to conduction of such activities to ascertain the potential stakeholders/partners and engage them in the planning process at the earliest possible point. The Milestone Four report outlines some of these costs in dollar terms and breaks them down into "start up" and
"ongoing" costs. However, a full assessment of costs will be outlined in the final report when it is possible to consider the project components (IIT, WUEM and FLWMM) and their associated activities as a complete package.

4.2. Management Costs

Management costs are related to the upkeep and maintenance of the software developed as part of this project. They can be split into two key components:

- **Currency with host software platforms**

  These costs will be incurred when new versions of the host software are widely adopted. In the main, they may be negligible as the software has been designed to operate on relatively new platforms that use common programming languages to perform their operations. The ESRI suite of ArcGIS products can be assumed to have a considerable product life as they are broadly acknowledged as leaders in the field and have a history of longevity between significant revisions. Minor costs may be expected to be borne by tool operators and will be associated with such processes as database upgrade. However, significant revisions to the host software platform will require contribution from the MDBC in order to ensure the currency of the tools and protect the investment of the tool operators in data acquisition and maintenance. This is particularly true is subsets of the information stored at the district level are to be fed up the tree for informing policy makers through a mechanism such as the Irrigation Management Information Reporting System (IMIRS).

- **Currency with industry/processor standards**

  These costs are associated with ensuring that the standard data coding structures built into the tools are maintained. This is essential for facilitating data capture in an environment where the data are dynamic. Examples of this include the planting of new varieties of crops, the adoption of new
irrigation systems and the proliferation of new crop types driven by market demands (e.g., the Wine boom). It is reasonable to expect some investment in these costs by industry/processor groups since the information store in the district irrigation database will provide valuable forecasting data and could provide the basis for accreditation of irrigators through schemes such as Environmental Management Systems. Bodies such as Horticulture Australia or processor groups such as cannery companies or large wineries may be keen to invest in this area.

4.3. Tangential Costs

Tangential costs are those associated with requested modification to the tools operations to facilitate the establishment of partnerships with groups whose sole focus is not WUE. These partnerships should be investigated and sought after to enhance the ongoing viability of WUE inquiry. Costs associated with these types of activities should be borne entirely by the partners for whom the modifications are to be incorporated. Benefits will include improved relationships between irrigators and regulators through the integration of NRM activities with economic stimuli thus making NRM activities relevant in the planning and operation of the whole farm.
5. RESULTS COMMUNICATION PROGRAM

5.1. Communication Tactics

The following communication tactics are recommended to complement tactics being undertaken as part of the broader Irrigated Regions Communication Strategy. The tactics outlined here are common to all projects under the Watermark umbrella. Annotation describes the current status of the task.

See Appendix 1 for a detailed list of Communication Tactics.

5.1.1. Brand the project

a) Create a logo for the WUE project and a distinctive visual style for communication materials, which complements the new Watermark and MDBC site style guide. COMPLETED

b) Create a template for PowerPoint presentations, reports and emails. COMPLETED

5.1.2. Communication Network

a) Develop a master contact list and internal/external email networks.

b) Send letter to irrigators informing them of the WUE project and how they can be involved, CIT, November 2001. COMPLETED

c) Target existing email list servers (e.g. MDBC, LAWNinfo) to report on project progress and trial outcomes. IN PROCESS

d) Send letter to irrigators informing them of the survey and requesting their cooperation and time. COMPLETED

e) Send follow-up letter to irrigators thanking them for their cooperation, report on results of the survey and provide CIT growers with a property plan. COMPLETED
5.1.3. Presentations and Publications

c) Working Group, Mildura, May 2001. COMPLETED
e) Presented a paper outlining the project at the ANCID conference, Bunbury, WA, July 2001. COMPLETED
g) Participated in the Riverland Field Days, Monash, 12-13 September 2001. COMPLETED
h) Presentation to Industry Development Board - Horticulture, Adelaide, February 2002. COMPLETED
i) Presentation to the MDBC Partnership workshop, Hepburn Springs, March 2002. COMPLETED
j) Presentation to the River Murray Catchment Water Management Board, Adelaide, April 2002. COMPLETED
k) Presentation to the River Murray Catchment Water Management Board, Murray Bridge, May 2002. COMPLETED
l) Display a poster at the Irrigation Association Australia conference, Sydney, 21-23 May 2002. COMPLETED
m) "National workshop to initiate establishment of national standards for irrigated crop water balance and ETc field methodologies", 27 June 2002. COMPLETED
o) ESRI User Group Meeting, 3 July 2002. COMPLETED
p) Presentation to Riverland Citrus Group, 4 July 2002. COMPLETED
q) Publish the Crop Standard, August 2002. PENDING
s) Present a paper on the project progress at the ANCID Conference, September 2002. COMPLETED
t) Presentation at Riverlink forum, 28 October 2002. COMPLETED
u) Grower Information Day, Loxton Centre, 8 November 2002. COMPLETED
w) Present at Sunraysia Rural Water Board, 14 November 2002. COMPLETED
x) Present the FLWMM to Jim Hallion, Loxton Centre, 25 November 2002. COMPLETED
y) Present the FLWMM to the Bookpurnong Irrigators group, 6 December 2002. COMPLETED
z) Present the FLWMM and IIT to representatives of the Onkaparinga Catchment Water Management Board, 22 January 2003. COMPLETED
aa) Present the IIT and FLWMM and obtain feedback through Interstate Information Exchange tour, Griffith, Leeton, Deniliquin, Tatura, Mildura and Dareton, 27-31 January 2003. COMPLETED
bb) Present the FLWMM and IIT to South East Benchmarking project management committee, 10 March 2003. COMPLETED
c) Present the FLWMM and IIT to Renmark Citrus Growers group, 11 March 2003. COMPLETED
dd) Present the FLWMM and IIT to Waikerie Citrus Growers group, 12 March 2003. COMPLETED
ee) Present the FLWMM and IIT to Loxton Citrus Growers group, 12 March 2003. COMPLETED
ff) Present the FLWMM and IIT to Barossa Viticulture Technical Committee including representatives from the Northern Adelaide Plains Catchment Water Management Board, 18 March 2003. COMPLETED
gg) Present the FLWMM at the DWLBC Seminar Series, Adelaide, 19 March 2003. COMPLETED
hh) Participate in the Central Irrigation Trust Irrigation Efficiency Expo, May 2003. COMPLETED
ii) Participate in the WUE workshop, Dubbo, 6 May 2003. **COMPLETED**
jj) Present at the Irrigation Association Australia conference, Dubbo, 7 May 2003. **COMPLETED**
kk) Present at the ANCID conference, July 2003. **PENDING**
ll) Publish a paper in an irrigation/horticulture journal/magazine. **PENDING**

mm) Target existing newsletters to report on project progress and trial outcomes. **PENDING**

*Date is unconfirmed*

5.1.4. Media Program

nn) Select a media spokesperson and review their media skills, and potential launch of the IIM tool in the Riverland. **PENDING**
a) Prepare press releases for local media regarding project trials and outcomes. **PENDING**

5.1.5. Promotional Kit

a) Create a WUE fact sheet. **PENDING**
b) Create a brochure for the WUE project. **PENDING**
c) Create posters of irrigator case studies. **PENDING**
d) Establish a WUE project website and look at including an overview and context of the project, a project fact sheet, contact information, a summary of the project outcomes, updates on progress of the project, and a feedback mechanism. **PENDING**
e) Develop a standard Microsoft PowerPoint presentation of the Irrigation Inventory Tool to demonstrate the tools application and use. **PENDING**
<table>
<thead>
<tr>
<th>Partner categories targeted</th>
<th>Strategy</th>
<th>Tactics/Evaluation</th>
<th>Responsibility</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 8</td>
<td>Brand the Project</td>
<td>Create a logo for the WUE project and a distinctive visual style for communication materials, which complements the new Watermark and MDPC SI&amp;E style guide.</td>
<td>Project Management Team, HIM and FLWMM Working Groups</td>
<td>August 2002</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8</td>
<td>Create a template for PowerPoint presentations, reports and emails.</td>
<td>Project Management Team, DEH</td>
<td>August 2002</td>
<td></td>
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<tr>
<td>1 2 3 4 5 6 7 8</td>
<td>Develop and review a master contact list and internal/external email networks.</td>
<td>DEH</td>
<td>Established &amp; Ongoing</td>
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<tr>
<td>1 2 3 4 5 6 7 8</td>
<td>Send letter to irrigators informing them of the WUE project and how they can be involved.</td>
<td>CIT, PIRSA</td>
<td>November 2001 &amp; November 2002</td>
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</tr>
<tr>
<td>1 2 3 4 5 6 7 8</td>
<td>Target existing email list servers (e.g. MDPC Watermark Projects, LAWNInfo) to report on project progress and trial outcomes.</td>
<td>Project Management Team</td>
<td>Ongoing</td>
<td></td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8</td>
<td>Send letter to irrigators informing them of the survey and requesting their cooperation and time.</td>
<td>CIT, SunRISE 21 Inc.</td>
<td>Pre 01-02 survey &amp; pre 02-03 survey</td>
<td></td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8</td>
<td>Send follow-up letter to irrigators thanking them for their cooperation, report on the results of the survey and provide CIT growers with a property plan.</td>
<td>CIT, SunRISE 21 Inc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8</td>
<td>Communication Strategy Meeting, Mildura.</td>
<td>Project Management Team</td>
<td>May 2001</td>
<td></td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8</td>
<td>Working Group, Mildura.</td>
<td>Project Management Team</td>
<td>May 2001</td>
<td></td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8</td>
<td>Information Session, Tatura.</td>
<td>Project Management Team</td>
<td>1 June 2001, late 2002*, late 2003/early 2004*</td>
<td></td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8</td>
<td>Present at the ANCID conference, Bunbury, WA.</td>
<td>Project Management Team (Gerrit Schnalle)</td>
<td>July 2001</td>
<td></td>
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<tr>
<td>Partner categories targeted</td>
<td>Strategy</td>
<td>Tactics/Evaluation</td>
<td>Responsibility</td>
<td>Timing</td>
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<tr>
<td>1 2 3 4 5 6 7 8</td>
<td>Presentations and Publications</td>
<td>Information Session, Griffith.</td>
<td>Project Management Team</td>
<td>8-9 August 2001, late 2002*, late 2003/early 2004*</td>
</tr>
<tr>
<td>!</td>
<td>Participate in the Riverland Field Days, Monash.</td>
<td>DEH, PIRSA</td>
<td>12-13 September 2001</td>
<td></td>
</tr>
<tr>
<td>! ! ! ! ! ! ! !</td>
<td>Publish the Crop Standard.</td>
<td>DEH</td>
<td>August 2002</td>
<td></td>
</tr>
<tr>
<td>! ! ! ! ! ! ! !</td>
<td>Present a paper on the project progress at the ANCID Conference.</td>
<td>Project Management Team</td>
<td>September 2002</td>
<td></td>
</tr>
<tr>
<td>! ! ! ! ! ! ! !</td>
<td>Presentation of the FLWMM to Jim Haillon, Loxton Centre.</td>
<td>PIRSA</td>
<td>25 November 2002</td>
<td></td>
</tr>
<tr>
<td>Partner categories targeted</td>
<td>Strategy</td>
<td>Tactics/Evaluation</td>
<td>Responsibility</td>
<td>Timing</td>
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<td>✓</td>
<td>Presentations and Publications</td>
<td>Publish a paper in an irrigation or horticulture journal/magazine.</td>
<td>Project Management Team</td>
<td>December 2002</td>
</tr>
<tr>
<td>✓</td>
<td>Present the FLWMM to Bookpumong irrigators Group.</td>
<td>PIRSA</td>
<td>6 December 2002</td>
<td></td>
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<tr>
<td>✓</td>
<td>Present the FLWMM and IIT to representatives of the Onkaparinga Catchment Water Management Board.</td>
<td>DEH, PIRSA</td>
<td>22 January 2003</td>
<td></td>
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<tr>
<td>✓</td>
<td>Present the IIT and FLWMM and obtain feedback through Interstate Information Exchange tour.</td>
<td>DEH, PIRSA</td>
<td>27-31 January 2003</td>
<td></td>
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<tr>
<td>✓</td>
<td>Present the FLWMM and IIT to South East Benchmarking project management committee.</td>
<td>DEH, PIRSA</td>
<td>10 May 2003</td>
<td></td>
</tr>
<tr>
<td>✓</td>
<td>Present the FLWMM and IIT to Renmark Citrus Growers group.</td>
<td>DEH, PIRSA</td>
<td>11 March 2003</td>
<td></td>
</tr>
<tr>
<td>✓</td>
<td>Present the FLWMM and IIT to Waikerie Citrus Growers group.</td>
<td>DEH, PIRSA</td>
<td>12 March 2003</td>
<td></td>
</tr>
<tr>
<td>✓</td>
<td>Present the FLWMM and IIT to Loxton Citrus Growers group.</td>
<td>DEH, PIRSA</td>
<td>12 March 2003</td>
<td></td>
</tr>
<tr>
<td>✓</td>
<td>Present the FLWMM and IIT to Barossa Viticulture Technical Committee including representatives from the Northern Adelaide Plains Catchment Water Management Board.</td>
<td>DEH, PIRSA</td>
<td>18 March 2003</td>
<td></td>
</tr>
<tr>
<td>✓</td>
<td>Present the FLWMM to DWLBC Seminar Series, Adelaide.</td>
<td>PIRSA</td>
<td>19 March 2003</td>
<td></td>
</tr>
<tr>
<td>✓</td>
<td>Participate in the Central Irrigation Trust Irrigation Efficiency Expo.</td>
<td>DEH, PIRSA</td>
<td>May 2003</td>
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<tr>
<td>✓</td>
<td>Participate in the WUE Workshop, Dubbo.</td>
<td>PIRSA</td>
<td>6 May 2003</td>
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<tr>
<td>✓</td>
<td>Present at the Irrigation Association Australia conference.</td>
<td>Project Management Team</td>
<td>21-23 May 2003</td>
<td></td>
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<tr>
<td>✓</td>
<td>&quot;National workshop to initiate establishment of national standards for irrigated crop water balance and ETc field methodologies&quot;.</td>
<td>Project Management Team</td>
<td>27 June 2002</td>
<td></td>
</tr>
</tbody>
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