WATERWISE
ON THE FARM

Introduction to Irrigation Management

Evaluating your pressurised system

System 1

Travelling irrigators and Rotating booms

Version: WA 20 September 2011

These materials are part of the WaterWise on the Farm education program Introduction to Irrigation Management. They were developed by NSW Agriculture staff from the Water Management subprogram with major input from Lindsay Evans.

CONTENTS

AIM

The aim of this workshop is to give you skills in the evaluation of your travelling irrigation system. These skills will include the determination of the rate that water is being applied, and how uniformly that water is being distributed over your irrigation area. These worksheets outline the equipment and procedure needed for you to these values.

OVERVIEW

Travelling irrigators

These irrigators come in two forms: with a soft hose/cable drum machine, or with a hard hose drum. Both incorporate a 'big gun' sprinkler. They are commonly used to irrigate pastures and lucerne, but machines with elevated wheels can be used on taller crops.

The **soft hose irrigator** is a self-propelled unit comprising chassis, wheels, hose reel, drive mechanism and sprinkler. The unit is moved by hydraulic cylinder or turbine drive though a lever action to a cable drum. A winch cable is anchored at the opposite end of field and the irrigator advances as the cable is wound onto the drum. Water supply is provided from the irrigation main though a heavy-duty drag hose pulled behind the irrigator. This hose may be 100 to 200 metres long. The water motor develops the pulling power across a range of operating conditions and speeds.

The **hard hose irrigator** remains stationary in the centre of the field and, when the drive mechanism is pressurised, the hose reel rotates and rewinds the hose, pulling the sprinkler unit across the paddock at the desired travel speed. The hose reel, which is mounted on a turntable, can then be rotated though 180o so irrigation can be performed on the opposite side of the field. The drive mechanisms for these machines are either bellows or turbines. The bellows system ensures that all energy is directly utilised to drive the hose reel and can be activated by low pressures and flows.

Travelling irrigators only require one person to operate them. The nozzle size (with ring nozzles) and travel speed can be adjusted to suit the soil infiltration rate and crop water requirements.

The most efficient operating pressures to maintain sprinkler operation and develop pulling power are between 400 kPa and 600 kPa. The high pressure is the biggest disadvantage of these machines, because this means high pumping costs.

Rotary boom irrigators

Rotary boom irrigators are similar in concept to the soft hose travelling irrigator except that the big gun sprinkler is replaced by a galvanised boom fitted with medium to low pressure sprinklers.

The boom of the irrigator is rotated by the discharge from the sprinkler nozzles. This rotating boom then provides the energy to operate the drive mechanism and cable winch.

Various sprinkler combinations (big gun, rotating, and low pressure) can be used. Working pressures range from 70 kPa to 500 kPa.

Because these irrigators are large and self-propelled, they can only be used on clear, flat paddocks.

EQUIPMENT NEEDED

To measure pressure:

- An accurate pressure gauge that can be attached to the irrigator. It should have an appropriate scale so it works mid-range at normal pressures (say 0 to 1000 kPa)

To measure coverage:

- Catch cans (between 20 and 40 may be needed depending on your coverage width)
  (4-litre square ice-cream containers are good catch cans)
- Gravel pieces to place in containers to stop them blowing away
- A 30-metre measuring tape
- A shovel for smoothing areas to set catch cans
- A measuring cylinder or jug with graduations in millilitres
- A calculator, a pen and evaluation sheets
- If possible, manufacturers performance charts giving showing pressure versus wetted diameter, pressure range, and output rates.

EVALUATION METHOD

To assess the performance of your travelling or rotary boom irrigator, you need to measure the pressure at various points in the system, the operating speed at the far end, and the output of the sprinklers using catch cans. To do this, work through the following procedure.

⚠ **NOTE**

Occupational health and safety

Whilst working with travelling irrigators, you, and anyone assisting you, should at all times be aware of the inherent dangers associated with working near moving machinery and high pressure water. Safety should be the primary concern at all times.

1. Before starting the irrigator, fit the pressure gauge.
2. Record details of the make and model of the irrigator, and the type of nozzle attached (ring or tapered) on your Data sheet.
3. Select a test location for the catch cans about midway along the run. The location should be:
    - Far enough ahead of the irrigator so no water reaches the catch cans before the test commences.
    - Far enough from the end of the run so that the irrigator coverage has completely passed over all catch cans.
    - Where the catch cans will be upright and stable. Set the catch cans in a straight line across the irrigators' towpath.
    - Place the containers 5 metres apart. Work outwards from the tow path with the first catch can placed 2.5 metres from the tow path. Subsequent catch cans are positioned 5 metres apart.
    - The outer catch-cans should be at the edges of the wetted strip. Add two extra cans each side to allow for changes in wind conditions.
    - If there is the chance of rain during the test, place a further can out of range of the irrigator to collect rainfall. Any rainfall collected must be deducted from the amount collected in all other cans.
    - Secure the cans with stones to prevent them blowing away or being knocked over by the stream of water from the irrigator. Make sure grass or other foliage does not interfere with water entering them.

4. Check the system for any malfunctions, leaks, blockages, and any damage. Record any faults in your maintenance report and schedule on the data sheet.
5. Measure the operating speed of the irrigator by placing a marker (a peg) next to one wheel. Allow the irrigator to travel for a set time (say 20 minutes). Place anther peg next to the wheel's new position.
    - Record the distance between each peg
    - Record the time you allowed the irrigator to travel
6. During the test
    - Record the wind direction and approximate speed (see table 1)
    - Measure the operating pressure at the irrigator
    - Measure the diameter of coverage of the irrigator
    - Measure the distance between each run (or irrigation lane spacing)

Table 1: Wind Speed

Visible effect	Wind description	Speed - knots
Calm. Smoke rises vertically.	Calm.	00
Direction of wind shown by smoke drift but not wind vane.	Light air.	02
Wind felt on face. Leaves rustle. Vane moved by wind.	Light breeze.	05
Leaves and small twigs in constant motion. Wind extends light flag	Gentle breeze.	09
Raises dust and loose paper. Small branches are moved.	Moderate breeze.	13
Small trees in leaf begin to sway. Crested wavelets on inland waters.	Fresh breeze.	18
Large branches in motion. Whistling heard in telegraph wires.	Strong breeze.	24
Whole trees in motion. Inconvenience felt when walking against wind.	Moderate gale.	30
Breaks twigs off trees. Generally impedes progress.	Fresh gale.	37
Slight structural damage occurs.	Strong gale.	44
Trees uprooted. Considerable structural damage. Seldom experienced inland.	Whole gale.	52
Very rarely experienced. Accompanied by widespread damage.	Storm. Hurricane.	60 68

Source: Bureau of Meteorology

7. When the irrigator has completely passed over all of the catch cans measure and record the volumes in EACH can at 'step 2' in your field record sheet. Each volume MUST be written in the correct space on the field record sheet.

8. Make sure all test data has been recorded and entered onto the Data Sheet.

Data Sheet Example

Data sheet	**Date** 3/July/03
Name	R T Fischal
Crop	Lucerne
Location/block	Paddock 2/3
Soil texture of Block	loam
Effective root depth	0.8 **metres**
Rootzone RAW	72 **mm**
Maximum infiltration rate	30 **mm/h**
Type of irrigator	[✓ **Fixed**] **Rotating boom** **Big Gun**
Irrigator model	Southern Cross 75
Sprinkler make	Nelson 150 series
Nozzle type/size	taper - 25 mm
Operating pressure	440 **kPa**
Lane spacing	60 **metres**
Irrigation frequency	10–14 **days**
Sprinkler wetted diameter	80 **metres**
Irrigation run length	200 to 280 **metres**
Test start time	9.15 am
Test end time	9.15 am
Test duration and distance covered	30 **minutes to cover** 17.5 **metres**
Wind direction & speed	Light Breeze
Catch Can Diameter	110 **mm**

Maintenance Report	Maintenance Schedule
Leaks in hose at 10 metres	Repair hose leaks 7/july 2003
Leak in hose at 17 metres	Oil rig 7/July 2003

Requires oiling	

9. Once you have collected the volumes caught by the catch cans you will need to convert them from millilitres (mL) into millimetres (mm). Use Table 2 below to convert your volumes into depths and record them at ‘step 3’ in your field record sheet
10. Check pump and record the pump operation in your pump record sheet

Table 2: Converting mL to mm

Diameter of catch can (mm)	Figure to divide the collected amount by
75	4.4
80	5.0
90	6.4
100	7.9
102	8.2
104	8.5
106	8.8
108	9.2
110	9.5
112	9.9
113	10.0
114	10.2
115	10.4
120	11.3
125	12.25
145	16.5
165	21.3
200	31.4

In order to convert Volume into depth (millimetres) we need to use a conversion factor. The conversion factors are listed in Table 2. You select your conversion factor by measuring the diameter of the mouth of your catch can

For instance, if the diameter of your catch can is 110 mm then our conversion factor from Table 2 will be 9.5 (circled).

If our cans collected 674 mL, then the conversion is our volume divided by the conversion factor;

674 mL ÷ 9.5 = 71 mm

Therefore the depth of water applied during the example test was 71 mm

If you use 4 litres square plastic ‘ice cream’ containers, 1 litre collected in one of these is equivalent to 25 mm of irrigation.

On a calculator, use

“water collected in mL” ÷ 40 = ………. mm

Travellor Irrigation System Evaluation Sheet (Example)

Field Layout Record Name: ....R T Fischal Block: Paddock 2/3

Direction of travel

Step 1. **On this sheet draw two vertical lines to mark the irrigator TOW PATH positions** (this heavy line represents today's towpath)

		Left Side of Tow Path																Right Side of Tow Path															
Tow Path Lane Spacing (metres)		80	70		60		50		40		30		20		10																		
Catch can number		L16	L15	L14	L13	L12	L11	L10	L9	L8	L7	L6	L5	L4	L3	L2	L1	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
Step 2. Enter each Catch can **Volume collected (mL)**		0	0	0	0	0	0	0	0	50	180	200	280	300	250	380	230	390	360	360	270	300	280	220	190	70	0	0	0	0	0	0	0
Catch can number		L16	L15	L14	L13	L12	L11	L10	L9	L8	L7	L6	L5	L4	L3	L2	L1	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
Step 3. Convert volume (mL) to depth (mm) **Depth of irrigation (mm)**	A	0	0	0	0	0	0	0	0	5	18	20	28	30	25	38	23	39	36	36	27	30	28	22	19	7	0	0	0	0	0	0	0
Step 4. **Copy right hand depths to these boxes** - Commence with 'R1' to the right of the tow path line you inserted at Step 1		R	R	R	R	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16												
	B					39	36	36	27	30	28	22	19	7	0	0	0																
Step 5. **Catch totals (mm)** Add left and right can depths between tow path lines	A + B					39	36	36	27	35	46	42	47	37	25	38	23																

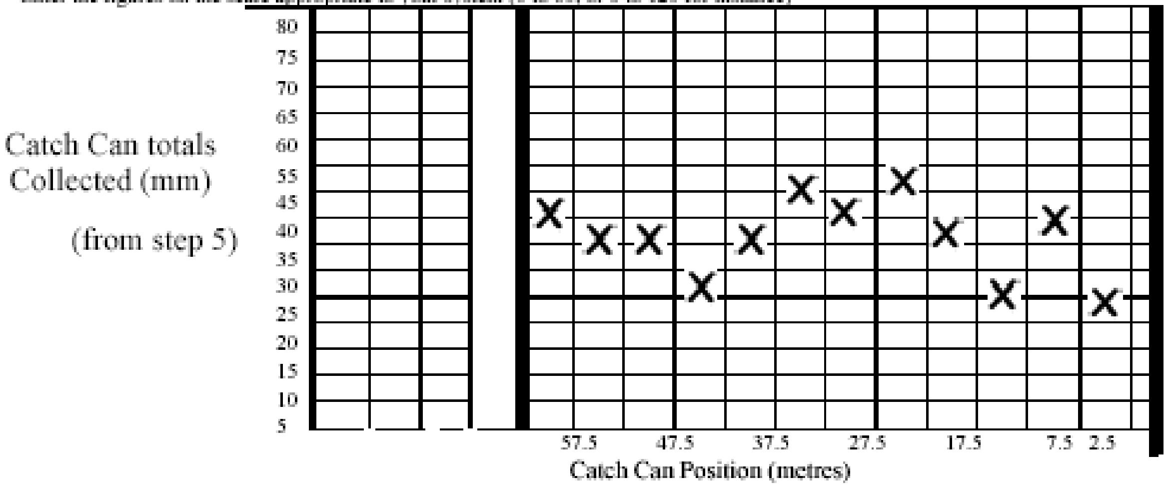
Step 6. **Circle ¼ of the catch totals** that contain the smallest depths as calculated in step 5

Step 7. Add up all depths to obtain a **TOTAL APPLICATION DEPTH (mm)**

(add up all the values calculated in step 5) = 431 mm [C]

Graph the catch totals on the chart below

Enter the figures on the scale appropriate to your system (0 to 60, or 0 to 120 for instance)



Calculating the application amount

Example data with full calculations

Average application depth = Total application depth collected ÷ number of catch cans *within* lane spacing*		
Total application depth collected [Step 7]	431 **mm**	**C**
Catch Cans within Lane Spacing	12	**D**
Average application depth = * NB Not the number of catch cans	**C ÷ D** = 431 ÷ 12 = 35.9 **mm**	**E**
This amount should be compared to the rootzone RAW on the data sheet. For our example, the application depth is half the RAW.		
Rootzone RAW (from data sheet)	72 **mm**	**RAW**

Calculating the mean application rate (MAR)

MAR = Average application depth x Travel speed ÷ wetted diameter		
Average Application Depth	35.9	**E**
Travel speed = distance travelled during test ÷ time taken during test		
Distance travelled during test	17.5 **metres**	**F**
Irrigator test time	30 **minutes**	**G**
Travel speed [S] =	**F ÷ G** 17.5 ÷ 30 = 0.583 **m/min**	
Convert into metres per hour **Multiply by 60**	0.583 **x 60 m/h** = 35 **m/hour**	**S**
Sprinkler wetted diameter (from data sheet)	80 **metres**	**H**
MAR =	**E x S ÷ H** 35.9 x 35 ÷ 80 = 15.7 **mm/h** **Rounding off to** 16 **mm/h**	MAR
The MAR should be ***less*** than the infiltration rate. If it is not then run-off is likely to be a problem		
Infiltration rate (from data sheet)	= 30 **mm/h**	

Calculating distribution uniformity (DU)

Example data with full calculations

Number of Catch cans *between* runs	**12 cans**	**A**
One quarter of catch cans [LQ cans] **Divide number of catch cans by 4** (If not a whole number round down)	**A ÷ 4** **12 ÷ 4** **= 3 cans**	LQ
On your field layout record sheet highlight the lowest amounts for the appropriate number of LQ cans *(Circled in Step 6). These are you Lowest Quarter Catch Cans (LQ Cans)*		
Total depth of the selected LQ cans	**= 27 + 25 + 23** **= 75 mm**	**B**
Average depth of LQ cans = Total depths of LQ cans ÷ number of LQ cans		
Average depth of LQ cans	**B ÷ LQ cans** = 75 **mm** ÷ 3 **cans** = 25 **mm**	**C**
DU = Average depth of LQ cans ÷ Average application depth		
Average application depth	**35.9 mm**	**E**
DU	**C ÷ E** **= 25 ÷ 35.9** **= 0.696**	**F**
Convert DU into a percentage = **F x 100**		
As a percentage the DU is	**0.696 x 100** **= 69.6 %** **Rounding to** **say 70 %**	

A DU of 75 % is acceptable. If the DU is below this, then changes to our irrigation system may be required in order to improve the DU%.

There are a range of factors that can change be attempted to change the application rate or improve the DU.

The best option will depend on your individual situation. Consider:

- Increasing travel speed
- Changing the lane spacing
- Changing nozzle size and type, and pressure

Pump Unit Record sheet

Name

Date:

Test Block:

Pump

Make:

Model:

Age: years

Impeller size: mm

Pump speed (RPM):

Has the impeller been turned down or replaced? If Yes, When?

Do you have a performance chart? If No see your dealer!

Transmission

Type (Please circle) Direct coupled Belts and Pulleys Gear driven

Pump pulley (PCD):

Prime mover pulley (PCD)

Type of belt

Number of belts

Pulley distance Metres

Prime mover

Type:

Model:

Age: Years

Operating RPM

Suction

Foot valve and strainer size: mm

Suction Pipe diameter: mm

Suction pipe Length: metres

Type of Pipe:

Static lift (water level to pump): metres

Pump Unit Operation

Friction loss for suction pipe:	1	metre (generally)		**A**
Pressure at discharge: *then convert*	………….	kPa*	* *if not in kPa*	**B**
Water Meter reading (start): *Megalitres?*	…………..		*Kilolitres or*	**C**
Water Meter reading (end): *Megalitres?*	…………..		*Kilolitres or*	**D**
Time at water meter reading (start):	……………		*Use 24 hour clock*	**E**
Time at water meter reading (end):	……………		*Use 24 hour clock*	**F**
Duration of pumping:	**Time at end reading - Time at start reading** **F - E** **………. - ……….** **= ……….. hours**			**G**

Maintenance

Previous service (Date):

Details of service:

Next service (Date):

Select your Type of meter and record your readings

Power Readings										
	Disc Meter	**1**	**2**	**3**	**Electronic meter**	**1**	**2**	**3**	**Fuel**	
H	r/kWh				Reading at start				Level at start	
J	Multiplier on meter				Reading at end				Level at end	
N	Number of disc revolutions				Multiplier (stated on bill)				Temperature	
T	Time for N (seconds)				Time between reading (seconds)				Oil Level (Dip stick)	
$	Price / kWhr				Price / kWhr				Price /litre of fuel	

Filter Losses		
Filter pressure Losses = Pressure at filter inlet - pressure at filter outlet		
Filter location:		
Pressure at filter inlet:		**PI**
Pressure at filter outlet		**PO**
Pressure Differential	= PI - PO = ………… - ………… = ………… kPa	
Normal allowance is about 70 kPa (7 metres)		

Pump Calculations

	Pump Flow Rate			
Water Pumped	D ………… = ……………. KL	- C - …………. or ……………. ML	Select unit of Reading	P
Convert volume pumped into Litres	If your meter reads in Kilolitres	P (KL) ………… = ………….. Litres	/ 1000 / …………	
Convert volume pumped into Litres	If your meter reads in Megalitres	P (ML) ………… = ………….. Litres	/ 100000 / …………	Q
Flow Rate of pump	Volume pumped (litres Q …………… = …………… L/s	Duration of Pumping (hours) G / ……………	/ 3600 / 3600 / ……………	R

Identify the power course and complete the Power used sheet appropriate for your situation.

Power Used - Disc Meter	**1**	**2**	**3**	
	N x 3600 x J ………. x 3600 x ………. = ……………			**a**
	H x T ………. x ………. = ……………			**b**
Power used	a / b ………. / ………. = …………… kW			**c**
Add the power used	Meter 1 c + Meter 2 c + Meter 3 c = ……………			**kW**
Pump Calibration Power per megalitre = Power used (kW) / Flow Rate (L/s) / 0.0036				
	kW / R / 0.0036 ………. x ………. x 0.0036 = …………… kWh/ML			**CAL**
Cost	CAL x $ ………. x ………. = ……………			

Compare your findings to your previous records. Variation in your findings to previous records may indicate changes in your system and its efficiency. Damaged or worn impellers may decrease flow rate or increase the power used to pump each mega litre of water. Clogged filters may be indicated by an increase in the pressure differential.

Power Used - Electronic	**1**	**2**	**3**	
	N x 3600 x J ………. x 3600 x ………. = ……………			**a**
Power Used = Difference in meter readings x 3600 x Multiplier / Time				
Power used	a / b ………. / ………. = …………… kW			**c**
Add all the Power used together =				**kW**
Calibration = Power used (kW) / Flow Rate (L/s) / 0.0036				
	kW / R / 0.0036 ………. x ………. x 0.0036 = …………… kWh/ML			**CAL**
Cost = CAL x $				
	………. x ………. = ……………			

Note: Another method to estimate costs per ML - Read water meter reading when council reads your electricity meter and then compare the electricity bill to the water used (Most recent water reading minus previous water reading).

Power bill / Water Use

For example Electricity bill = $5400, water usage = 270 ML

= $5400 / 270

= $20 per ML

Power Used - Diesel		
Fuel used	At start - at finish H - J …….. - ………… = ………… Litres	**b**
Pump Duration	……… hours	**G**
Pump fuel use	b ÷ G …….. ÷ ……….. = ………….. Litres of fuel per hour	**c**
Time to pump one megalitre	1000000 ÷ Flow Rate (L/s) ÷ 3600 1000000 ÷ R ÷ 3600 = 1000000 ÷ …….. ÷ 3600 = ………. hours	**d**
Fuel used to pump one ML	c x d …….. x ………..	**e**
Running Cost	e x $ ………. x ………… = …………..	
To estimate the kW of a diesel powered unit we may use the following equation Volume of fuel per hour ÷ 0.34		
	c ÷ 0.34 **= ………….. kW**	

Compare your findings to your previous records. Variation in your findings to previous records may indicate changes in your system and its efficiency. Damaged or worn impellers may decrease Flow rate or increase the power used to pump each mega litre of water. Clogged filters may be indicated by an increase in the pressure differential.

Pumping Unit Efficiency

When you check your pump you should also look at the suction. That is, are there any air pockets or leaks? Recording equipment such as gauges and meters should also be regularly serviced and calibrated. Gauges should be easily removable so that they may be stored away from the vibrations of the pump.

Pump efficiency is difficult to determine and will vary between pumps. Power usage in diesel pumps cannot be easily measured. However using the data you have collected you may be able to estimate the efficiency of electric pumping units. By collecting further data on your pump, a pump expert may be able to determine the efficiency of your pump and whether it is suitable for the duty of your system.

Efficiency of Pumping Unit = Flow rate x head (m) ÷ power

Pumping Unit Efficiency		
Suction Static lift	metres	**S**
Friction Loss	Assume 1 metre	**A**
Pressure at Discharge	kPa	**B**
Convert kPa Pressure into Head (metres)	KPa pressure x 0.102 B x 0.102 = ………. metres	**PM**
Head	PM + S + A …………… + …………… + 1 = ………… metres	**Head**
Flow rate	…………. L/s	**R**
Power		**kW**
Efficiency = Flow rate x Head (m) ÷ power = R x Head ÷ kW		
	= ……… x ………… ÷ ……… = ………….. %	

Note: Dirty filter will drastically affect operation pressure of emitter.

Compare your findings on the pump curve for your pump

EVALUATION SHEETS

Data sheet	**Date**
Name	
Crop	
Location/block	
Soil texture	
Effective root depth	**metres**
Rootzone RAW	**mm**
Max. infiltration rate	**mm/h**
Type of irrigator	**Fixed Rotating boom Big Gun**
Irrigator model	
Sprinkler make	
Nozzle type/size	**mm**
Operating pressure	**kPa**
Lane spacing (approx only)	**metres**
Irrigation frequency	**Days**
Sprinkler wetted diameter	**metres**
Irrigation run length	**metres**
Test start time	
Test end time	
Test duration and distance covered	**…………minutes to cover………metres**
Wind direction & speed	
Catch Can Diameter	**mm**

Maintenance Report	Maintenance Schedule

Traveller Irrigation System Evaluation Sheet

Field Layout Record Name: .... Block: .... Direction of travel

Step 1 **On this sheet draw two vertical lines to mark the irrigator TOW PATH positions** (this heavy line represents test towpath)

		Left Side of Tow Path																**Right Side of Tow Path**															
Tow Path Lane Spacing (metres)		**80**	**70**		**60**		**50**		**40**		**30**		**20**		**10**																		
Catch can number		L16	L15	L14	L13	L12	L11	L10	L9	L8	L7	L6	L5	L4	L3	L2	L1	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
Step 2 Enter each Catch can **Volume collected (mL)**																																	
Catch can number		L16	L15	L14	L13	L12	L11	L10	L9	L8	L7	L6	L5	L4	L3	L2	L1	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
Step 3 Convert volume (mL) to depth (mm) **Depth of irrigation (mm)**	**A**																																
Step 4 **Copy right hand depths to these boxes -** Commence with 'R1' to the right of the tow path line you inserted at Step 1		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R												
	B																																
Step 5 **Catch totals (mm)** Add left and right can depths between tow path lines	*A + B*																																

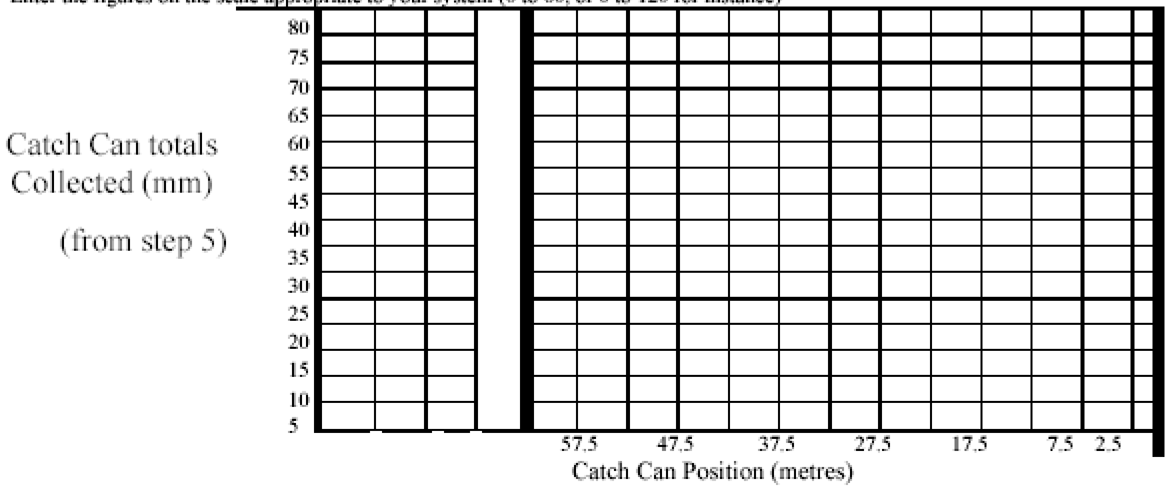
Step 6 **Circle ¼ of the catch totals** that contain the smallest depths as calculated in step 5

Step 7 Add up all depths to obtain a **TOTAL APPLICATION DEPTH (mm)**

(add up all the values calculated in step 5) = ... **mm** [C]

Graph the catch totals on the chart below

Enter the figures on the scale appropriate to your system (0 to 60, or 0 to 120 for instance)



Calculating the application amount

<table>
<tr><td colspan="3">Average application depth = Total application depth collected ÷ number of catch cans <i>within</i> lane spacing*</td></tr>
<tr><td>Total application depth collected [Step 7]</td><td>……………. mm</td><td>C</td></tr>
<tr><td>Catch Cans within Lane Spacing</td><td>……………..</td><td>D</td></tr>
<tr><td>Average application depth =
* NB Not the number of catch cans</td><td>C ÷ D
= ………… ÷ …………
= ……………. mm</td><td>E</td></tr>
<tr><td colspan="3">This amount should be compared to the rootzone RAW on the data sheet.
For our example, the application depth is half the RAW.</td></tr>
<tr><td>Rootzone RAW (from data sheet)</td><td>…………….. mm</td><td>RAW</td></tr>
</table>

Calculating the mean application rate (MAR)

MAR = Average application depth x Travel speed ÷ wetted diameter		
Average Application Depth	………………..	**E**
Travel speed = distance travelled during test ÷ time taken during test		
Distance travelled during test	**……………… metres**	**F**
Irrigator test time	**……………….minutes**	**G**
Travel speed [S] =	**F ÷ G** **………….. ÷ ……………** **= ……………… m/min**	
Convert into metres per hour **Multiply by 60**	**………… x 60** **= …………… m/hour**	**S**
Sprinkler wetted diameter (from data sheet)	**……………. m**	**H**
MAR =	**E x S ÷ H** **……….. x ………… ÷ ……………** **= ……………. mm/h**	**MAR**
The MAR should be ***less*** than the infiltration rate. If it is not then run-off is likely to be a problem		
Infiltration rate (from data sheet)	**= ……………. mm/h**	

Calculating distribution uniformity (DU)

<table>
<tr><td>**Number of Catch cans *between* runs**</td><td>……………. cans</td><td>A</td></tr>
<tr><td>**One quarter of catch cans [LQ cans]**
Divide number of catch cans by 4
(If not a whole number round down)</td><td>A ÷ 4
= ……….. ÷ 4
= ………..</td><td>LQ cans</td></tr>
<tr><td colspan="3">On your field layout record sheet highlight the lowest amounts for the appropriate number of LQ cans *(Circled in Step 6). These are you Lowest Quarter Catch Cans (LQ Cans)*</td></tr>
<tr><td>**Total depth of the selected LQ cans**</td><td>=
= …………….. mm</td><td>B</td></tr>
<tr><td colspan="3">**Average depth of LQ cans = Total depths of LQ cans ÷ number of LQ cans**</td></tr>
<tr><td>Average depth of LQ cans</td><td>B ÷ LQ cans
= ………….. mm ÷ ………. cans
= ……………..mm</td><td>C</td></tr>
<tr><td colspan="3">**DU = Average depth of LQ cans ÷ Average application depth**</td></tr>
<tr><td>Average application depth</td><td>………………</td><td>E</td></tr>
<tr><td>**DU =**</td><td>C ÷ E
= ………… ÷ …………
= …………</td><td>F</td></tr>
<tr><td colspan="3">Convert DU into a percentage = F x 100</td></tr>
<tr><td>As a percentage the DU is</td><td>= ………… x 100
= ………… %</td><td></td></tr>
</table>

A DU of 75 % is acceptable. If the DU is below this, then changes to our irrigation system may be required in order to improve the DU%.

Pump Unit Record sheet

Name	Date:	Test Block:

Pump

Make:

Model:

Age: years

Impeller size: mm

Pump speed (RPM):

Has the impeller been turned down or replaced? If Yes, When?

Do you have a performance chart? If No see your dealer!

Transmission

Type (Please circle)	Direct coupled	Belts and Pulleys	Gear driven

Pump pulley (PCD):

Prime mover pulley (PCD)

Type of belt

Number of belts

Pulley distance Metres

Prime mover

Type:

Model:

Age: Years

Operating RPM

Suction

Foot valve and strainer size: mm

Suction Pipe diameter: mm

Suction pipe Length: metres

Type of Pipe:

Static lift (water level to pump): metres

Pump Unit Operation

Friction loss for suction pipe:	1	metre (generally)		**A**
Pressure at discharge:	………….	kPa*	** if not in kPa then convert*	**B**
Water Meter reading (start):	…………..		*Kilolitres or Megalitres?*	**C**
Water Meter reading (end):	…………..		*Kilolitres or Megalitres?*	**D**
Time at water meter reading (start):	……………		*Use 24 hour clock*	**E**
Time at water meter reading (end):	……………		*Use 24 hour clock*	**F**
Duration of pumping:	**Time at end reading - Time at start reading** **F - E** **………. - ……….** **= ………… hours**			**G**

Maintenance

Previous service (Date):
Details of service:
Next service (Date):

Select your Type of meter and record your readings

Power Readings										
	Disc Meter	**1**	**2**	**3**	**Electronic meter**	**1**	**2**	**3**	**Fuel**	
H	r/kWh				Reading at start				Level at start	
J	Multiplier on meter				Reading at end				Level at end	
N	Number of disc revolutions				Multiplier (stated on bill)				Temperature	
T	Time for N (seconds)				Time between reading (seconds)				Oil Level (Dip stick)	
$	Price / kWhr				Price / kWhr				Price /litre of fuel	

Filter Losses		
Filter pressure Losses = Pressure at filter inlet - pressure at filter outlet		
Filter location:		
Pressure at filter inlet:		**PI**
Pressure at filter outlet		**PO**
Pressure Differential	= PI - PO = ………… - ………… = ………… kPa	
Normal allowance is about 70 kPa (7 metres)		

Pump Calculations

Pump Flow Rate		
Water Pumped	D - C Select unit of Reading ………… - …………. = ……………. KL or ……………. ML	**P**
Convert volume pumped into Litres	If your meter reads in Kilolitres P (KL) / 1000 ………… / ………… = ………….. Litres	
Convert volume pumped into Litres	If your meter reads in Megalitres P (ML) / 100000 ………… / ………… = ………….. Litres	**Q**
Flow Rate of pump	Volume pumped (litres Duration of Pumping (hours) / 3600 Q G / 3600 …………… / …………… / …………… = …………… L/s	**R**

Identify the power course and complete the Power used sheet appropriate for your situation.

Power Used - Disc Meter	1	2	3	
	N x 3600 x J ………. x 3600 x ………. = ……………			**a**
	H x T ………. x ………. = ……………			**b**
Power used	a / b ………. / ………. = …………… kW			**c**
Add the power used	Meter 1 c + Meter 2 c + Meter 3 c = ……………			**kW**
Pump Calibration Power per megalitre = Power used (kW) / Flow Rate (L/s) / 0.0036				
	kW / R / 0.0036 ………. x ………. x 0.0036 = …………… kWh/ML			**CAL**
Cost	CAL x $ ………. x ………. = ……………			

Compare your findings to your previous records. Variation in your findings to previous records may indicate changes in your system and its efficiency. Damaged or worn impellers may decrease flow rate or increase the power used to pump each mega litre of water. Clogged filters may be indicated by an increase in the pressure differential.

Power Used - Electronic	**1**	**2**	**3**	
	N x 3600 x J ………. x 3600 x ………. = ……………			**a**
Power Used = Difference in meter readings x 3600 x Multiplier / Time				
Power used	a / b ………. / ………. = …………… kW			**c**
Add all the Power used together =				**kW**
Calibration = Power used (kW) / Flow Rate (L/s) / 0.0036				
	kW / R / 0.0036 ………. x ………. x 0.0036 = …………… kWh/ML			**CAL**
Cost = CAL x $				
	………. x ………. = ……………			

Note: Another method to estimate costs per ML - Read water meter reading when council reads your electricity meter and then compare the electricity bill to the water used (Most recent water reading minus previous water reading).

Power bill / Water Use

For example Electricity bill = $5400, water usage = 270 ML

= $5400 / 270

= $20 per ML

Power Used - Diesel		
Fuel used	At start - at finish H - J …….. - ………… = ………… Litres	**b**
Pump Duration	……… hours	**G**
Pump fuel use	b ÷ G …….. ÷ ……….. = ………….. Litres of fuel per hour	**c**
Time to pump one megalitre	1000000 ÷ Flow Rate (L/s) ÷ 3600 1000000 ÷ R ÷ 3600 = 1000000 ÷ …….. ÷ 3600 = ……… hours	**d**
Fuel used to pump one ML	c x d …….. x ………..	**e**
Running Cost	e x $ ……… x ………… = …………..	
To estimate the kW of a diesel powered unit we may use the following equation Volume of fuel per hour ÷ 0.34		
	c ÷ 0.34 **= ………….. kW**	

Compare your findings to your previous records. Variation in your findings to previous records may indicate changes in your system and its efficiency. Damaged or worn impellers may decrease Flow rate or increase the power used to pump each mega litre of water. Clogged filters may be indicated by an increase in the pressure differential.

Pumping Unit Efficiency

When you check your pump you should also look at the suction. That is, are there any air pockets or leaks? Recording equipment such as gauges and meters should also be regularly serviced and calibrated. Gauges should be easily removable so that they may be stored away from the vibrations of the pump.

Pump efficiency is difficult to determine and will vary between pumps. Power usage in diesel pumps cannot be easily measured. However using the data you have collected you may be able to estimate the efficiency of electric pumping units. By collecting further data on your pump, a pump expert may be able to determine the efficiency of your pump and whether it is suitable for the duty of your system.

Efficiency of Pumping Unit = Flow rate x head (m) ÷ power

Pumping Unit Efficiency		
Suction Static lift	metres	**S**
Friction Loss	Assume 1 metre	**A**
Pressure at Discharge	kPa	**B**
Convert kPa Pressure into Head (metres)	KPa pressure x 0.102 B x 0.102 = ……… metres	**PM**
Head	PM + S + A …………… + …………… + 1 = ………… metres	**Head**
Flow rate	…………. L/s	**R**
Power		**kW**
Efficiency = Flow rate x Head (m) ÷ power = R x Head ÷ kW		
	= ……… x ………… ÷ ……… = ………….. %	

Note: Dirty filter will drastically affect operation pressure of emitter.

Compare your findings on the pump curve for your pump