Water Savings

Technical Basis For Loss and Water Savings Through and Around Outlets

Draft

Date: 2 October 2008

Document Number: 2476026

Document History and Distribution

Version(s)

Version	Date	Author(s)	Notes
3	9 October 2008	Derek Poulton, Mike Schulz, Michelle Winter	Document Creation as a formal report, replaces technical note in previous version, and more rigorous assessment of loss values, effectiveness & durability.
5	3 February 2009	Derek Poulton	Adopting comments from peer review meeting 5 January, and agreed effectiveness and durability values
6	24 February	Derek Poulton	Taking on Board comments from meeting between Hydro Environmental staff, Ian Moorhouse, Kevin Preece and Derek Poulton on 23 February 2009

Distribution

Version	Recipient(s)	Date	Notes
3	Internal Peer review	13 October 2008	For discussion.
5	Internal Peer review	3 February 2009	
6	HE staff, NVIRP, Matt Barden, Darren Nabbs		For information

Executive Summary

The appropriate water savings estimates for outlets with the potential for leakage are:

<u>**System Loss**</u>

Around the meter	0.4 ML/y/outlet
Through the meter	1.9 ML/y/outlet
Around and Through the meter - prior to 2006/07	2.3 ML/y/outlet

<u>**Effectiveness and Durability**</u>

Rationalisation

100% effective 100% durability

Replacement

For savings around meters

Engineering Standard	% Effectiveness	% Durability
Ideal	100	95
Less than Ideal	100	85
Unsuitable	100	0

For savings through meters

Type of replacement	% Effectiveness	% Durability
automatic	100	80
manual	90	80

1.1 Recommendation(s)

- The engineering standard associated with replacement of new meters be investigated and new standards recommended for each meter type.
- G-MW set standards for the minimum flow rate that can be detected through different meter types. Water savings associated with loss through meters be revised based, in part, on this standard.
- The values of system loss shown above be adopted for business case development and water savings project implementation.

Table of Contents

1 INTRODUCTION 1

2 LEAKS THROUGH OUTLETS 2

2.1 LOSS ESTIMATION 2
2.2 WATER SAVING ESTIMATION 3
2.3 RECOMMENDATIONS 4

3 LOSS AND SAVINGS AROUND OUTLETS 5

3.1 LOSS ESTIMATION 5
3.2 WATER SAVING ESTIMATION 5

4 SUMMARY 8

4.1 CONCLUSION(S) 8
4.2 RECOMMENDATION(S) 8

5 APPENDICES 9

5.1 APPENDIX A – TECHNICAL SPECIFICATION ON LEAKAGE RATES FOR PENSTOCK 9

6 GLOSSARY OF TERMS 10

2 Introduction

Loss through and around outlets was first identified as an issue in the research study 'Benchmarking Distribution Efficiency' (#335268) which suggested some 10% of loss was through water being lost through irrigation outlets. A subsequent study by area staff confirmed that similar loss rates were experienced in all irrigation areas. The issue of loss around meter outlets was analysed in the Water Systems Operational Review (2002).

As part of the study into loss components in the CG1234 system more rigorous studies were undertaken to analyze loss through outlets. Pondage test analysis confirmed that bank leakage and loss around outlets was a significant proportion of loss in the CG1234 system. Investigation of high loss pools suggested that in some pools the leakage around outlets was the main cause of loss through leakage.

This report summarises the technical basis for assumptions of system loss and water savings through and around outlets. The recommendations form the basis for various projects G-MW is involved in including asset rationalisation, reconfiguration, Shepparton/CG1234 modernisation and NVIRP.

3 Leaks Through Outlets

Leaks through outlets account for a large part of system loss. For instance, leakage through outlets account for about 8% of loss in the CG134 system and loss through outlets occur in about 20% of outlets (#1943471). About half of the loss is a result of customers allowing a flow of water through doors, at a rate greater than 20,000 L/h. This practice is considered as 'unauthorised use' and is not considered as 'leakage through an outlet' in this report.

Areas have improved surveillance of leaking outlets as part of the loss measurement program. This has resulted in savings through a G-MW investment in improved operations. However, leakage is due to poorly maintained neoprene seals and improper closing of the door by customers. During the 2006/07 season a program to locate and repair neoprene seals occurred.

3.1 Loss estimation

From the experience in CG1234 (#1943471).

- Average loss through outlets (CG134) - 3.86 ML/y/outlet
- Discounting outlets with loss rates >20,000L/hr - 2.1 ML/y/outlet
- Assuming outlets are non-operating 90% of time - 1.9 ML/y/outlet
- The average leak rate for outlets leaking <20,000 L/h – 400 l/hr

This technical basis established the estimate of loss in the CG1234 water balance study. The result has been extrapolated to other areas. While there is potential that different standards of maintenance have occurred in different irrigation areas, investigations by Area staff in 1998 on selected spur channels suggested similar loss rates occur throughout G-MW. In response to drought G-MW has been making continual investment in loss management since 2002/03. The finding of significant losses through irrigation outlets triggered a special purpose program to repair neoprene seals and improve maintenance on meters.

In CG134, of DMO outlets with leak rates in the 500-20,000 L/hr range, 36% required new gate seals, 25% required removal of debris from the gate and 29% were not leaking on re-inspection (#2013541 v1 - file note - outcome of testing to confirm savings possible on leaking doors in CG134 area).

Subsequently, as part of the 2006/07 meter maintenance program, neoprene seals were replaced on outlets found to be leaking in all irrigation areas. The results are shown in the table below.

Table 1 Results of Meter Rehabilitation Program

Area	Area DMOs	2006/07 maintenance program			
		rubbers	doors	sum	
	#	#	#	#	%
Shepparton[1]	2,197	264	0	264	12.0%
Central Goulburn 5-9[2]	4,084	32	3	35	0.9%
Rochester	2,251	0	0	0	0.0%
Pyramid-Boort[2]	2,198	4	0	4	0.2%
Murray Valley[1]	*2,735*	56	24	80	2.9%
Torrumbarry[3]	3,485	14	5	19	0.5%
GMID	16,950			402	2.4%
NVIRP	14,753			138	0.9%

1 - recorded as "required" (no record of "replaced", therefore assumed that required=replaced)

2 - recorded as "1" or "Y" in Rubbers or Doors fields (no record of "replaced", therefore assumed that 1=Y=replaced)

3 - recorded as "replaced"

Assuming that each (NVIRP)outlet repaired gave a sustained saving of 4 ML/y (#1943471) the overall saving is 552 ML. The total leakage through NVIRP DMO outlets was estimated to be 28031 ML in 2004/05. The 2006/07 meter maintenance program would have reduced this loss rate to 27,479 or 1.86 ML/outlet (27,479/14753). However, the number of seals and/or doors replaced was relatively small and this activity could be similar to routine maintenance. It is likely there was no sustained benefit because, a similar number of seals/doors on other outlets could become damaged.

This analysis suggests area staff are unable to repair the majority of leaking outlets. It is likely the major cause of leaking outlets is due to improper closure, or detritus in the water (sticks, weeds) that inadvertently cause the outlets to leak.

Recommendation

The loss rate through outlets should be 1.9 ML/outlet.

3.2 Water Saving Estimation

The water savings estimation will depend on the initial ‘effectiveness’ and longer term ‘durability’ of the change that occurs to the G-MW infrastructure (#2315603v3).

Where outlets are removed, as part of an asset rationalisation program, the water saving is considered 100% effective and 100% durable into the future. It is therefore assumed that the loss associated with the outlet removed will result in a water-saving over time of 1.9 ML/outlet, regardless of whether the outlet was found to be leaking.

Where the outlet is replaced it is considered there will be no leaks immediately after replacement (that is effectiveness = 100%). Further, new meters will have penstocks, low flow rates will be measured and surveillance will be improved.

Advice provided by Bill Heslop suggests:

- Magflow meters (0.45m) will measure low flows through outlets > 20,000 L/hr, but will have software set to ignore water flows below this value, to avoid a spurious flow being registered.

- Penstocks will be designed to reduce leakage to below 50 L/hr, if correctly closed down by customers. Flume gates will also be maintained to ensure leaks are less than 50 L/hr. However, there may be a difference in effectiveness between automatic outlets, because automatic outlets will close to a preset pressure level, and is not dependant on manual operation of a penstock, to achieve closure.
- Under the national metrological framework, maintenance schedules will be part of an annual audit requirement and this has been allowed for in all meter costing calculations. Maintenance consists of an annual check, meter validation and replacement interval on the gate. It will be recorded in an Asset management system.

Leakage through meters will be substantially reduced in the future, but not eliminated. It is therefore assumed:

- incidence of leakage will continue to occur in 20% of outlets but leaks greater than 100 L/hr will be repaired
- loss rate of leaking outlets will in the future be 80 L/hr (Appendix A , 6.1).
- loss rate of leaking outlets in the past was 400 L/h, that is the rate found in the CG134 area, excluding 5 outlets with leak rates over 20,000 l/h considered to be unauthorised use.

the overall leak rate will be 20% lower than the rate that occurred prior to modernisation, that is a durability of 80%.

3.3 Recommendations

Loss through outlet – 1.9 ML/y

Table 2 Effectiveness and Durability for loss through meters

	Effectiveness - %	Durability - %	Eff x Durability %
Rationalisation	100	100	100
Replacement (automatic)	100	80	80
Replacement (manual)	90	80	72

Water savings associated with rationalisation – 1.9 ML/outlet

Water savings associated with replacement (automatic)– 1.52 ML/outlet

Water savings associated with replacement (manual)– 1.37 ML/outlet

4 Loss and Savings Around Outlets

Leaks around outlets makes up a large part of the routine leaks repaired by operational staff. About half the total numbers of leaks repaired are leaks around outlets. The loss rate for individual leaks is thought to be between 2.4-11.8 ML/y in 2002 (#900407), based on area estimates, which compares with 1.9-4.9 ML/y in 2006 (#1814829), based on actual field measurements in the CG134 area.

4.1 Loss estimation

Before February 2008 a conservative approach, was taken and each outlet was assumed to have a leak rate of 0.1 ML/year around outlets. This value was adopted subsequently by Hydroenvironmental (#2315603v2) and also in G-MW programs such as reconfiguration and the loss measurement program.

This approach has now been updated based on the following consideration.

Table 3 Outlets by type and irrigation area

Data	Central Goulb	CG1234	CG (NVIRP)	Rochester	Pyramid-Boor	Murray Valley	Torrumbarry	Shepparton
Channel Evaporation	12,325	2,137	10,188	8,802	9,853	16,274	16,214	7,542
Channel Seepage	15,571	3,004	12,567	9,264	9,518	21,998	14,649	9,179
Undeemed D&S Use3	350	200	150	60	120	170	420	230
Length (km)[1,2]	1,482	263	1,219	579	1,254	959	1,234	678
Open Outlets	362	50	312	165	30	64	313	205
Magflow Outlets	61	15	46	35	7	14	27	18
Flume Gates	143	143	-	-	-	-	-	0
DLMOs	63	6	57	55	68	17	13	20
LMOs & SMOs	4,842	815	4,027	2,196	2,130	2,718	3,472	2177
Total # Outlets that Leak	5,471	1,029	4,442	2,451	2,235	2,813	3,825	2,420
All other outlets[3]	2,934	405	2,529	1,535	528	1,750	2,314	2,006

In 2004/05 there were 15,637 NVIRP outlets which had a potential for leakage through the outlet (excludes magflow and flume gates) in the NVIRP area and 15,766 with potential for leakage around the outlet.

There were 1890 outlets with a leak around the outlet, (10.7% of all outlets) reported by Moorhouse (#900407) between 1999/00 -2000/01. The loss for outlets found to be leaking was reported as 4.6 ML/y (#900407) and 3.6 ML/y (#1814829), that is a mean of 4.1 ML/y over two studies. This represents a total loss of 7.75 GL/y in the GMID. Over 19,215 outlets that had a potential for leakage, in the GMID, this represents 0.4 ML/y system loss for each outlet that has the potential for leakage.

4.2 Water Saving Estimation

The following approach is proposed based on discussion with DSE consultant Hydro Environmental:

Rationalisation

Effectiveness = 100% (outlet has been removed and therefore no leakage can occur around the emplacement – assume that the bank has been adequately recompacted following removal)

Durability = 100% (outlet remains removed and therefore no leakage can occur around the emplacement – any leakage that did occur due to inadequate compaction would be attributed to bank leakage)

Therefore
Savings = 100% x 100% x 0.4 = 0.4 ML/yr for each outlet rationalised

Replacement

Effectiveness = 100% (that is we can assume that an outlet that is replaced with adequate backfill and to adequate engineering standards to eliminate all leakage immediately). It is further assumed that the warranty period associated with works is at least 12 months, so that any work completed and found to be leaking, will be required to reinstated so it is not leaking. If the warranty period is less than 12 months, an effectiveness of 100% is not appropriate.

Durability depends on the engineering standard of the replacement works. It is likely that in the future, there will be a certain amount of leakage that will occur around the emplacement headwall, depending on the extent of the cutoff wall installed or the length of the pipe. It is considered that if the replacement is consistent with ideal engineering standards, for instance cut off walls, 2.5x the width of the emplacement) the durability is 95%, (consistent with Lanes formula). It is assumed adequate cut off walls will be used to both increase the seepage path, and to provide an effective barrier for yabby (crustacean) damage. It is assumed the emplacement will be installed consistent with approved G-MW engineering standards, in good foundation soil, in the centre of the bank, with protection from erosion with rock beaching. Appropriate construction standards will be used regarding the placement and setting of concrete, and compaction of soil around the emplacement. Failure to follow any aspect of this procedure will result in reduced durability, and hence lower water savings.

However, if engineering standards are less than ideal, perhaps to reduce cost, a durability value of 85% should be used. If no cut off walls are used then the durability is zero, that is no benefit beyond the current leakage rates around meters.

Table 4 Effectiveness and Durability for loss around meters

Engineering Standard	% Effectiveness	% Durability	Details
Ideal	**100 %**	**95 %**	• Appropriate Depth/Length of Cut Off Walls • Cut Off Walls designed to match outlet dimensions • Appropriate rock beaching • Ongoing Maintenance of Channel Profiles through Asset Maintenance Program (AMP), or equivalent. • Construction standards, and quality control during construction appropriate

Less than Ideal	**100 %**	**< 85 %**	• Cut Off Wall designed to a lower standard and constructed to match outlet dimensions • Less than Appropriate level of rock beaching • No Ongoing Maintenance of Channel Profiles through AMP or equivalent • Construction standards, and quality control during construction not appropriate
Unsuitable	**100 %**	**0 %**	• No cut off walls • No rock beaching • No ongoing maintenance through AMP or equivalent • Construction standards, and quality control during construction not used during construction.

5 Summary

5.1 Conclusion(s)

The appropriate water savings estimates for outlets with the potential for leakage are:

System Loss

Around the meter	0.4 ML/y/outlet
Through the meter	1.9 ML/y/outlet
Around and Through the meter	2.3 ML/y/outlet

Effectiveness and Durability

Rationalisation

100% effective 100% durability

Replacement

For savings around meters

Engineering Standard	% Effectiveness	% Durability
Ideal	100	95
Less than Ideal	100	85
Unsuitable	100	0

For savings through meters

Type of replacement	% Effectiveness	% Durability
automatic	100	80
manual	90	80

5.2 Recommendation(s)

- The engineering standard associated with replacement of new meters be investigated and new standards recommended for each meter type including construction standards.
- G-MW set standards for the minimum flow rate that can be detected through different meter types. Water savings associated with loss through meters be revised based, in part, on this standard.
- The values of system loss shown above be adopted for business case development and water savings project implementation.

6 Appendices

6.1 Appendix A – Technical Specification on leakage rates for penstock

AWMA - The seals on the penstock are specially designed to give the best degree of water tightness, assuming that the installation procedure has been correctly followed. However, whilst many units will be water tight, leakage will occur from time to time. The maximum leakage rate under normal operating on and off seating conditions, up to 6m head, is 0.1 L/ minute per metre of periphery.

Therefore a maximum leakage rate for a new penstock is calculated as:
Leak rate (new penstock) = [0.45 + 0.45 +0.8] x 0.1 = 0.17 l/min = 10.2 L/hr

However, with wear of seals over time a leak rate of 1.7 l/min (102 L/hr) is anticipated for those (~20%) of outlets that are leaking.

With agreed maintenance and acceptance of the above industry standard then all leakage through the meter could be kept to below 80 L/hr or 0.5 – 1 ML/year.

7 Glossary of Terms

This section defines the terms used throughout the document.

Term/Acronym	Description
effectiveness	The initial effectiveness of civil works that occur in the first 12 months of change in system infrastructure. Multiplied by 'effectiveness' gives the discount to be applied to 'system loss' when assessing the sustainable water saving associated with civil works.
durability	The extent to which the system loss rate reduces over time, and thereby reducing the sustainable water saving associated with water savings measures.
sustainable water saving	The water saving that can be considered to be sustained over the long term after an infrastructure upgrade, and as a result allows water entitlement to be made available for environmental and other purposes, without reducing the reliability of entitlement currently held.
LMP	Loss measurement program