Audit of Irrigation Modernisation Water Recovery 2014/15 Irrigation season

Report

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Cardno
Shaping the Future

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Summary of findings

Background and scope

This report details the findings from Cardno's audit of the estimates of the water recovery achieved through irrigation modernisation in northern Victoria for 2014/15. The majority of the water recovery is being delivered through the Goulburn-Murray Water (GMW) Connections Project. The GMW Connections Project is being implemented in two stages. Stage 1, which is funded by the Victorian Government, has been underway since 2008 and Stage 2, which is funded by the Commonwealth, commenced in 2012. The GMW Connections Project must be audited each year. This is the seventh annual audit of water savings from irrigation modernisation in the Goulburn-Murray Irrigation District.

The scope of activities included in this audit, as described in the audit brief, is as follows:

- The irrigation modernisation works in place for the 2014/15 'water year' (1 July 2014 to 30 June 2015).
- The GMW Connections Project operating area which is the whole Goulburn-Murray Irrigation District (Central Goulburn, Rochester, Pyramid-Boort, Murray Valley, Shepparton and Torrumbarry Irrigation Areas).
- Irrigation modernisation works and savings separately accountable to GMW Connections Project Stage 1 GMW Connections Project Stage 2 and the Shepparton and CG1234 irrigation modernisation project.

Audited Water Savings Estimates

Water savings are achieved through modernisation of irrigation infrastructure. The scope of the audit is to review Phase 3 and Phase 4 water savings estimates. The Phase 3 water savings estimates represent actual savings realised in the 2014/15 irrigation season as a result of works completed to date based on deliveries in 2014/15 and observed losses. Phase 4 savings represent the long term average savings that might be expected from the works completed to date.

The audited Phase 3 and Phase 4 estimates are set out in the following tables and, as required in the project brief, are separately accounted to the:

- Stage 1 project
- Stage 2 project
- Shepparton and CG1-4 residual works

Water savings from Stage 1 project (2014/15)

Water Savings Intervention	SH	CG1-4	CG 5-9	MV	RO	PB	TO	TOTAL
Phase 3 water savings								
Channel Rationalisation (ML)	12	-	1,033	4,524	695	2,234	7,730	16,229
Channel Automation (ML)	-	-	21,299	2,364	3,452	2,086	3,388	32,590
Service Point Replacement (ML)	-	-	14,119	7,221	5,734	7,679	7,281	42,034
Service Point Rationalisation (ML)	18	-	2,446	3,191	1,934	3,028	4,367	14,985
Channel Remediation (ML)	-	-	4,853	3,277	1,514	-	2,153	11,797
Total Phase 3 savings (ML)	**30**	**-**	**43,751**	**20,577**	**13,329**	**15,028**	**24,920**	**117,634**
Phase 4 water savings								
Channel Rationalisation (ML)	22	-	1,158	5,684	1,138	2,247	10,159	20,408
Channel Automation (ML)	-	-	29,852	4,593	4,834	2,700	5,209	47,188
Service Point Replacement (ML)	-	-	17,680	10,714	7,976	9,406	9,562	55,337
Service Point Rationalisation (ML)	39	-	3,115	4,921	2,709	3,838	5,953	20,575
Channel Remediation (ML)	-	-	5,160	3,712	1,777	-	3,031	13,680
Total Phase 4 savings (ML)	**61**	**-**	**56,965**	**29,624**	**18,434**	**18,191**	**33,914**	**157,188**

Note – Totals may not sum due to rounding

Water savings from Stage 2 project (2014/15)

Water Savings Intervention	SH	CG1-4	CG 5-9	MV	RO	PB	TO	TOTAL
Phase 3 water savings								
Channel Rationalisation (ML)	187	792	512	1,800	519	582	2,221	6,612
Channel Automation (ML)	99	-	-	-	-	-	-	99
Service Point Replacement (ML)	261	-	987	696	808	661	1,162	4,575
Service Point Rationalisation (ML)	3	-	180	724	448	347	708	2,411
Channel Remediation (ML)	356	822	40	1,125	-	-	248	2,591
Total Phase 3 savings (ML)	**906**	**1,614**	**1,719**	**4,344**	**1,776**	**1,590**	**4,338**	**16,287**
Phase 4 water savings								
Channel Rationalisation (ML)	189	1,066	720	2,464	2,694	709	3,193	11,036
Channel Automation (ML)	581	-	-	-	-	-	-	581
Service Point Replacement (ML)	350	-	2,026	1,094	935	1,455	1,843	7,704
Service Point Rationalisation (ML)	4	-	365	1,185	477	906	1,282	4,220
Channel Remediation (ML)	365	817	40	1,046	-	-	228	2,496
Total Phase 4 savings (ML)	**1,489**	**1,883**	**3,152**	**5,789**	**4,106**	**3,070**	**6,546**	**26,036**

Note – Totals may not sum due to rounding

Shepparton and CG1-4 Residual works (2014/15)

Water Savings Intervention	SH	CG1-4	TOTAL
Phase 3 water savings	ML	ML	ML
Service Point Replacement (ML)	190	920	**1,110**
Service Point Rationalisation (ML)	3	213	**216**
Total Phase 3 savings (ML)	**193**	**1,133**	**1,326**
Phase 4 water savings			
Service Point Replacement (ML)	385	1,104	**1,489**
Service Point Rationalisation (ML)	8	590	**598**
Total Phase 4 savings (ML)	**393**	**1,694**	**2,087**

Note – Totals may not sum due to rounding

Total water estimated savings for all projects

Project	SH	CG1-4	CG 5-9	MV	RO	PB	TO	TOTAL
Phase 3 water savings								
Stage 1 project (ML)	30	0	43,751	20,577	13,329	15,028	24,920	117,634
Stage 2 project (ML)	906	1,614	1,719	4,344	1,776	1,590	4,338	16,287
Shepparton - CG1-4 residual works (ML)	193	1,133	-	-	-	-	-	1,326
Total Phase 3 savings (ML)	**1,129**	**2,747**	**45,469**	**24,922**	**15,105**	**16,618**	**29,258**	**135,248**
Phase 4 water savings								
Stage 1 project (ML)	61	0	56,965	29,624	18,434	18,191	33,914	157,188
Stage 2 project (ML)	1,489	1,883	3,152	5,789	4,106	3,070	6,546	26,036
Shepparton - CG1-4 residual works (ML)	393	1,694	-	-	-	-	-	2,087
Total Phase 4 savings (ML)	**1,943**	**3,577**	**60,117**	**35,413**	**22,540**	**21,261**	**40,460**	**185,311**

Note – Totals may not sum due to rounding
Note – There are additional water savings volumes that are outside the scope of this audit

Mitigation water

Mitigation water is identified in Environmental Watering Plans as being required for environmental purposes in specific locations. Environmental Watering Plans require Ministerial approval. Some mitigation water is delivered through outfalls from the GMID and is required to be subtracted from the gross outfall savings achieved for channel automation. The table following summarises the mitigating flows subtracted from gross water savings attributable to water recovery.

	SH	CG5-9	MV	RO	TO	PB	Total
Phase 3 Mitigating Flows (ML)	-	-	-	-	-858	-1,174	-2,032
Phase 4 Mitigating Flows (ML)	-	-	-	-	-1,197	-1,588	-2,785

Systems and Processes

Our review for the 2014/15 audit of the information systems and processes used by GMW has found that they continue to be sufficiently robust to generate data and inputs that are as accurate as could reasonably be expected for the purpose of calculating water recoveries. GMW has made a significant improvement in 2014/15 through the introduction of the outfall data tool that sources data from SCADA.

Trailing of construction records

We found that most assets included in our samples for data trailing had sufficient evidence to support the fact that they have been constructed and commissioned. We are satisfied that GMW has completed the works claimed in the calculations. Over recent years, GMW has been consistently improving its documentation and construction records by keeping comprehensive work packs containing Inspection Test Procedures (ITP) and photos. However coinciding with recent changes in delivery models it appears that there has been a decrease in the quality of information provided in some areas. We note that ongoing diligence is required to ensure the quality of construction records. We make the following recommendations in relation to quality assurance of construction records:

- If decommissioning of channels or service points has occurred through a channel block then an ITP or other quality assurance document should still be generated that covers all assets downstream of the block with asset data and photos included, as well as a plan showing the location of the decommissioned assets in relation to the block.
- GMW should reiterate to all internal staff and external contractors responsible for recording construction activities the importance of the quality of documentation.

Water Savings Protocol Reporting Requirements

The Water Savings Audit Process[1] is a document under the Water Savings Protocol that sets out the approach to be taken to the independent audit of water savings. The scope of independent audit work relating to irrigation modernisation is to include the elements detailed below. Where each element is addressed in this report is set out below the individual element.

Verifying that the Phase 3 (and Phase 4) water savings calculations have been calculated in accordance with the Technical Manual for the Quantification of Water Savings.

We address this requirement in Section 6 of this report.

Checking that the data collection and inputs are as accurate as could reasonably be expected for the purpose of calculating water savings.

We address this requirement in Section 4 and 5 of this report.

Spot checks that the program of works has been implemented as documented in the water saving calculations.

We address this requirement in Section 5 of this report.

Checking that water savings have been calculated based on the nature and the extent of all modernisation works

We address this requirement in Section 5 of this report.

Providing a corrected estimate of the water savings for any component where the project proponent calculations are found to be non-compliant or deficient.

We address this requirement in Section 6 of this report.

Identifying potential improvements to the data collection, data analysis, assumptions and methods used to estimate the water savings. Recommend changes to the Technical Manual for the Quantification of Water Savings to the Director of Allocations and Licences within DSE (now DELWP) that will improve useability and accuracy of water savings.

We address this requirement in Section 7 of this report.

Checking if suggestions from the previous year's audit have been actioned upon and report upon the status of each of the suggested improvements.

We address this requirement in Section 8 of this report.

[1] *Water Savings Audit Process (Water Savings Protocol), Department of Sustainability and Environment Victoria, Version 2.0 June 2009.*

Glossary

A	Ratio of the length of channel to be or actually automated to the total length of channel in the defined system (%)
CG	Central Goulburn
CG134	Central Goulburn Channel 1, 3 and 4
CG2	Central Goulburn Channel 2 System
CL	Ratio of length of spur channel length rationalised to total spur channel length in system
D_{base}	Customer Deliveries in the Baseline Year in the irrigation system
DELWP	Department of Environment, Land, Water and Planning
DF	Durability factor to account for the durability of water savings interventions
DF_{error}	Durability factor for reducing measurement error
$DF_{leakage\ around}$	Durability factor for reducing leakage around the meter
$DF_{leakage\ through}$	Durability factor for reducing leakage through the meter
$DF_{unauthorised}$	Durability factor for reducing unauthorised use
D_{Mbase}	Customer deliveries through the Rationalised meters in the Baseline Year
$D_{MYear\ X}$	Customer deliveries through the replaced meters for the year in question
DSE	The Department of Sustainability and Environment
D_{YearX}	Customer deliveries in the year in question to the irrigation system
E_{Base}	Evaporation in Baseline Year
$EF_{bank\ leakage}$	Effectiveness Factor Channel automation (bank leakage)
EF_{error}	Effectiveness Factor for reducing measurement error
$EF_{leakage\ around}$	Effectiveness Factor for reducing leakage around the meter
$EF_{leakage\ through}$	Effectiveness Factor for reducing leakage through the meter
$EF_{rationaliation}$	Effectiveness Factor for channel rationalisation
$EF_{remediation}$	Effectiveness Factor for channel remediation
$EF_{unauthorised}$	Effectiveness Factor for reducing unauthorised use
$F(LTCE_{Base})$	Long Term Cap Equivalent Factor to convert Baseline Year volumes to Long Term Cap Equivalent volume
$F(LTCE_{YearX})$	Long Term Cap Equivalent Factor to convert Current Year volumes to Long Term Cap Equivalent volume
F(PA)	Pondage Testing Adjustment Factor to account for dynamic losses in addition to static losses
FL	Proportion of bank leakage recognised as fixed
GCP	
GIS	Geographic Information System
GMID	Goulburn Murray Irrigation District
GMW	Goulburn Murray Water
HR	High Reliability
IPA	Inter-Project Agreement
IPM	Irrigation Planning Module
ITP	Inspection Test Procedure
L_{Base}	Leakage in Baseline Year
$L_{Post\ works}$	Post works bank leakage

LR	Low Reliability
LTA	Defined Fixed Leakage Rate (ML/year/service point) around service points
LTCE	Long Term Cap Equivalent
LTDLE	Long Term Diversion Limit Equivalent
LTT	Defined Fixed Leakage Rate (ML/year/service point) through service points
M&E	mechanical and electrical
MCF	Adopted Meter Correction Factor for Dethridge Meter Service Points or associated with deemed Service Points
MV	Murray Valley
$N_{rationalised}$	Number of meters rationalised
$N_{replaced}$	Number of meters replaced
NVIRP	Northern Victoria Irrigation Renewal Project
O_{Base}	Outfalls in Baseline Year
OP_{yearX}	Ratio of the length of time a channel has been automated in the year in question relative to the irrigation season length in the Baseline Year
O_{yearX}	Outfalls in Current Year
PB	Pyramid-Boort
RL	Ratio of length of channel length remediated to total channel length in system
RO	Rochester
S_{Base}	Seepage in Baseline Year
SCADA	Supervisory Control and Data Acquisition
SH	Shepparton
SMC	Stuart Murray Canal
SMP	Strategic Measurement Project
$S_{post\ works}$	Post works seepage
the *Manual*	the Water Savings Protocol *Technical Manual*
the *Protocol*	the Water Savings Protocol for the Quantification of Water Savings from Irrigation Modernisation Projects
the *Technical Manual*	*Technical Manual for the Quantification of Water Savings*
t_m	Ratio of the length of time that the service point was replaced for irrigation purposes in the year in question to the irrigation season length in the Baseline Year
TO	Torrumbarry
t_r	Ratio of the length of time a channel has been rationalised in the year in question relative to the irrigation season length in the Baseline Year
TSA	Transfield Services Australia
U_{Base}	Unauthorised use loss in the Baseline Year
V_d	Deemed customer deliveries through individual unmetered service points in the Baseline Year
VL	Proportion of bank leakage recognised as variable
WEE	Water Entitlement Entity

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1 Introduction

1.1 Introduction and purpose

The Victorian State Government and the Commonwealth Government have committed significant funding for the renewal and modernisation of the Goulburn-Murray Irrigation District (GMID). The water savings achieved through the renewal and modernisation works are to be shared between the environment, Melbourne and irrigation customers. The works are also expected to improve the efficiency of delivery and increase the level of service provided to irrigation customers.

Goulburn-Murray Water (GMW) is the owner and operator of the GMID. The GMW Connections Project (previously the Northern Victorian Irrigation Renewal Project but since 1 July 2012 part of GMW) forms the greater part of the modernisation of the Goulburn-Murray Irrigation District (GMID).

The water savings achieved by the GMW Connections Project are to be audited each year. Cardno has been engaged by the Department of Environment, Land, Water and Planning (DELWP) to undertake an independent audit of the water recovery for the 2014/15 irrigation season. This purpose of this report is to present the findings of this independent audit. This is the seventh annual audit of the water savings achieved by the renewal and modernisation works in the GMID.

1.2 Water Savings Protocol

The Victorian State Government has developed a Water Savings Protocol so that water savings can be consistently and transparently calculated and audited. The Water Savings Protocol is a series of documents including the 'Audit Process' and 'Technical Manual'. The Audit Process document sets out that independent audit of water savings is to include:

- Verifying that the Phase 3 (and Phase 4) water recoveries calculations have been calculated in accordance with the Technical Manual for the Quantification of Water Savings
- Checking that the data collection and inputs are as accurate as could reasonably be expected for the purpose of calculating water recoveries
- Spot checks that the program of works has been implemented as documented in the water saving calculations
- Checking that water recoveries have been calculated based on the nature and the extent of all modernisation works completed prior to 30th June[2] in the year of the audit
- Providing a corrected estimate of the water recoveries for any component where the project proponent calculations are found to be non-compliant or deficient
- Identifying potential improvements to the data collection, data analysis, assumptions and methods used to estimate the water recoveries. Recommend changes to the Technical Manual for the Quantification of Water Savings to the Director of Allocations and Licences within DELWP that will improve useability and accuracy of water recoveries
- Checking if suggestions from the previous year's audit have been acted upon and report upon the status of each of the suggested improvements.

The Technical Manual defines the components of water savings and the methodology for estimating them. This is the principal document against which water savings estimates are verified.

A copy of the Protocol is available on the DELWP website at this location:
http://www.depi.vic.gov.au/water/rural-water-and-irrigation/improving-irrigation-efficiency/water-savings-protocol

[2] The Audit Protocol previously set the end date for the completion of modernisation works as 15 May. The point in time for determining water savings is now 30 June, as set out in the scope of works issued by DELWP.

1.3 Scope of 2014/15 irrigation season irrigation modernisation water recovery audit

The audit scope has been set by DELWP and is set out in the Project Brief, dated 31 August 2015. The scope of works is broadly an audit of water recovery estimates for the modernisation works being undertaken in Goulburn Murray Water's operating area. The audit scope included the following:

- Irrigation modernisation works in place for the 2014/15 water year (up to 30 June 2015).
- The water recovery estimates for the whole Goulburn Murray Irrigation District (Central Goulburn, Rochester, Pyramid-Boort, Murray Valley, Shepparton and Torrumbarry Irrigation Areas).
- The cumulative irrigation modernisation works and savings separately accountable to the:
  - GMW Connections Project Stage 1;
  - GMW Connections Project Stage 2; and
  - CG1234-Shepparton irrigation modernisation project.

  No audit is required for the long-term average water savings arising from the decommissioning of Campaspe Irrigation District and the East Loddon Stock and Domestic system as these savings are confirmed through independent auditing of water resource modelling.

The scope has required the auditor to address the following:

- Verifying that stated modernisation works have been carried out.
- Verifying that GMW estimated the water savings correctly in accordance with the Water Savings Protocol – Technical Manual for the Quantification of Water Savings in Irrigation Water Distribution Systems Version 4. The audit of water savings shall include:
  - Phase 3 – water savings generated in the 2014/2015 water year (for the GMW Connections Project only).
  - Phase 4 – long-term average water savings estimates.
- Confirming the water savings estimates or, if appropriate, establish corrected estimates.
- Identifying and recommending improvements to the collection and processing of information used for estimating water savings.

2 Background

2.1 Goulburn Murray Irrigation District

The Goulburn Murray Irrigation District (GMID) is composed of the following six main irrigation areas located in northern Victoria:

- Central Goulburn (CG) (which is divided into sub-areas CG1-4 and CG5-9)
- Murray Valley (MV)
- Pyramid-Boort (PB)
- Rochester (RO)
- Shepparton (SH) and
- Torrumbarry (TO).

Goulburn Murray Water (GMW) is responsible as both the Water Resource Manager and System Operator for the GMID. Figure 2-1 shows the location of the GMID and the main irrigation district.

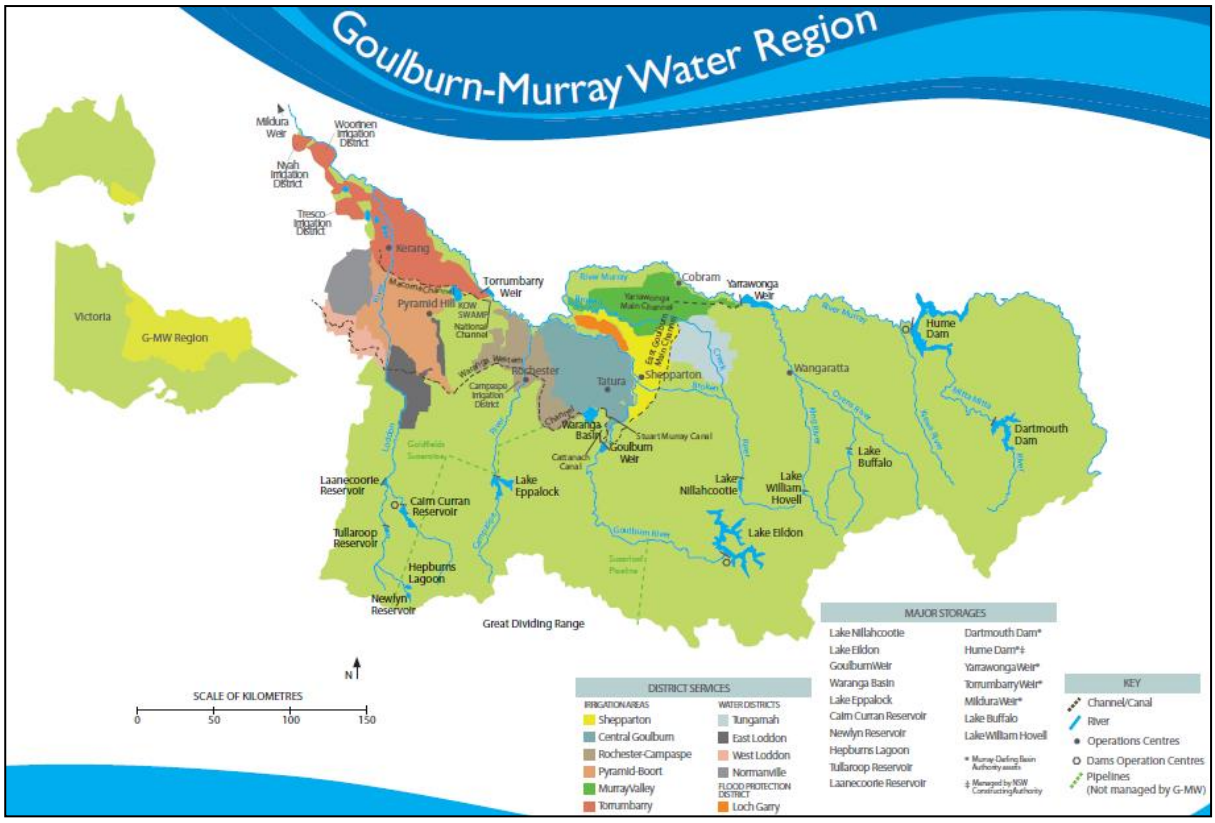

Figure 2-1 Goulburn Murray Irrigation District

Source: http://www.g-mwater.com.au/about/regionalmap

2.2 Irrigation modernisation

In 2004, the Victorian Government put in place a long-term plan for water resource management titled “Our Water Our Future”. A key initiative to deliver the sustainable outcomes targeted in this plan is modernisation of irrigation areas in northern and southern Victoria. Irrigation modernisation seeks to improve the efficiency of irrigation systems.

Irrigation modernisation typically involves the automation of channel infrastructure, construction of pipelines, upgrading the accuracy of metered outlets to farms, lining and remodelling of channels and rationalising the

channel network. Many systems are currently controlled manually and the automation of these systems allows water flows to be delivered more accurately and more quickly. These capital works, in unison with changed operational approaches, should have the twin benefits of reducing the amount of water lost in irrigation systems and improving service levels to customers.

The DELWP website[3] outlines the following main elements of irrigation modernisation:

Channel automation

Channel automation is a way of improving the efficiency of irrigation networks by using new technology to control the flow of water from the storage (usually a dam) through the distribution system to the irrigator. It involves replacing manual flow control structures in channels with updated gates that accurately measure flows, provide real time measurement data and, in most cases, are automated. The automation greatly reduces the water spilt from the end of channels (known as outfalls). Further the gate measurement allows more accurate location of the worst seepage and leakage losses and more effective targeting of channel remediation works.

Automation of the gates also provides the ability to interact with meters and on-farm automation equipment, so best practice irrigation methods can be employed on farms. Other benefits include constant flows and faster water delivery times.

Pipes and channels

Much of the irrigation system relies on open earthen channels to transport water. Inefficient operation and leaky sections result in up to 30% of the total volume being lost. Water losses can be minimised by reducing outfall losses, lining, remodelling or pipelining parts of the channel system.

Improved meter accuracy

Dethridge wheels are inaccurate and on average under-measure water delivery by about 8%. They fail to meet the new metering standards introduced by the Australian Government that specify a maximum of plus or minus 5% measurement inaccuracy. There are also occupational health and safety risks associated with using Dethridge wheels.

2.3 Irrigation modernisation projects

The GMW Connections Project is being implemented in two stages. Stage 1, which is funded by the Victorian Government, has been underway since 2008 and Stage 2, which is funded by the Commonwealth, commenced in 2012. Additionally, GMW is also responsible for the delivery of the Shepparton and Central-Goulburn 1234 irrigation modernisation project which was largely complete in 2010.

2.3.1 Shepparton and CG1234 Project

The Shepparton and CG1234 project was undertaken several years ago as an alliance, (named Futureflow), between GMW, a consultant and a contractor and was substantially completed by the 15 May 2010. The water savings from this project were audited in 2011. However, some works, principally meter replacements are not yet completed. The water savings achieved for the remaining works under this project also require audit.

2.3.2 Stage 1 Project

Under the funding arrangement between the State and Commonwealth Governments, signed in October 2011, Stage 1 of the project is being funded by contributions from the Victorian Government ($600 million

[3] http://www.depi.vic.gov.au/water/rural-water-and-irrigation/improving-irrigation-efficiency/modernising-irrigation-systems. *Note - minor edits have been made to this text to clarify its meaning.*

initial contribution and $100 Million from a portion of the funds relevant to the sale of 102 GL of water associated with GMW Connections Project) and Melbourne Water ($300 Million). This stage commenced in 2008 and is planned for completion in 2018.

The objectives of the Stage 1 project are to:

- Deliver a long-term average of 225 GL of annual project generated water by July 2018 to be shared equally between irrigators, the environment and other funding contributors
- Deliver a modernised backbone channel water distribution system
- Connect approximately 30% of those customers currently supplied by smaller spur channels to the backbone channel via a modern connection
- Upgrade metering (including real time measurement) on up to 50 per cent of customer supply points, by July 2018, and
- Provide channel remediation to reduce high loss channel pools.

2.3.3 Stage 2 project

The Commonwealth and Victorian Governments are providing funding of $1.059 billion for Stage 2 of the GMW Connections Project, which commenced delivery in 2012 and is planned to be completed in 2018. The Commonwealth Government is contributing $953 million and $106 million from a portion of the funds associated with the sale of 102 GL of water associated with GMW Connections Project.

The Stage 2 project is planned to raise the efficiency of the GMID system to over 85%, generating a long-term average of 204 GL of annual water savings from reduced distribution losses. Half of these savings are to be transferred to the Commonwealth Government for environmental use and in particular, contributing to Sustainable Diversion Limits in the Murray Darling Basin.

The works planned to be implemented under Stage 2 include:

- Metering: installation of 5,900 national measurement standard compliant irrigation meters, many of which will be fully automated with remote monitoring.
- Connections: development of new connections for 3,400 customers currently supplied by smaller spur channels (approximately 2,259km) and not dealt with in Stage 1. This also provides for new on-farm infrastructure and restructuring incentives for customers wishing to retire land from irrigation.
- Modernisation works across all irrigation areas including some work in the CG1-4 and Shepparton areas,
- Channel lining: lining of 75 km of high loss pools Service enhancement projects: construction of a number of projects to improve service standards in the GMID including key bottlenecks in the Torrumbarry irrigation area.
- Environmental enhancement projects: implementation of projects to enhance key environmental assets in the GMID.

The continuing works of this stage and other future works are planned to be managed by the GMW Connections Project until the project's estimated completion in 2018.

3 Audit Methodology

3.1 Water Savings Audit Process requirements

The Water Savings Audit Process[4] is a document under the Water Savings Protocol that sets out the approach to be taken to the independent audit of water savings. The scope of independent audit work relating to irrigation modernisation is to include the elements detailed below. Where each element is addressed in this report is set out below the individual element.

Verifying that the Phase 3 (and Phase 4) water savings calculations have been calculated in accordance with the Technical Manual for the Quantification of Water Savings.

We address this requirement in Section 6 of this report.

Checking that the data collection and inputs are as accurate as could reasonably be expected for the purpose of calculating water savings.

We address this requirement in Sections 4 and 5 of this report.

Spot checks that the program of works has been implemented as documented in the water saving calculations.

We address this requirement in Section 5 of this report.

Checking that water savings have been calculated based on the nature and the extent of all modernisation works

We address this requirement in Section 5 of this report.

Providing a corrected estimate of the water savings for any component where the project proponent calculations are found to be non-compliant or deficient.

We address this requirement in Section 6 of this report.

Identifying potential improvements to the data collection, data analysis, assumptions and methods used to estimate the water savings. Recommend changes to the Technical Manual for the Quantification of Water Savings to the Director of Allocations and Licences within DSE (now DELWP) that will improve useability and accuracy of water savings.

We address this requirement in Section 7 of this report.

Checking if suggestions from the previous year's audit have been actioned upon and report upon the status of each of the suggested improvements.

We address this requirement in Section 8 of this report.

The Audit Process also defines the expected content of the water savings audit report. The minimum requirements of the report and where they are fulfilled in this report is summarised in the following table:

[4] *Water Savings Audit Process (Water Savings Protocol), Department of Sustainability and Environment Victoria, Version 2.0 June 2009.*

Table 3-1 Expected Content of Water Savings Audit Report

Requirement	Relevant Section
A summary of findings.	Summary of Findings
An audited supporting data set and reports.	Section 6
Full evaluation of water savings estimation against protocol.	Section 6
Documentation of any instances of non-compliance and the required changes to the proponent's estimates.	Section 5 and 6
Full tabulation of water savings estimation against Project Proponent's Business Case targets.	Summary of Findings
Description of the audit process undertaken, including a description of how the information was audited and/or verified (e.g. sighted documentation, persons spoken to etc.).	Section 3
In addition to the audit report, the auditor can recommend, to DSE (now DELWP), improvements to the method for estimation, calculation and reporting water savings for future years. This may include recommendations of revisions to the Technical Manual for the Quantification of Water Savings, or to the Project Proponent's processes for estimating and reporting water savings.	Section 7

The following sub-sections detail the audit process undertaken.

3.2 Overview of audit methodology

The Cardno approach to auditing water recoveries is based around structured interviews with key authority staff. These structured interviews allow us to scrutinise the water recovery calculations and assess the veracity of the supporting information. Our audit focuses on these areas:

- Reviewing the systems and procedures in place to manage the data used in the calculations, including trailing the data used in the calculations back to source records
- Verifying that the works claimed are complete and commissioned through review of works handover and commissioning documents
- Checking that the audit calculations have been performed correctly
- Reviewing the GMW Connections Projects progress on the implementation of previous audit recommendations.

3.3 Schedule of audit meetings

Table 3-2 lists the meetings held to complete the audit work.

Table 3-2 Schedule of Audit Meetings

Date	Audit Work	Auditee	Position
Monday 2 November 2015	Audit of water savings calculations	Peter Roberts	Project Manager, Water Savings
Tuesday 3 November 2015	Site inspections	Peter Roberts	Project Manager, Water Savings
		Ben Morse	Water Savings Analyst
Wednesday 4 November 2015	Start-up Meeting	Ross Plunkett	Manager Environment & Water Savings
		Peter Roberts	Project Manager, Water Savings
		Ben Morse	Water Savings Analyst

Date	Audit Work	Auditee	Position
		Trudi Woodward	Construction Database Administrator
	Review of IPM and SCADA records	Mick Doherty	Water Systems Planner
		Chris Tomlinson	Water Systems Planner
		Peter Roberts	Project Manager, Water Savings
	Shepparton and CG1234 residual works	Jeremy Nolan	Design Authority Manager
		Jamie Cowan	Project Manager Construction
Thursday 4 November 2015	Close out meeting	Peter Roberts	Project Manager, Water Savings
		Kane Dougherty	Senior Project Manager
		Trudi Woodward	Construction Database Administrator
		Ben Morse	Water Savings Analyst
		Mick Doherty	Water Systems Planner
		Chris Tomlinson	Senior Business Consultant

3.4 Document register

A list of the documents received before, during and after the audit are included in Appendix A.

4 Information Systems and Business Processes Supporting Water Savings Calculations

4.1 Introduction

Our audit considers the systems and processes in use by GMW and its contractors that support the calculation of water recoveries to determine whether they are sufficiently reliable to produce accurate, repeatable and transparent data. Our review of systems and processes focuses on those business areas central to the water recovery estimates:

- Planning and delivery of construction works
- Outfall measurement and recording
- Customer deliveries
- Assignment of works between Stage 1 and Stage 2 projects.

Because of the importance of demonstrating that the water recoveries have been calculated based on accurate information, we have complemented this review of systems and processes, with trailing of selected data, used in the calculations, to their source. The results of this trailing are documented in Section 5.

To operate its irrigation network, GMW employs a number of information systems. The key systems are:

- SCADA – provides real time monitoring of gate operation, including trending. Field readings are stored and can be accessed through a data warehouse.
- Maximo – asset information system and computerised maintenance management system
- GIS – records location of channels and control gates. Channel lengths and widths are measured from here.
- The Irrigation Planning Module (IPM) takes customer orders, checks system capacity to deliver orders and records delivered volumes
- Agresso – the finance system for the GMW Connections Project which is used for tracking works progress and costs, as well as recording the categorisation of works between Stage 1 and 2.

4.2 Planning and delivery of construction works

In previous years, construction records were held across a number of different systems reflecting the different parties responsible for providing infrastructure. However, as the project has progressed, the majority of works are undertaken by a single contractor, TransCom Connect with construction records stored in its document management system, SharePoint (previously Aconex). TransCom Connect is a joint venture between Transfield Services Australia and Comdain Infrastructure. Previously, works were predominantly constructed by Transfield Services Australia alone.

TransCom Connect as the managing contractor typically manages a number of sub-contractors including designers, civil works contractors and mechanical and electrical (M&E) contractors to complete the required works. Works within the channels (e.g. regulator gate automation and channel remediation) are usually completed outside of the irrigation season, while service point replacements and rationalisations are delivered throughout the year.

Delivery of the modernisation assets generally follows the following sequence:

1. GMW's planners determines the schedule of works to be undertaken
2. TransCom Connect project manages the asset delivery:
    a. Engage designer to complete detailed design
    b. Engage civil subcontractor to complete civil works

c. Engage M&E subcontractor to complete M&E works

3. Asset commissioning
4. Handover of assets to GMW.

Some works are also being undertaken by GMW work crews, for example the Shepparton and CG1234 works.

When new assets are commissioned, or redundant channel decommissioned, an ITP certificate is produced which records relevant commissioning/decommissioning details. These ITP certificates are stored on SharePoint along with other documents relevant to the construction and commissioning of each site. These documents are collectively referred to as the 'work pack' for the constructed asset.

While handover of assets to GMW following a defects liability period is important for the successful ongoing operation of the modernisation works, we have focused on asset commissioning rather than handover, as water recoveries are typically achieved from the time that an asset is commissioned. Asset commissioning dates are recorded by TransCom Connect on schedules and forwarded to GMW. GMW then uses these dates in its water recovery calculations.

We believe that GMW's and TransCom Connect's systems for asset delivery and commissioning are sufficiently robust to completely and correctly record the details of irrigation modernisation asset installation and commissioning. TransCom Connect's document management system provides the reference database for the storage and retrieval of all construction and commissioning records. The database has been in use for several years.

4.3 Recording of outfall flow volumes

The volumes of flows through outfalls are an important data input into water savings calculations as savings from outfalls currently are a significant component of all water savings achieved. Now that irrigation modernisation works in the GMID have been in progress for several years, most major outfalls have online flow measurement which is recorded in the GMW SCADA. A number of unmetered outfalls still exist where flows are estimated by operators remain in operation (mainly on spur channels that may be decommissioned in the future). However, these account for only a small proportion of the water savings achieved and will largely be removed or replaced by SCADA monitored outfalls by the end of the GMW Connections Project, as decommissioning of spur channels occurs.

Where an outfall has online measurement, field staff record the outfall volume each day in a logsheet. There is a separate logsheet for each irrigation area. The field staff review the SCADA data and, if necessary, make adjustments for any erroneous readings, e.g. if the water level in the channel is particularly low, the flow reading may be a false high reading when in fact no water is leaving the outfall.

We note in Section 5.3 that GMW has implemented a tool in 2014/15 that sources outfall volumes from SCADA and uses these as the point of truth for reporting. We consider that this is a significant improvement compared to previous practices and is sufficient to meet the audit requirement "that the data collection and inputs are as accurate as could reasonably be expected for the purpose of calculating water recoveries". We note that this approach requires ongoing quality assurance to validate the outfalls recorded.

4.4 Customer delivery volumes

The IPM is the business system used by GMW to manage irrigation supply orders and plan the delivery of these orders. When an order is placed by a customer online or by telephone, it is sent to IPM. For customers on fully automated channels, IPM essentially sends the order to the customer's outlet. The orders specify the times to open and close the customer outlet and the ordered flow rate. The channel automation system uses a combination of feedback control on water level with feed-forward on flow to control to the channel.

IPM also provides management reporting facilities on a range of operational aspects and records delivery volumes for billing purposes. It also records delivery volumes against entitlements and rejects orders where the entitlement has been exceeded.

For the purposes of the water savings calculations, IPM is used to determine customer deliveries through service points. We have reviewed the procedures for extracting this data from IPM and found that they adequately describe the process.

4.5 Assignment of savings between Stage 1 and Stage 2

The Victorian and Commonwealth Governments enter into funding agreements for modernisation works in the GMID which are the basis on which water savings are assigned between the Stage 1 and Stage 2 projects. For all new proposed works, a Business Case is written and this Business Case details the Stage to which the works belong with reference to the relevant funding agreement. For historical works, a Business Case may not have been written, therefore, assignment of the works is undertaken by inspection. However, because the nature of the Stage 1 works, which typically involved the backbone, are generally different to the Stage 2 works, assignment of works to a project stage is usually reasonably straightforward.

When a Business Case is raised, it is entered as a record into the GMW Connections Project finance system, Agresso. The Business Case record has an identification number (referred to as the BCID) and linked to this record is the project stage. Progress and costs relating to the Business Case are then tracked using Agresso.

4.6 Conclusions

Our review for the 2014/15 audit of the information systems and processes used by GMW has found that they continue to be sufficiently robust to generate data and inputs that are as accurate as could reasonably be expected for the purpose of calculating water recoveries. GMW has made a significant improvement in 2014/15 through the introduction of the outfall data tool that sources data from SCADA.

4.7 Recommendations

As for previous years, we make no specific recommendations in the area of systems and processes.

5 Data trailing of calculation inputs

5.1 Objective

We have trailed data used in the calculation of water savings back to source systems and original data sets as part of our audit to test that the inputs utilised to estimate water savings is based on complete and accurate data contained in GMW information systems. The data trailing undertaken at the audit is a combination of random and targeted sampling.

We discuss the data trailing undertaken in the following sections.

5.2 Construction records

5.2.1 General

As in previous year, our review of construction records has focused on works constructed during 2014/15 as we have reviewed samples of assets constructed in previous years through previous audits. As noted in Section 4.2, construction of modernised irrigation infrastructure in 2014/15 was predominantly undertaken by TransCom Connect, a joint venture between Transfield Services Australia and Comdain Infrastructure. Some modernisation works are currently being undertaken by GMW.

5.2.2 Service point (meter) replacement and rationalisation – Stage 1 and Stage 2 project

We requested commissioning certificates (ITP certificates) for a sample of 24 sites (3.5% sample of 689 work packages undertaken in the 2014-15 irrigation year) where service points had been replaced or rationalised to confirm that the works have been completed. We also checked that that the date of the commissioning certificates agreed with the date claimed in the water recovery calculations.

The results of reconciling these records with the data used in the water savings calculation is summarised in Table 5-1. Note that the initial sample of meters selected included a number of meters which were outside of the scope of the audit, e.g. because they were stock and domestic meters or because they were not commissioned within the audit period. We confirm that GMW has not included savings arising from these out of scope meters.

Table 5-1 Results of service point replacement and rationalisation data trailing

Region	Asset	Audit notes
Murray Valley	MV6047	Evidence sufficient that work undertaken including ITP and photos
Murray Valley	MV5031	Evidence sufficient that work undertaken – no ITP but description and photos confirm works complete
Pyramid-Boort	PH189	Evidence sufficient that work undertaken including ITPs
Central Goulburn	RN1829	Evidence sufficient that work undertaken including ITPs
Torrumbarry	TO3074	Evidence sufficient that work undertaken including ITPs
Central Goulburn	TN5766	Evidence sufficient that work undertaken including ITPs and photos
Murray Valley	MV1230	No ITP “Done by others” but evidence sufficient that work undertaken
Central Goulburn	TN13206A	No ITP “Done by others” but evidence sufficient that work undertaken
Pyramid-Boort	PHDS2547B	Evidence sufficient that work undertaken including ITPs
Torrumbarry	TO1687	No ITP – just one email that doesn’t refer to this meter specifically
Torrumbarry	TODS2198A	Determined out of scope – no water savings
Murray Valley	MV6165	Evidence sufficient that work undertaken – no ITP but description and photos confirm works complete
Central Goulburn	TN5769	Evidence sufficient that work undertaken including ITPs and photos
Torrumbarry	TO0286	Evidence sufficient that work undertaken including ITPs and photos

Region	Asset	Audit notes
Pyramid-Boort	PH1229	No ITP "Done by others" but evidence sufficient that work undertaken
Central Goulburn	TN5673	Evidence sufficient that work undertaken including ITPs and photos
Murray Valley	MVDS5398	Determined out of scope – no water savings
Pyramid-Boort	PH108	Evidence sufficient that work undertaken including ITP
Murray Valley	MV6207	Evidence sufficient that work undertaken including ITPs and photos
Pyramid-Boort	PH124	Evidence sufficient that work undertaken including ITPs and photos
Torrumbarry	TO3009	Evidence sufficient that work undertaken including ITPs and photos
Torrumbarry	TO2219	Evidence sufficient that work undertaken including ITPs and photos
Murray Valley	MV6256	No ITP "Done by others" but evidence sufficient that work undertaken

The analysis in Table 5-1 shows that the information provided by GMW Connections is sufficient to confirm that the works claimed have been completed. 60% (15) of the sampled workpacks had robust evidence of completion, including ITPs and photos. Two of the 25 sampled sites (8%) reviewed had sufficient evidence of works completion including photos but were missing ITPs. Four additional sample sites, did not have ITPs but were marked as having been "done by others". These were found to be a part of a greater project, the decommissioning of a 100m channel, and were rationalised by a block upstream, with farmers removing the meters themselves. We recommend that if decommissioning of channels or service points has occurred through a channel block then an ITP or other quality assurance document should still be generated that covers all assets downstream of the block with asset data and photos included, as well as a plan showing the location of the decommissioned assets in relation to the block.

Three of the 24 sampled sites (12%) were identified as out of scope for this audit due to them being stock and domestic meters or because they are not yet commissioned.

The construction records provided for the sample of service point works reviewed are of a lower quality than those reviewed in 2013/14 where 95% of sampled sites reviewed had workpacks that contained ITPs and photos, but remains an improvement on the prior (2012/13) year's results where only 51% of sites included ITPs. This demonstrates the need for ongoing diligence regarding the quality assurance of construction records.

A number of other opportunities for improvement of GMW Connections Project's service point construction records were identified as follows:

- Many of the workpacks contained photos that had no identifying features, with no assurance that they related to the site. It is recommended that all photos of works include the identifier (e.g. meter number or channel name) latitude, longitude, date, and time within the photo attributes, and if practical, these attributes stamped onto the photo or contained within a paper sheet within the shot when taken.
- Few of the workpacks contained photos of 'before' works, to compare to 'after'; while this is not a necessity, it would provide further evidence of works completion.
- Some ITPs were not completely filled out – either missing references to the asset or business case, year/s in date fields, or sign-off pages so that initials were unidentifiable. It is recommended that these items are stressed as necessary by contractors and others completing works.

5.2.3 Service point replacement – Shepparton and CG1234 project

For this audit, we are required to review the water savings resulting from the completion of residual service point replacement works in 2014/15. The majority of this project was completed in previous years and has been subject to audit.

The remaining works to be audited this year are the replacement or rationalisation of 78 meters, all located in the Central Goulburn 1-4 area. The works were originally included in the scope of the Futureflow alliance but

were not completed because large diameter meters were required (large diameter meters have not become available until recent years).

We are satisfied that all works claimed are complete. We requested GMW to provide to us ITP certificates for 13 sites. For six sites (46%), the ITP certificates were provided. For seven of the sites without an ITP, five had both a Maximo screen shot and at least one (undated) photo; while two only had a Maximo screen shot as construction evidence. It is recommended that besides completed ITPs, labelled and dated photos before and after decommissioning works be kept for all works.

5.2.4 Channel Rationalisation (Decommissioning)

We requested that GMW provide us with construction records verifying that the channel rationalisation works claimed in the water recovery calculations have been completed for a sample of 23 sites of 144 channel rationalisation projects undertaken in 2014/15 (20% sample size). The results of this record trailing are detailed in Table 5-2.

Table 5-2 Results of channel rationalisation construction record trailing

Business Case	Region	A-ID	IPM/Asset Code	Notes
0615	Rochester	0615-101	ST032974 block	No ITP – photo is partial evidence work complete
2118	Torrumbarry	2118-500	ST004155	Evidence sufficient that work undertaken including ITPs and photos
2301	Pyramid-Boort	2301-500	ST009562	Evidence sufficient that work undertaken including ITPs and photos
0615	Rochester	0615-101	ST032967-block	Out of scope – construction finished 10/7/2015. Excluded from water savings.
2133	Murray Valley	2133-112	ST053708	No ITP – aerial map print out and photo evidence work complete
1278	Torrumbarry	1278-101	CH000913	No ITP – photo is partial evidence work complete
1500	Rochester	1500-500	8/23 Retic Pipeline	No ITP – photo is partial evidence work complete
9999	Central Goulburn	9999-500	ST010980	No ITP – photo is partial evidence work complete
0016	Murray Valley	0016-144	ST056673	The construction records for these works date from 2011. The savings have only been recognised by GMW this year.
2075	Torrumbarry	2075-500	CH000288	No ITP – photo is partial evidence work complete
9999	Central Goulburn	9999-500	CH009742	Evidence sufficient that work undertaken including ITPs
0024	Murray Valley	0024-110	MV5398	Evidence sufficient that work undertaken including ITPs and photos
2520	Shepparton	2520-500	CH015152	Out of scope – construction finished 28/7/2015. Excluded from water savings calculations.
1534	Pyramid-Boort	1534-129	PH56-Block	No ITP – photo is partial evidence work complete
2260	Central Goulburn	2260-500	2/12/9 BBEP	No ITP – photo is partial evidence work complete
2385	Central Goulburn	2385-100	TN1287	Evidence sufficient that work undertaken including ITPs and photos
2370	Rochester	2370-100	CH003853	No ITP – photo is partial evidence work complete

Business Case	Region	A-ID	IPM/Asset Code	Notes
2102	Central Goulburn	2102-500	ST044777	No ITP – photo is partial evidence work complete
2075	Torrumbarry	2075-100	TO1680	Evidence sufficient that work undertaken including ITPs and photos
2384	Pyramid-Boort	2384-100	ST009111 Block	Evidence sufficient that work undertaken including ITPs and photos
2595	Torrumbarry	2595-101	SH7540Block	No ITP – photo and aerial map is partial evidence work complete
1388	Torrumbarry	1388-500	ST044204	Evidence sufficient that work undertaken including ITPs and photos
1191	Rochester	1191-500	CH013272	Evidence sufficient that work undertaken including ITP

The analysis in Table 5-2 shows that the information provided by GMW is sufficient to confirm that the works claimed have been completed. For nine out of the 23 sites reviewed (39%), a comprehensive work pack that included an ITP and photos was provided. 11 of the 23 sites reviewed (47%) lacked an ITP and only had photos (sometimes accompanied with marked up maps) as evidence of works completion. This appears to be a reversal of the progress noted at the 2013/14 audit which recorded a significant improvement on the previous year (2012/13) when only 48% of the sites reviewed had a work pack that included an ITP. We recommend that GMW reiterate to all internal staff and external contractors responsible for recording construction activities the importance of the quality of documentation.

5.2.5 Remediation

We requested that GMW provide construction records for a sample of remediation works completed in 2014/15 to verify that the channel remediation works claimed in the water recovery calculations had been completed. A total of 11 pools were remediated in 2014/15. Six pools were included in the sample of sites reviewed and these are detailed in Table 5-3.

The records provided included maps, photos, track sheets and commissioning paperwork. Based on the evidence provided, we were able to confirm that the works in our sample are complete.

Table 5-3 Sample of remediation sites 2014-15

Area	Pool	Comment
MV	MV530-532(b)	Work confirmed
SH	SP1118-1121	No drawing
SH	SP616-617	Work confirmed
CG	TN255-256	Work confirmed
CG1-4	RN311-312	Work confirmed
TO	TO559-565	Work confirmed

Some forms also had some minor administrative issues in the workpack paperwork that should be addressed in future:

- ITPs missing sign-off pages, and some lack any indication of year (just show month and date) in sign offs
- Some property consent forms are missing landowner sign off.

As noted above, we recommend that GMW should reiterate to all internal staff and external contractors responsible for recording construction activities the importance of the quality of documentation to address the observed shortcomings.

5.2.6 Automation

Cardno undertook an audit of 11 (10%) of the 102 automation works that were undertaken in 2014/15. Table 5-4 shows the sample used.

Table 5-4 Sample of automation sites 2014-15

Area	IPM Number	Comment
ST004148	TO1022	Evidence sufficient that work undertaken
ST032820	RO107	Evidence sufficient that work undertaken
ST044435	RN442	Evidence sufficient that work undertaken
ST048677	RO602	Evidence sufficient that work undertaken
ST033662	RO466	Evidence sufficient that work undertaken
ST054712	MV577	Evidence sufficient that work undertaken
ST007819	TN509	Evidence sufficient that work undertaken
ST056633	MV900A	Evidence sufficient that work undertaken
ST008213	PH979	Evidence sufficient that work undertaken
ST027843	SH71	Evidence sufficient that work undertaken
ST034401	RO853	Evidence sufficient that work undertaken

All eleven workpacks provided evidence of works being completed including ITPs and photos.

A few minor quality control issues were identified that would improve GMW Connections Project's process:

- Some workpacks contained black and white photocopied photos which made them very poor quality and difficult to see. It is recommended that original PDFs or scanned colour copies are used in workpacks.
- Some ITPs were missing the year (only showing date and month) – the importance of the full completion of these forms should be reiterated to work package contractors.

5.3 Outfall volumes

We have noted in previous years that there has been some significant discrepancies observed between outfall flows recorded in SCADA and outfall records kept by operations staff. The water savings calculations have historically been based on the records kept by operations staff. While there may be sound reasons for the differences between the two records (e.g. if a level sensor is being maintained then the SCADA reading will likely be incorrect) we have found in previous years that the differences could not always be explained.

We stated in our 2013/14 audit report that "we expect that GMW Connections will put in place appropriate processes to understand the variances for future audit years to provide the necessary confidence in the outfall volumes used in the calculations. We also note that similar observations about outfall volumes have been made in previous years". During the 2014/15, GMW has created a tool that 'mines' SCADA for outfall data and stores the resulting set of data within IPM as the point of truth for outfall records. The monthly outfall flows are recorded for each outfall and sent to operations staff to review and advise of any discrepancies. Any changes to the data that can be justified are made in the central data set. Changes must have a reason recorded against them and the change is date stamped.

We consider that this tool is a considerable improvement compared with the approach to recording outfalls in previous years which relied on operator records. The tool has the benefit of being transparent and auditable back to meter readings. There is a risk though that erroneous flow readings are not identified through quality assurance. We identified one such erroneous set of flow data at outfall RO.405A at audit which on investigation GMW advised should not have been included in the outfall totals because the apparent readings were due to the channel being drained for maintenance. The reading had previously been sent to operations to check and the error had not been identified and the initial response from operations to our query was that the flow recorded on SCADA was correct. This demonstrates that there is need for some

further education on the use of the tool and associated change management as this tool is implemented and developed. However, we note that significant improvement has already been affected by GMW through the introduction of the tool.

5.4 Mitigating Flows

Mitigating flows are volumes of water that have been identified for alleviating the impacts of irrigation modernisation on wetlands and waterways of high environmental value. These flows are subtracted from water savings due to automation. Mitigating flow volumes are set out in Environmental Watering Plans approved by the relevant Minister. The approved Environmental Watering Plans are usually published on GMW's website at the below location, however they were not accessible online during the audit period and had to be requested directly.

http://www.GMWater.com.au/connections/planningandenvironment/the_environment/effects

Mitigating flows have been included in the water savings calculation for 2014/15 at 12 sites. We reviewed the Environmental Watering Plans relating to each of these sites to confirm that the correct allowance for mitigating flows had been made in the water savings calculations. The result of this data trailing is summarised in Table 5-5.

Table 5-5 Findings of review of Environmental Watering Plans

IPM Code	Asset Code	Site of environmental significance	EWP	Commitment %	2014/15 w/ Adjustment Volume (Annual BMW)	Audit notes
PH1052A	ST025235	Lake Leaghur	Lake Leaghur	33%	38ML / 117ML = 33%	Confirmed correct allowance for mitigating flows
PH1249	ST008516	Little Lake Boort	Lake Little Boort	67%	119ML / 177ML = 67%	Confirmed correct allowance for mitigating flows
PH1119	ST023738	Duncan	Loddon River	40%	38ML / 117ML = 33%	Confirmed correct allowance for mitigating flows
PH1138A	ST023656	Lake Meran	Lake Meran	100%	139ML / 139ML = 100%	Confirmed correct allowance for mitigating flows
PH1186	ST023234	River Pool	Loddon River	100%	707ML / 707ML = 100%	Confirmed correct allowance for mitigating flows
PH1211	ST025135	Dowdy's	Loddon River	90%	89ML / 78ML = 90%	Confirmed correct allowance for mitigating flows
PH1096	ST047427	Gannons	Loddon River	85%	57ML / 67ML = 85%	Confirmed correct allowance for mitigating flows
PH1224	ST023628 (ST073298)	Delamare	Loddon River	50%	36ML / 74ML = 49%	Confirmed correct allowance for mitigating flows
TO1025	ST004154	Lake Elizabeth	Lake Elizabeth	67%	355ML / 530ML = 67%	Confirmed correct allowance for mitigating flows
	Straight Cut	Pig Swamp	Pig Swamp	37%	170ML (Fixed amount)	Confirmed correct allowance for mitigating flows as per EWP

IPM Code	Asset Code	Site of environmental significance	EWP	Commitment %	2014/15 w/ Adjustment Volume (Annual BMW)	Audit notes
TO70	ST001206	McDonald's Swamp	McDonald's Swamp	100%	97 ML / 97ML = 100%	Confirmed correct allowance for mitigating flows
SH110	ST072390 (ST043937)	Round Lake	Round Lake	100%	236ML / 236ML	Confirmed correct allowance for mitigating flows

The structure code used for Round Lake in its Environmental Watering Plan (ST043937) differs from that which is used in the spreadsheet (ST072390). We confirmed that the correct mitigating flow amount has been allowed for. We recommend that GMW note this discrepancy in its calculation methodology.

5.5 Conclusions

We found that most assets included in our samples for data trailing had sufficient evidence to support the fact that they have been constructed and commissioned. We are satisfied that GMW has completed the works claimed in the calculations. Over recent years, GMW has been consistently improving its documentation and construction records by keeping comprehensive work packs containing ITPs and photos. However it appears that there has been a decrease in the quality of information provided in some areas. We note that ongoing diligence is required to ensure the quality of construction records.

5.6 Recommendations

We make the following recommendations in relation to quality assurance of construction records:

- If decommissioning of channels or service points has occurred through a channel block then an ITP or other quality assurance document should still be generated that covers all assets downstream of the block with asset data and photos included, as well as a plan showing the location of the decommissioned assets in relation to the block.
- GMW should reiterate to all internal staff and external contractors responsible for recording construction activities the importance of the quality of documentation.

6 Audit Findings –Water Savings Calculations

6.1 Structure of this chapter

This chapter has been structured to align with the structure of the *Technical Manual,* with each water saving intervention presented in the same order as found in that document. The *Technical Manual* provides additional discussion on the application of the water savings calculations that have been omitted from this report to avoid repetition.

For each water saving intervention (channel rationalisation, channel automation, service point replacement and rationalisation, and channel remediation) we detail:

- The nature of the works that lead to water recovery and the scope of works undertaken to date
- An overview of the components that contribute to water recovery in each area
- The calculations from the *Technical Manual* used to determine the savings in that area
- The data used in the calculation. Input data is sourced mainly from the *Technical Manual*, the baseline year water balance and operational records
- The water savings resulting from applying the calculation.

The scope of this audit is to review Phase 3 and Phase 4 water savings achieved, where:

- Phase 3 water savings are the annual post-works measurement or verification of interim water savings able to be allocated from the water savings account
- Phase 4 water savings are the assessment of the overall long term water savings achieved through the modernisation program.

6.2 Baseline year water balance

In calculating water savings, reference is made for some components to water loss that occurred in a baseline year. For most water savings components, the baseline year was the 2004/05 irrigation season. A water balance that establishes the value for water loss components in each irrigation area for this baseline year was compiled by GMW. This baseline year water balance has been previously independently audited.

Since the completion of this independent audit, GMW has revisited the baseline year water balance and made some revisions on the basis of better information being available or a more complete understanding of the nature of losses in the irrigation districts. This revised baseline year water balance was independently audited in 2012 and has been used as the basis of this audit.

6.3 Overview of water recovery achieved in 2014/15

The 2014/15 audit requires water savings to be separately accounted to the Stage 1 and Stage 2 projects. The Stage 1 project has been in progress since 2008 while the Stage 2 project commenced in 2012. Therefore, the Stage 1 project accounts for the great majority of savings, as shown in Table 6-1. Note that this table excludes savings from the residual works undertaken in the Shepparton and CG1-4 irrigation areas.

Table 6-1 Audited Phase 4 water savings by project

Project	Phase 4 water savings (ML)	% Total
Stage 1 project	157,188	86%
Stage 2 project	26,036	14%
Total	**183,224**	

Figure 6-1 provides an overview of the contribution of the different modernisation activities to the audited Phase 4 water savings for 2014/15 for both the Stage 1 and Stage 2 projects. This figure shows that service point replacement (34%) and channel automation (26%) are the most significant contributors to water savings achieved to date. Channel Automation works are largely complete and the share accountable to this intervention will reduce as a proportion of the total with time. As the Stage 2 projects progress, savings due to service point replacement and rationalisation and channel rationalisation are expected to increase.

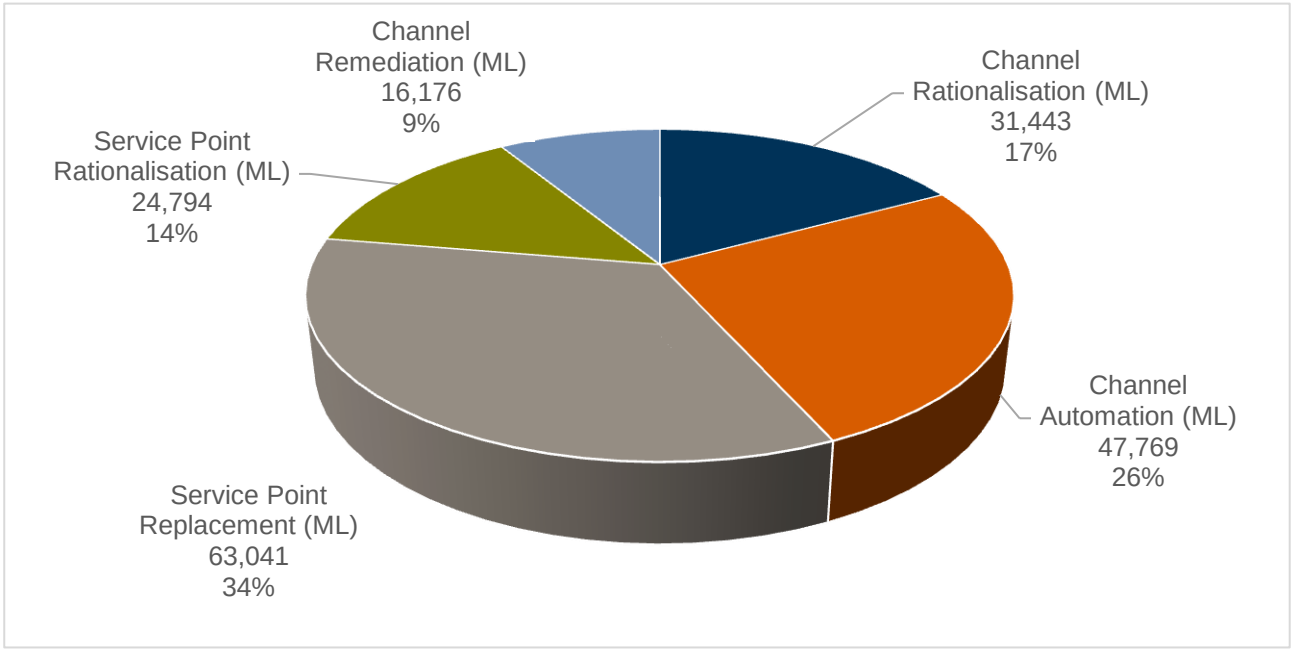

Figure 6-1 Audited Phase 4 Water Savings Estimates (Stage 1 and Stage 2 projects) 2014/15

6.4 Savings from Channel Rationalisation

6.4.1 Scope of Channel Rationalisation Works

Channel rationalisation involves redesigning the channel network so that channel length can be minimised while still providing service to customers. Channels that are determined to be redundant are abandoned and isolated from the distribution network and no flows enter them. This means that there are water savings due to reduced evaporation, bank seepage and bank leakage.

Channel rationalisation has been completed under the Stage 1 and Stage 2 projects. Rationalisation of spur channels under the Stage 2 project is expected to contribute significantly to water savings in future years as the GMW Connections Project progresses.

Figure 6-2 details the length of channels rationalised in each irrigation area under the Stage 1 and Stage 2 projects.

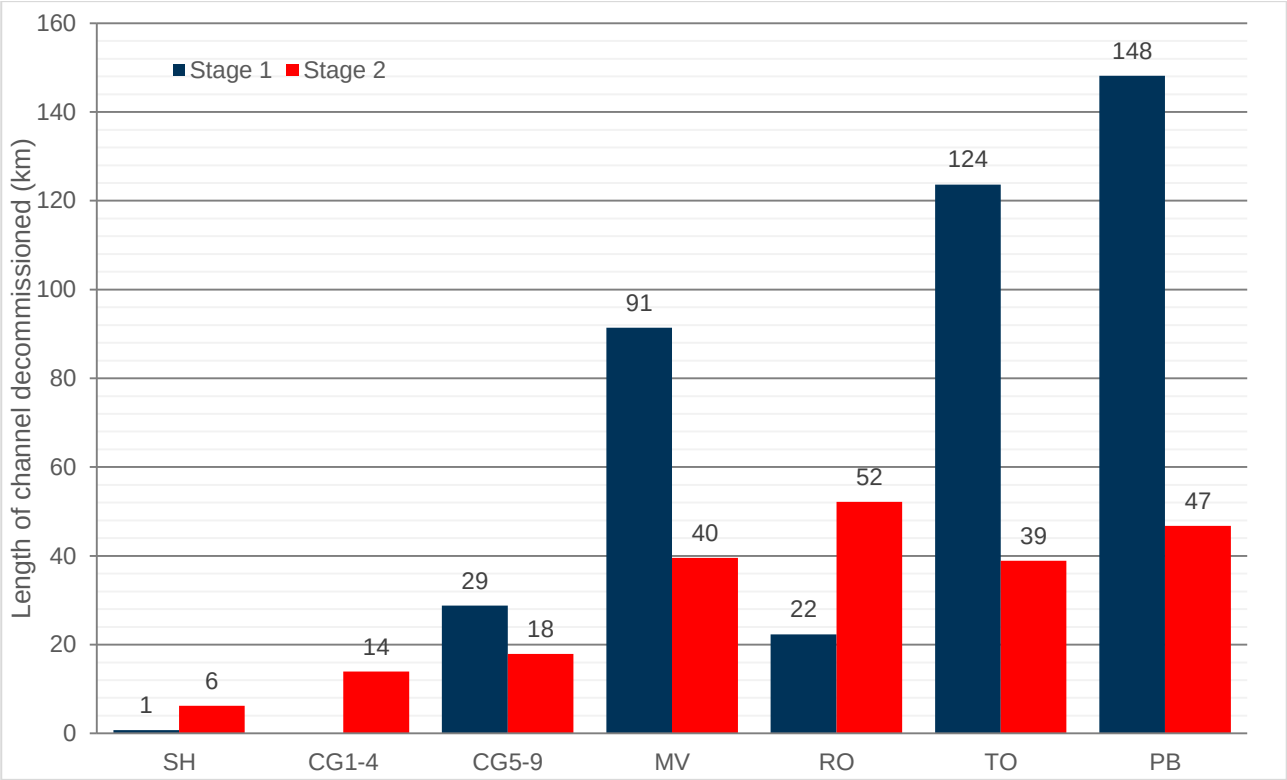

Figure 6-2 Length of rationalised channel by irrigation area under Stage 1 and Stage 2 project

6.4.2 Overview

Water savings due to channel rationalisation are the sum of the savings due to water no longer being lost in the channel to seepage, bank leakage, and evaporation:

Phase 3: $WS_{Yearx} = WS_{seepage} + WS_{bank\ leakage} + WS_{evaporation}$

Phase 4: $WS_{(LTCE)} = WS_{seepage(LTCE)} + WS_{bank\ leakage(LTCE)} + WS_{evaporation\ (LTCE)}$

6.4.3 Water Savings Calculations

Phase 3 Calculations

Phase 3 water savings have been calculated by GMW using the Phase 3 channel rationalisation formulae from the *Technical Manual*:

$$WS_{Seepage} = S_{Base} \times CL \times t_r \times EF$$

$$WS_{bank\ leakage} = [(L_{Base} \times FL) + (L_{Base} \times VL \times (D_{YearX} / D_{Base})] \times CL \times t_r \times EF$$

$$WS_{evaporation} = E_{Base} \times CL \times t_r \times EF$$

Phase 4 Calculations

Phase 4 water savings due to channel rationalisation are estimated by the following equations from the *Technical Manual*:

$$WS_{Seepage(LTCE)} = S_{Base} \times CL \times EF \times DF$$

$$WS_{bank\ leakage(LTCE)} = [(L_{Base} \times FL) + (L_{Base} \times VL \times F(LTCE_{Base}))] \times CL \times EF \times DF$$

$$WS_{evaporation(LTCE)} = E_{Base} \times CL \times EF \times DF$$

The differences between the Phase 4 calculations and the Phase 3 calculations are the addition of the durability factor (DF) and the replacement of the deliveries ratio with F(LTCE). The revision of the *Technical Manual* for Version 4 has also eliminated the time factor t_r from the Phase 4 calculation.

The revision of the baseline year in 2011/12 adjusted the baseline year losses for leakage, seepage and evaporation losses. Seepage and evaporation losses are also now taken to occur over a full year rather than just the irrigation season.

GMW applies the calculations on a channel by channel basis which gives a more accurate assessment of Phase 3 estimates than if the time and length factors were applied as an average across the entire irrigation area.

6.4.4 Input Data

The inputs required to calculate Phase 3 and Phase 4 water savings due to channel rationalisation are summarised in Table 6-2 and Table 6-3. The first table details the parameters that are fixed or have been previously audited, e.g. the baseline year parameters. The second table details the input data from the current year.

Table 6-2 Fixed Parameters and Baseline Year Parameters for Channel Rationalisation Water Savings Calculation

Parameter	Description	Source
S_{Base}	Seepage in Baseline Year	Baseline Year water balance
L_{Base}	Leakage in Baseline Year	Baseline Year water balance
E_{Base}	Evaporation in Baseline Year	Baseline Year water balance
D_{Base}	Deliveries in Baseline Year	Baseline Year water balance
FL	Proportion of bank leakage recognised as fixed	Technical Manual
VL	Proportion of bank leakage recognised as variable	Technical Manual
EF	Effectiveness Factor for channel rationalisation	Technical Manual
DF	Durability Factor to account for the durability of water savings	Technical Manual
F(LTCE)	Long Term Cap Equivalent Factor to convert Current Year volumes to Long Term Cap Equivalent volume	Calculated from deliveries and base figure advised by Department of Environment, Land, Water and Planning

Table 6-3 Current Year Parameters for Channel Rationalisation Water Savings Calculation

Parameter	Description	Source
CL	Ratio of length of spur channel length rationalised to total spur channel length in system	GIS and direct measurement
t_r	Ratio of the length of time a channel has been rationalised in the year in question relative to the irrigation season length in the baseline year	Construction records
$D_{Year\ x}$	Customer deliveries in the year in question to the irrigation system	IPM reports

We have reviewed the input data and confirm that the fixed parameters sourced from the *Technical Manual* are correct. We cross-checked the baseline year values against the baseline year audit report and confirmed that GMW has used values from the spur channels water balance.

Our review of the current year parameters used in the calculations found the following:

Customer Deliveries in the Current Year (D_{YearX})

Customer deliveries through the meters replaced in each irrigation district are determined through IPM. These delivery volumes are used for customer billing, as noted previously, and therefore we believe they will be reliable due to the scrutiny they are subject to by GMW and customers.

Ratio of Channel Length Rationalised to Total Channel Length (CL)

We confirm that GMW has correctly used the length of spur channels in each irrigation area as the denominator in this calculation. The numerator is the length of channels rationalised. We believe that the systems used for capturing and reporting lengths of channel rationalised are robust. GMW has improved its processes for estimating channel lengths with additional verification through GIS. We comment on our trailing of channel rationalisation records in section 5.2.4.

Ratio of Length of Time Channels Rationalised to Baseline Year (t_r)

This variable is determined from the channel de-commissioning date recorded. This factor has previously been material for Phase 3 savings given that the amount of rationalisation work completed each year is a significant proportion of the total. However, this is less so for 2014/15 and will not be significant in future. We note in our review of channel rationalisation construction records in section 5.2.4 that GMW provided comprehensive construction records.

6.4.5 Results

We found that GMW has correctly applied the water savings formulae to the input data. The audited water savings due to channel rationalisation are summarised in Table 6-4 for Phase 3 savings and Table 6-5 for Phase 4 savings.

Table 6-4 Phase 3 Water Savings due to Channel Rationalisation – Stage 1 and Stage 2

	SH	CG1-4	CG5-9	MV	RO	PB	TO	TOTAL
Stage 1								
Seepage (ML)	8	-	370	1,413	211	1,477	1,632	**5,110**
Bank leakage (ML)	1	-	505	2,487	391	2	5,547	**8,932**
Evaporation (ML)	3	-	158	625	93	756	552	**2,187**
Total	**12**	**-**	**1,033**	**4,524**	**695**	**2,234**	**7,730**	**16,229**
Stage 2								
Seepage (ML)	129	257	182	563	181	384	459	**2,156**
Bank leakage (ML)	7	446	252	988	259	-	1,606	**3,558**
Evaporation (ML)	50	89	78	249	80	197	155	**898**
Total	**187**	**792**	**512**	**1,800**	**519**	**582**	**2,221**	**6,612**
Total (Stage 1 and Stage 2)	**199**	**792**	**1545**	**6,324**	**1,214**	**2,816**	**9,951**	**22,841**

Table 6-5 Phase 4 Water Savings due to Channel Rationalisation – Stage 1 and Stage 2

	SH	CG1-4	CG5-9	MV	RO	PB	TO	TOTAL
Stage 1								
Seepage (ML)	15	-	376	1,500	297	1,485	1,738	**5,411**
Bank leakage (ML)	1	-	622	3,520	710	2	7,833	**12,688**
Evaporation (ML)	6	-	160	663	131	760	588	**2,309**
Total	**22**	**-**	**1,158**	**5,684**	**1,138**	**2,247**	**10,159**	**20,408**
Stage 2								
Seepage (ML)	129	301	234	650	704	468	546	**3,033**
Bank leakage (ML)	10	661	387	1,526	1,680	1	2,462	**6,725**
Evaporation (ML)	50	104	100	288	310	240	185	**1,277**
Total	**189**	**1,066**	**720**	**2,464**	**2,694**	**709**	**3,193**	**11,036**
Total (Stage 1 and Stage 2)	**212**	**1,066**	**1,878**	**8,148**	**3,832**	**2,956**	**13,352**	**31,443**

Note – Totals may not sum due to rounding

6.5 Savings from Channel Automation

6.5.1 Scope of Automation Works

Automation involves the replacement of manual flow control structures with modern automated gates that accurately measure flows, provide real time operational data, and can be controlled to meet the flow demands of customers. Automation greatly reduces the water spillage from the end of channels (outfalls), and reduces bank leakage by maintaining the level of water in a pool within a relatively restricted band.

Automation of the backbone channels in the GMW Connections Project works areas is complete for the Central Goulburn 5-9, Rochester and Pyramid-Boort areas.

6.5.2 Overview

Water savings due to automation are the sum of the savings realised through reduced outfall volumes:

Phase 3: $WS_{YearX} = WS_{outfalls}$

Phase 4: $WS_{YearX(LTCE)} = WS_{outfalls(LTCE)}$

There has been an important change in determining savings due to automation in that the updated version of the *Technical Manual* no longer includes savings due to reduced upper bank leakage in this component. Savings due to upper bank leakage when calculated previously composed less than 1% of all savings so it was not material. However, there is significant uncertainty in this estimate. Therefore, it has been omitted from the calculation until stronger evidence supporting its inclusion in savings estimates is established.

6.5.3 Water Savings Calculations

Phase 3 Calculations

Phase 3 water savings have been calculated by GMW Connections Project using the Phase 3 outfalls formula from the *Technical Manual:*

$$WS_{outfalls} = [(O_{base} \times (D_{YearX} / D_{Base})) - (O_{YearX})]$$

Phase 4 Calculations

Phase 4 water savings due to reduction in outfalls are estimated by the following equations from the *Technical Manual*:

$$WS_{outfalls} = [(O_{base} \times F(LTCE_{base})) - (O_{YearX} \times F(LTCE_{YearX}))] \times DF$$

The latest version of the *Technical Manual* has omitted the time factor OP which was the ratio expressing the proportion of the irrigation season for which the channels had been fully automated.

6.5.4 Input Data

The inputs required to calculate Phase 3 and Phase 4 water savings due to outfall automation are summarised in Table 6-6 and Table 6-7. The first table details the parameters that are fixed or have been previously audited, i.e. the baseline year parameters. The second table details the input data from the current year.

Table 6-6 Fixed parameters and baseline year parameters for Automation water savings calculation

Parameter	Description	Source
O_{Base}	Outfalls in Baseline Year	Baseline Year water balance
D_{base}	Customer Deliveries in the Baseline Year in the irrigation system	Baseline Year water balance
DF	Durability factor to account for the durability of water savings interventions	Technical Manual
$F(LTCE_{Base})$	Long Term Cap Equivalent Factor to convert Baseline Year volumes to Long Term Cap Equivalent volume	Department of Environment, Land, Water and Planning

Table 6-7 Current Year Parameters for Automation Water Savings Calculation

Parameter	Description	Source
O_{yearX}	Outfalls in Current Year	SCADA and operator logsheets
D_{yearX}	Customer Deliveries in the Current Year in the irrigation system	IPM reports
$F(LTCE_{YearX})$	Long Term Cap Equivalent Factor to convert Current Year volumes to Long Term Cap Equivalent volume	Calculated from deliveries and base figure advised by Department of Environment, Land, Water and Planning

We have reviewed the input data and confirm that the fixed parameters sourced from the Technical Manual are correct. We also found that the parameters sourced from the Baseline Year Water Balance are correct, noting that only outfall volumes for channels that have now been automated are included in the 2014/15 calculations.

GMW has applied an adjustment factor of 1.6 to the volumes recorded at unmetered outfalls in the baseline year to arrive at an adjusted baseline outfall volume.

The following summary is a review of the inputs from the current operating year:

Outfalls in Current Year (O_{yearX})

The largest outfalls responsible for the greatest water savings are generally measured on-line with feedback to GMW's SCADA. We note in Section 5.3 that GMW now uses SCADA data as the point of truth for outfall records.

Again this year, GMW has acted on the recommendation included in the 2011/12 audit and not set equal to zero the savings from groups of outfalls (pods) where the outflow in the current year

exceeded that in the baseline year (which would result in 'negative' savings) unless it has been able to find sufficient justification for doing so[5].

The impact of this change *can be* material – in 2011/12, the zeroing of outfalls contributed 1,831ML to Phase 4 savings. For the current year, no outfalls have been zeroed. We support this conservative approach.

GMW has subtracted environmental mitigating flows volumes from its savings. Environmental mitigating flows are specified in Environmental Watering Plans and are volumes determined by catchment managers as necessary to support specific high value habitats. Mitigating flows occur only in the Torrumbarry and Pyramid-Boort irrigation areas. Because mitigating flows occur through some outfalls that have 'negative' savings (i.e. the outfall in this year is greater than that in the baseline year) the mitigating flow cannot be subtracted from the outfall meaning that it is not possible to reconcile outfall savings and mitigating flows on an outfall by outfall basis. In this case the mitigating flow is zeroed and the loss is deducted from the overall automation savings.

As decommissioning of channels occurs, where an outfall previously existed, this may cause outfall volumes to be directed to neighbouring outfalls, increasing outfall at neighbouring sites relative to 2004/05 losses, potentially creating negative losses. Over the next few years, with decommissioning of outfalls occurring, the interaction of outfalls into larger groups (or for the operating system) needs to be taken into account by GMW.

Customer Deliveries in the Current Year (D_{YearX})

Customer deliveries in each irrigation district are determined from IPM reports. The volumes used are sourced from the same reports used for GMW's annual reporting.

Long Term Cap Equivalent Factor F($LTCE_{YearX}$)

This factor has been calculated by GMW in accordance with the formula in the Technical Manual using a factor of 1.3 for $LTCE_{Base}$ as advised by the Department of Environment, Land, Water and Planning. The ratio of delivered volumes has been applied for all operating areas.

6.5.5 Results

The audited water savings due to channel automation are summarised in Table 6-8. All channel automation works are attributable to the Stage 1 project except for channel automation works for Shepparton which are part of the Stage 2 project.

[5] Where the outfalls from a pod in the current year exceeded that in the baseline year the calculated saving would be less than zero, i.e. worse performance than in the baseline year. The *Technical Manual* allows these negative numbers to be set to zero on the basis that they are considered to be operational aberrations that would disappear in time. However, we consider that it is more appropriate, and a better indication of current water savings performance, to not set these values to zero. If these are operational aberrations, the savings will be 'caught up' in future

Table 6-8 Phase 3 and Phase 4 Water Savings due to Channel Automation

	SH	CG5-9	MV	RO	PB	TO	Total
Inputs							
O_{base} (ML)	1,539	26,503	8,981	8,047	5,307	8,410	**58,787**
O_{yearx} (ML)	898	1,959	4,421	3,635	1519	1989	**14,421**
D_{base} (ML)	191,844	312,082	293,026	199,271	221,668	405,049	**1,622,940**
D_{yearx}(ML)	124,237	273,878	221,413	171,804	200,673	334,807	**1,326,812**
Phase 3 Water Savings							
Gross Phase 3 savings (ML)	99	21,299	2,364	3,452	3,260	4,246	34,720
Zeroed outfalls (ML)	-	-	-	-	-	-	0
Mitigating flows (ML)	-				1,174	858	-2,032
Net Phase 3 savings (ML)	**99**	**21,299**	**2,364**	**3,452**	**2,086**	**3,388**	**32,688**
Phase 4 Water Savings							
Gross Phase 4 savings (ML)	**581**	**29,852**	**4,593**	**4,834**	**4,288**	**6,406**	**50,554**
Zeroed outfalls (ML)	-	-	-	-	-	-	-
Mitigating flows (ML)	-	-	-	-	- 1,588	- 1,197	-2,785
Net Phase 4 savings (ML)	**581**	**29,852**	**4,593**	**4,834**	**2,700**	**5,209**	**47,769**

Note – Totals may not sum due to rounding

6.6 Savings from Service Point Replacement and Rationalisation

6.6.1 Scope of Service Point Replacement and Rationalisation Works

Water savings are achieved when existing customer service points, usually Dethridge Wheels, are replaced with modern outlets. The modern designs are typically pipes with magflow meters or flume gates. Savings may also be achieved when existing service points are removed and not replaced (i.e. rationalised). The savings achieved are due to the improved construction of the service points, preventing leakage through and around the meter, as well as the increased accuracy of the new meters which better account for water use.

Service point replacement and rationalisation has been completed under the Stage 1 and Stage 2 projects. For this audit, we are also required to review residual works undertaken in 2014/15 for the Shepparton and CG1234 Project. The water savings achieved under this project have previously been audited and reported separately.

Figure 6-3 shows the number of service points replaced and rationalised in each irrigation area. Note that numbers for Stage 1 and Stage 2 projects have been shown combined.

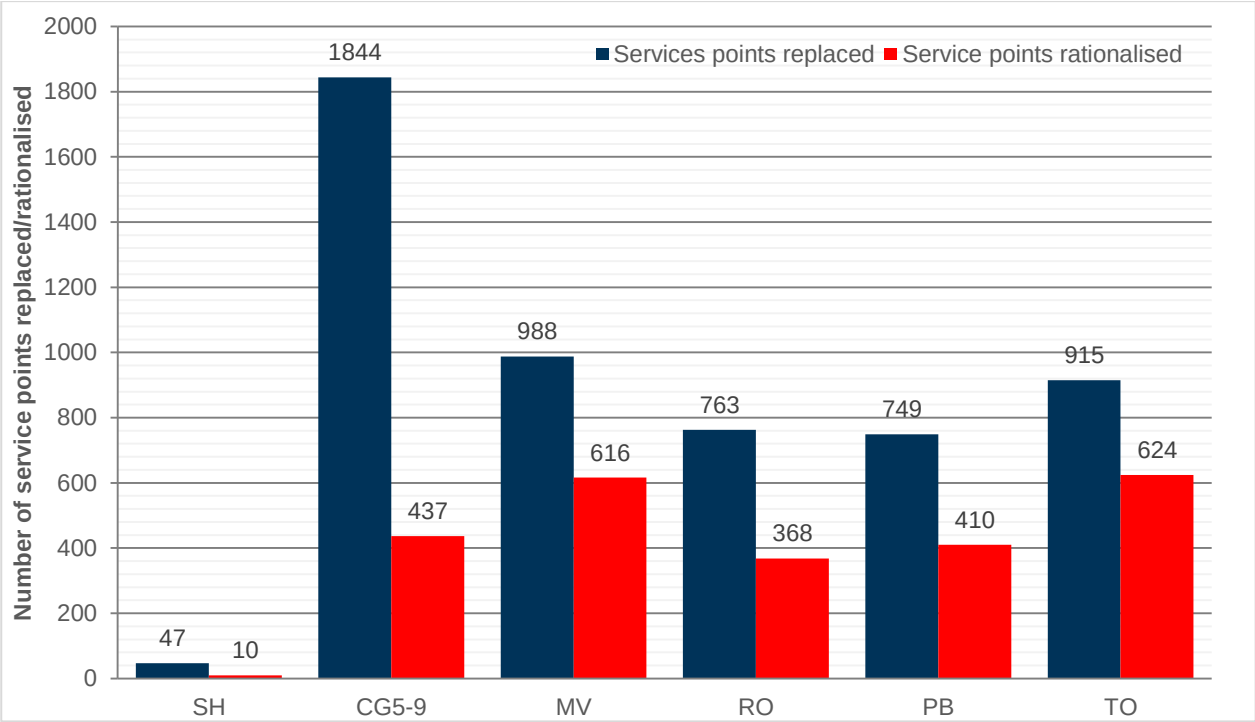

Figure 6-3 Numbers of service points replaced and rationalised (Stage 1 and Stage 2)

6.6.2 Overview

Water savings due to service point replacements and rationalisations are the sum of the savings realised through reduced meter errors, lowered leakage through and around the old meter, previously unmetered volumes and reduced unauthorised use. The same high level Phase 3 and 4 equations apply to both replacements and rationalisations although the individual components are determined differently.

The high level equations are the same for both Phase 3 and Phase 4 savings:

$$WS_{YearX} = WS_{meter\ error} + WS_{leakage\ through} + WS_{leakage\ around} + WS_{unmetered} + WS_{unauthorised}$$

6.6.3 Water Savings Calculations

The components of the Phase 3 and 4 water savings calculations are detailed following. Version 4 of the *Technical Manual* no longer includes the time discounting factor (t_m) in the Phase 4 calculations for either replacement or rationalisation of service points. GMW does not include the component for savings due to unmetered volumes as it believes that these are negligible.

Phase 3 Calculations – Service Point Replacement

Phase 3 water savings have been calculated by GMW using the formula in the *Technical Manual*:

$$WS_{YearX} = WS_{meter\ error} + WS_{leakage\ through} + WS_{leakage\ around} + WS_{unmetered} + WS_{unauthorised}$$

where

$$WS_{meter\ error} = D_{MyearX} \times (1/MCF) \times (MCF - 1) \times EF$$

$$WS_{leakage\ through} = N_{replaced} \times t_m \times LTT \times EF$$

$$WS_{leakage\ around} = N_{replaced} \times t_m \times LTA \times EF$$

$$WS_{unmetered} = \Sigma\ D_{MyearX} \times (1/MCF) \times (MCF - 1) \times EF \quad \textit{(not used)}$$

$$WS_{unauthorised} = N_{replaced} \times U_{base} \times EF \times (D_{YearX}/D_{base}) \times t_m$$

In the cases where a new service point has been added into a channel previously serviced by less meters, GMW denotes these as a "new-new meter". The new-new meter decreases water savings due to the leakage through and around the structure. Therefore, GMW has used a slightly different formula to calculate 'savings', which accounts for introduced losses that would not have been experienced before. The formulas only change in leakage through and unauthorised losses in Phase 3, and Leakage through, around, meter error and unauthorised losses for Phase 4. This is a conservative approach that we feel is appropriate.

Phase 3 Calculations – Service Point Rationalisation

Phase 3 water savings due to service point rationalisation have been calculated by GMW using the formula in the *Technical Manual*:

$$WS_{YearX} = WS_{meter\ error} + WS_{leakage\ through} + WS_{leakage\ around} + WS_{unmetered} + WS_{unauthorised}$$

where

$$WS_{meter\ error} = (D_{MBase} \times (MCF - 1) \times EF) \times (D_{YearX}/D_{base})$$

$$WS_{leakage\ through} = N_{rationalised} \times t_m \times LTT \times EF$$

$$WS_{leakage\ around} = N_{rationalised} \times t_m \times LTA \times EF$$

$$WS_{unmetered} = (V_D \times (MCF - 1) \times EF) \times (D_{YearX}/D_{base})$$

$$WS_{unauthorised} = N_{rationalised} \times U_{Base} \times EF \times (D_{YearX}/D_{base}) \times t_m$$

Phase 4 Calculations – Service Point Replacement (not used, see explanation at end of this section)

Phase 4 water savings have been calculated by GMW using a formula from the May 2012 *Technical Manual*, however with meter error estimated on D_{Base} rather than $D_{Year\ X}$:

$$WS_{YearX(LTCE)} = WS_{meter\ error(LTCE)} + WS_{leakage\ through(LTCE)} + WS_{leakage\ around(LTCE)} + WS_{unmetered(LTCE)} + WS_{unauthorised(LTCE)}$$

where

$$WS_{meter\ error} = D_{MYearX} \times (1/MCF) \times (MCF\text{-}1) \times EF \times DF \times F(LTCE_{YearX})$$

$$WS_{leakage\ through} = N_{replaced} \times LTT \times EF \times DF$$

$$WS_{leakage\ around} = N_{replaced} \times LTA \times EF \times DF$$

$$WS_{unauthorised} = N_{replaced} \times U_{Base} \times EF \times DF \times F(LTCE_{base})$$

$$WS_{unmetered} = D_{MBase} \times (1/MCF) \times (MCF - 1) \times EF \times DF \times F(LTCE_{YearX})$$

Phase 4 Calculations – Service Point Rationalisation

Phase 4 water savings due to service point rationalisation have been calculated by GMW using the formula in the *Technical Manual:*

$$WS_{YearX(LTCE)} = WS_{meter\ error(LTCE)} + WS_{leakage\ through(LTCE)} + WS_{leakage\ around(LTCE)} + WS_{unmetered(LTCE)} + WS_{unauthorised(LTCE)}$$

where

$$WS_{meter\ error(LTCE)} = (D_{MBase\ x} \times (MCF - 1) \times EF \times DF) \times F(LTCE_{base})$$

$$WS_{leakage\ through(LTCE)} = N_{rationalised} \times LTT \times EF \times DF$$

$$WS_{leakage\ around(LTCE)} = N_{rationalised} \times LTA \times EF \times DF$$

$$WS_{unmetered(LTCE)} = (V_D \times (MCF - 1) \times EF \times DF) \times F(LTCE_{base})$$

$$WS_{unauthorised(LTCE)} = N_{rationalised} \times U_{Base} \times EF \times DF \times F(LTCE_{base})$$

The same formula for calculating Phase 4 long term meter error savings (Equation 13.3.4) as the basis for both rationalised and replaced service outlets has been adopted. The meter error savings is based on customer deliveries in the baseline year (2004/05) instead of the year in question as previously used in Equation 12.3.4 for the calculation of long term meter error savings for service point replacement. DELWP has endorsed this approach and intends to revise the Technical Manual accordingly at the next opportunity.

6.6.4 Input Data

The inputs required to calculate Phase 3 and Phase 4 water savings due to service point replacement and rationalisation are summarised in Table 6-9 and Table 6-10.

Table 6-9 details the parameters that are fixed or have been previously audited. Table 6-10 details the input data from the current year.

Table 6-9 Fixed Parameters and Baseline Year Parameters for Service Point Replacement and Rationalisation Water Savings Calculation

Parameter	Description	Source
MCF	Adopted Meter Correction Factor for Dethridge Meter Service Points or associated with deemed Service Points	Technical Manual
$EF_{meter\ error}$	Effectiveness Factor for reducing measurement error	Technical Manual
$EF_{leakage\ through}$	Effectiveness Factor for reducing leakage through the meter	Technical Manual
$EF_{leakage\ around}$	Effectiveness Factor for reducing leakage around the meter	Technical Manual
$EF_{unauthorised}$	Effectiveness Factor for reducing unauthorised use	Technical Manual
LTA	Defined Fixed Leakage Rate (ML/year/service point) around service points	Technical Manual
LTT	Defined Fixed Leakage Rate (ML/year/service point) through service points	Technical Manual
U_{base}	Unauthorised use loss in the Baseline Year	Technical Manual
D_{base}	Customer Deliveries in the Baseline Year	Baseline Year water balance
DM_{base}	Customer deliveries through the Rationalised meters in the Baseline Year	Baseline Year water balance
DF_{error}	Durability factor for reducing measurement error	Technical Manual
$DF_{leakage\ through}$	Durability factor for reducing leakage through the meter	Technical Manual
$DF_{leakage\ around}$	Durability factor for reducing leakage around the meter	Technical Manual

Parameter	Description	Source
$DF_{unauthorised}$	Durability factor for reducing unauthorised use	Technical Manual
$F(LTCE_{base})$	Long Term Cap Equivalent Conversion Factor for the baseline year	Department of Environment, Land, Water and Planning

Table 6-10 Fixed Parameters and Baseline Year Parameters for Service Point Replacement and Rationalisation Water Savings Calculation

Parameter	Description	Source
D_{MYearX}	Customer deliveries through the replaced meters for the year in question	IPM reports
D_{YearX}	Customer deliveries in the year in question to the irrigation system	IPM reports
$N_{replaced}$	Number of meters replaced	Construction records
$N_{rationalised}$	Number of meters rationalised	Construction records
$F(LTCE_{YearX})$	Long Term Cap Equivalent Factor to convert Current Year volumes to Long Term Cap Equivalent volume	Calculated from deliveries

We have reviewed the input data and confirm that the fixed parameters sourced from the Technical Manual are correct. GMW has correctly applied the different effectiveness factors for preventing leakage through automated (100%) and manual (90%) meters.

We also found that the parameters sourced from the Baseline Year Water Balance are correct. The following summary is a review of the inputs from the current operating year:

Customer Deliveries through Replaced Service Points (D_{MYearX}) and in the Irrigation System (D_{YearX})

Customer deliveries through the replaced meters and in each irrigation district are determined through IPM. These delivered volumes are used for customer billing and, as noted previously, we believe they will be reliable due to the scrutiny they are subject to by GMW and customers.

Number of Service Points Replaced and Rationalised ($N_{replaced}$, $N_{rationalised}$)

The number of meters replaced and rationalised is determined from construction records. GMW demonstrated the process it undertakes for handling service point record data. This process includes collating data from different sources and then filtering this data and removing any duplicate or anomalous records. We are satisfied that this process is robust. GMW also achieves meter error savings where new meters have been installed as part of system decommissioning works.

We reviewed the commissioning certificates for a sample of service points under the Stage 1 and Stage 2 projects, as outlined in Section 5.2.2. We also reviewed this year work packs and commissioning certificates for service points replaced under the Shepparton and CG1234 project as outlined in Section 5.2.3. This review provided evidence that the sample of works claimed as complete by GMW had been completed.

Ratio of time Service Point in use compared to Baseline Year (t_m)

This factor is calculated by GMW based on the commissioning (or de-commissioning in the case of rationalisation) dates for each service point. As the works have been in progress for a number of years, the t_m factor has limited impact on the calculated Phase 3 savings. We found that the t_m factor has been calculated and applied correctly by GMW for service point replacements.

Our review of commissioning certificates for a sample of service points is outlined in Section 5.2.2 and Section 5.2.3. We found that GMW has robust construction records for meter replacement and rationalisation.

Long Term Cap Equivalent Factor F($LTCE_{Base}$)

This factor has been calculated by GMW in accordance with the formula in the Technical Manual using a factor of 1.3 for $LTCE_{Base}$ as advised by the Department of Environment, Land, Water and Planning. The ratio of deliveries volumes has been applied for all of the GMW operating areas.

6.6.5 Results

The audited water savings due to service point replacements are summarised in Table 6-11 and Table 6-12. Note that GMW performs these calculations on a meter by meter basis and not for an irrigation area nor as a whole system.

Table 6-11 Phase 3 and Phase 4 Water Savings due to Service Point Replacement and Rationalisation– Stage 1 project

	SH	CG5-9	MV	RO	PB	TO	Total
Service point replacement							
Phase 3 Water Savings							
Meter error (ML)	-	9,466	4,972	3,944	6,062	5,418	29,862
Leakage through service points (ML)	-	2,981	1,491	1,157	1,036	1,211	7,877
Leakage around service points (ML)	-	648	324	247	221	263	1,703
Unauthorised Use (ML)	-	1,024	434	386	360	388	2,592
Total (ML)	**-**	**14,119**	**7,221**	**5,734**	**7,679**	**7,281**	**42,034**
Phase 4 Water Savings							
Meter error (ML)	-	13,307	8,537	6,232	7,823	7,710	43,610
Leakage through service points (ML)	-	2,307	1,147	925	841	975	6,195
Leakage around service points (ML)	-	595	299	234	214	253	1,596
Unauthorised Use (ML)	-	1,471	730	584	528	622	3,936
Total (ML)	**-**	**17,680**	**10,714**	**7,976**	**9,406**	**9,562**	**55,337**
Service point rationalisation							
Phase 3 Water Savings							
Meter error (ML)	-	1,284	1,982	1,078	2,105	3,046	9,495
Leakage through service points (ML)	12	716	769	529	563	821	3,410
Leakage around service points (ML)	2	149	162	110	118	173	714
Unauthorised Use (ML)	4	298	278	217	242	327	1,366
Total (ML)	**18**	**2,446**	**3,191**	**1,934**	**3,028**	**4,367**	**14,985**
Phase 4 Water Savings							
Meter error (ML)	18	1,805	3,404	1,703	2,716	4,335	13,981
Leakage through service points (ML)	11	718	828	551	614	882	3,604
Leakage around service points (ML)	2	149	174	114	129	186	755
Unauthorised Use (ML)	7	442	515	340	379	551	2,235
Total (ML)	**39**	**3,115**	**4,921**	**2,709**	**3,838**	**5,953**	**20,575**
Total Phase 3 savings (Replacement and rationalisation)	**18**	**16,566**	**10,412**	**7,668**	**10,707**	**11,648**	**57,019**
Total Phase 4 savings (Replacement and rationalisation)	**39**	**20,795**	**15,635**	**10,685**	**13,244**	**15,515**	**75,912**

Note – Totals may not sum due to rounding

Table 6-12 Phase 3 and Phase 4 Water Savings due to Service Point Replacement and Rationalisation – Stage 2 project

	SH	CG5-9	MV	RO	PB	TO	Total
Service point replacement							
Phase 3 Water Savings							
Meter error (ML)	146	640	512	671	496	860	3,325
Leakage through service points (ML)	73	228	122	83	114	197	816
Leakage around service points (ML)	17	41	27	18	24	43	169
Unauthorised Use (ML)	24	78	35	37	27	62	263
Total (ML)	**260**	**987**	**696**	**808**	**661**	**1,162**	**4,574**
Phase 4 Water Savings							
Meter error (ML)	229	1,496	905	785	1,238	1,455	6,107
Leakage through service points (ML)	62	284	100	80	114	203	843
Leakage around service points (ML)	17	64	26	20	31	54	213
Unauthorised Use (ML)	42	182	63	50	72	131	541
Total (ML)	**350**	**2,026**	**1,094**	**935**	**1,455**	**1,843**	**7,704**
Service point rationalisation							
Phase 3 Water Savings							
Meter error (ML)		98	490	355	196	544	1,683
Leakage through service points (ML)	2	50	149	58	92	102	454
Leakage around service points (ML)		10	31	12	19	22	95
Unauthorised Use (ML)	1	22	53	24	40	40	179
Total (ML)	**3**	**180**	**724**	**448**	**347**	**708**	**2,411**
Phase 4 Water Savings							
Meter error (ML)	1	229	866	311	656	921	2,984
Leakage through service points (ML)	2	74	175	91	137	198	676
Leakage around service points (ML)	-	15	37	19	29	42	142
Unauthorised Use (ML)	1	47	108	56	84	122	418
Total (ML)	**4**	**365**	**1,185**	**477**	**906**	**1,282**	**4,220**
Total Phase 3 savings (Replacement and rationalisation)	**263**	**1,167**	**1,419**	**1,256**	**1,008**	**1,870**	**6,984**
Total Phase 4 savings (Replacement and rationalisation)	**353**	**2,391**	**2,280**	**1,412**	**2,361**	**3,125**	**11,923**

Note – Totals may not sum due to rounding

Table 6-13 Phase 3 and Phase 4 Water Savings due to Service Point Replacement and Replacement – Shepparton and CG1-4 residual works

	SH	CG1-4	Total
Service point replacement			
Phase 3 Water Savings			
Meter error (ML)	153	641	793
Leakage through service points (ML)	25	180	205
Leakage around service points (ML)	5	39	44
Unauthorised Use (ML)	7	61	68
Total (ML)	**190**	**920**	**1,110**
Phase 4 Water Savings			
Meter error (ML)	348	823	1,171
Leakage through service points (ML)	20	148	168
Leakage around service points (ML)	5	39	44
Unauthorised Use (ML)	12	94	106
Total (ML)	**385**	**1,104**	**1,489**
Service point rationalisation			
Phase 3 Water Savings			
Meter error (ML)	-	-	-
Leakage through service points (ML)	2	131	133
Leakage around service points (ML)	-	28	28
Unauthorised Use (ML)	1	55	55
Total (ML)	**3**	**213**	**216**
Phase 4 Water Savings			
Meter error (ML)	4	312	317
Leakage through service points (ML)	2	152	154
Leakage around service points (ML)	-	32	32
Unauthorised Use (ML)	1	94	95
Total (ML)	**8**	**590**	**598**
Total Phase 3 Savings (Replacement and rationalisation)	**193**	**1,133**	**1,326**
Total Phase 4 Savings (Replacement and rationalisation)	**393**	**1,694**	**2,087**

Note – Totals may not sum due to rounding

6.7 Savings from Channel Remediation

6.7.1 Scope of Irrigation Channel Remediation Works

Channel remediation involves lining earthen channels, replacing channels with pipelines and bank remodelling. These works can generate irrigation water savings through reduced bank seepage and reduced bank leakage. A total of 189km of channel lining has been completed to date. 13.8km was completed in 2014/15 compared with 14.1km in 2013/14. The length of channel that has been remediated by irrigation area is shown in Figure 6-4.

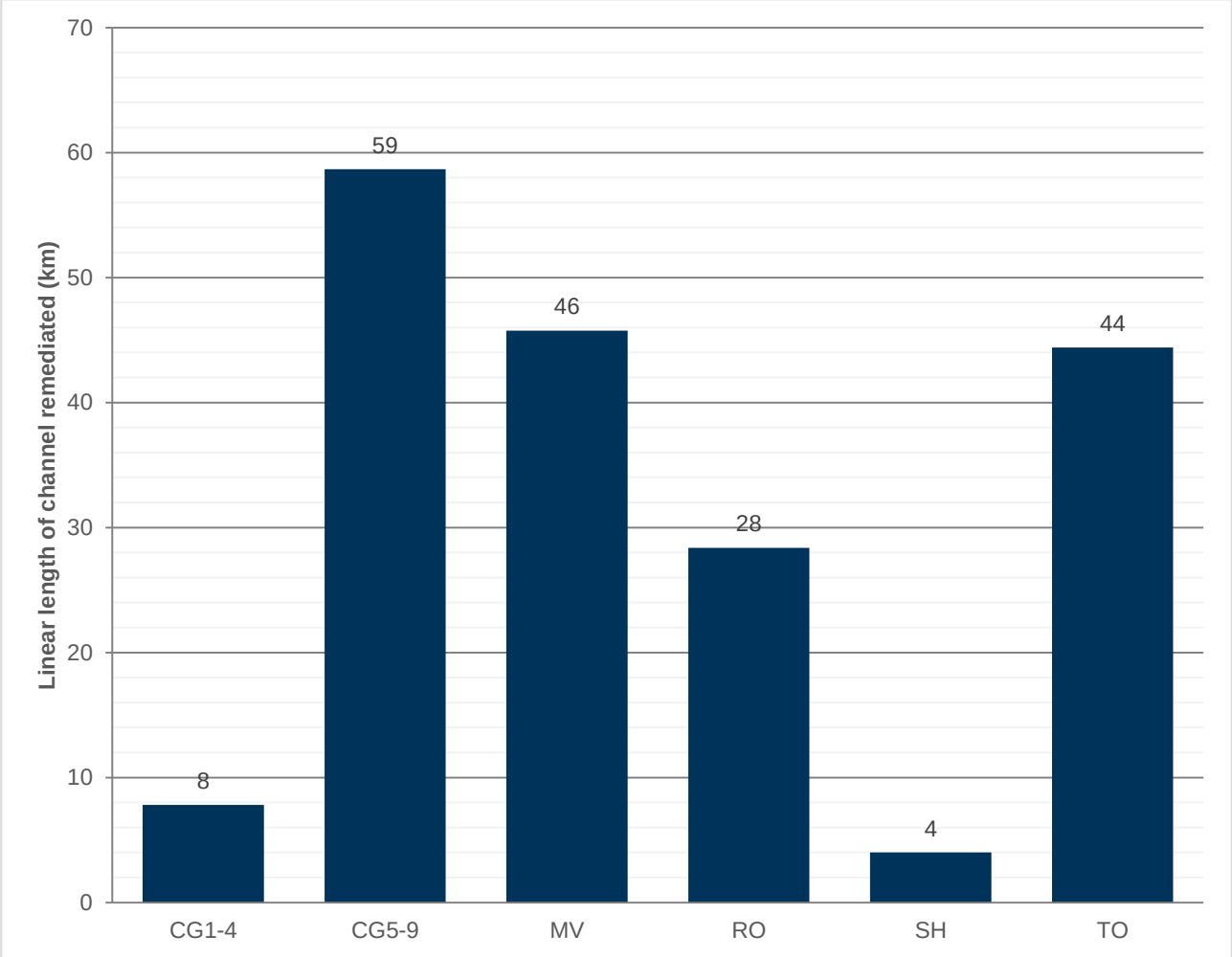

Figure 6-4 Length (Km) of channel remediated by irrigation area

6.7.2 Overview

The type of calculation employed for determining water savings due to channel remediation depends on the availability of pre and post works pondage data as detailed in Table 6-14.

Table 6-14 Calculation methods for Channel remediation works

Data availability	Calculation method
No pre or post remediation pondage testing data available	Theoretical method (No pre-works pondage test data) using Technical Manual Phase 2 calculations
Pre remediation pondage testing only available	Theoretical method (using pre-works pondage test data)
Both pre and post remediation pondage testing data available	Direct method

For the remediation works completed in 2008 (5km), no pre or post works pondage test data is available. Therefore, the theoretical method has been used for these works. The inputs and method are unchanged from the 2009/10 audit report for these works from 2008 and will not be discussed further.

For the works completed in 2009 pre-works pondage data is available for all sites except one. Post-works pondage testing data is only available for three of the 13 sites. For the works completed in 2010, 30 of 42 sites have both pre and post works pondage testing data available. This total is an increase on the 27 sites where both pre and post works data was available. The remaining sites from 2010 have only pre works pondage testing data available.

Savings estimates made using only pre works data and historical typical expected effectiveness factors will be validated with post works data over time. This may adjust the savings claimed in later years.

GMW omits the evaporation component from its savings as it assumes that there is likely to be negligible change in surface area of a channel pre and post remediation. This is a reasonable assumption and is conservative.

Both direct and theoretical equations have the same high level form:

$$WS_{YearX} = WS_{bank\ leakage} + WS_{seepage} + WS_{evaporation}$$

6.7.3 Water Savings Calculations

Theoretical Phase 3 calculations, where no pre-works pondage testing data is available, are not discussed as these only apply to the 2008 works. These were reviewed in 2009/10 and there has been no change since then. The equations in the updated *Technical Manual* for determining savings due channel remediation have been revised with the length and time discounting factors being removed.

Theoretical Method - Phase 3 Calculations– Pre-works pondage test data available

$$WS_{bank\ leakage} = [(L^{PRE\ WORKS} \times VL \times F(PA) \times (D_{YearX}/D_{base})) + (L^{PRE\ WORKS} \times FL \times F(PA)] \times EF$$

$$WS_{seepage} = S^{PRE\ WORKS} \times EF \times F(PA)$$

$$WS_{evaporation} = E^{PRE\ WORKS} \times EF$$

Direct Method - Phase 3 Calculations– Measured pre-works and post-works pondage test data is available

$$WS_{bank\ leakage} = (L^{PRE\ WORKS} - L^{POST\ WORKS}) \times F(PA)$$

$$WS_{seepage} = (S^{PRE\ WORKS} - S^{POST\ WORKS}) \times F(PA)$$

$$WS_{evaporation} = (E^{PRE\ WORKS} - E^{POST\ WORKS})$$

Theoretical Method - Phase 4 Calculations– Pre-works pondage test data available

$$WS_{leakage} = [(L^{PRE\ WORKS} \times VL \times F(LTCE)) + (L^{PRE\ WORKS} \times FL)] \times DF \times EF_S \times F(PA)$$

$$WS_{seepage} = S^{PRE\ WORKS} \times EF \times DF \times F(PA)$$

$$WS_{evaporation} = E^{PRE\ WORKS} \times EF \times DF$$

Direct Method - Phase 4 Calculations – Measured pre-works pondage test data is available

$$WS_{leakage(LTCE)} = [[(L^{PRE\ WORKS} - L^{POST\ WORKS}) \times F(PA) \times FL] + [(L^{PRE\ WORKS} - L^{POST\ WORKS}) \times F(PA) \times VL \times F(LTCE_{YearX})]] \times DF$$

$$WS_{seepage(LTCE)} = (S^{PRE\ WORKS} - S^{POST\ WORKS}) \times F(PA) \times DF$$

$$WS_{evaporation(LTCE)} = (S^{PRE\ WORKS} - S^{POST\ WORKS}) \times DF$$

GMW has adopted an alternative direct method for calculating $WS_{leakage}$ for Phase 3 savings as the Technical Manual appears to incorrectly omit the variable proportion of bank leakage. For calculating $WS_{leakage(LTCE)}$ in Phase 4 using the direct method, factor $F(LTCE_{base})$ replaces $F(LTCE_{YearX})$ as factor **F(PA)** in the equation is estimated for the baseline year. We consider that this is an appropriate approach and note that the water savings estimate are lower using this approach than that in the Technical Manual.

The revised baseline year water balance[6], has removed the concept of system fill. System fill was treated as operational flows that were not impacted by improved irrigation infrastructure because they occurred outside of the irrigation season. However, it has now been recognised that most channels that have been lined will hold water over the full year, including the non-irrigation season, and therefore water savings occur across the full year. In particular, there is reduced seepage in both the irrigation and non-irrigation seasons. As a result, the interpretation of the seepage calculation has been updated to be applied across the full 365 days of the year of operation, instead of only the irrigation season as previously calculated.

GMW has adjusted the water savings estimated due to channel remediation downwards for old leaking outlets existing when pondage tests were carried out. This is to avoid any possibility of double counting savings on both the remediation program and from service point upgrade works.

6.7.4 Input Data

The inputs required to calculate Phase 3 and Phase 4 water savings due to channel remediation are summarised in Table 6-15 and

[6] The revised baseline year water balance was independently audited in 2011/12.

Table 6-16. The first table details the parameters that are fixed or have been previously audited. The second table details the input data from the current year.

Table 6-15 Fixed Parameters and Baseline Year Parameters for Channel Remediation Water Savings Calculation

Parameter	Description	Source
VL	Proportion of bank leakage recognised as variable	Technical Manual
FL	Proportion of bank leakage recognised as fixed	Technical Manual
D_{base}	Customer deliveries in the baseline year	Baseline Year water balance
EF	Effectiveness Factor for channel remediation	Technical Manual
DF	Durability Factor for Channel Remediation	Technical Manual
$F(LTCE_{base})$	Long Term Cap Equivalent Conversion Factor for the baseline year	Department of Environment, Land, Water and Planning
F(PA)	Pondage Testing Adjustment Factor to account for dynamic losses in addition to static losses	Technical Manual Appendix F

Table 6-16 Current Year Parameters for Channel Remediation Water Savings Calculation

Parameter	Description	Source
$L^{PRE\ WORKS}$	Pre works bank leakage	Pondage testing
$L^{POST\ WORKS}$	Post works bank leakage	Pondage testing
$D_{Year\ X}$	Customer deliveries in the year in question to the irrigation system	IPM reports
$S^{PRE\ WORKS}$	Pre works seepage	Pondage testing
$S^{POST\ WORKS}$	Post works seepage	Pondage testing

We have reviewed the input data and confirm that the fixed parameters sourced from the Technical Manual are correct, as are the deliveries in the Baseline Year sourced from the Baseline Year Water Balance. Where no post-works pondage testing data is available, GMW has adopted an EF estimate of 90% for HDPE, 85% for clay, and 50% for bank remediation, having been revised overtime from a flat 90% EF as more pre and post-works pondage testing data became available.

The following summary is a review of the inputs from the current operating year:

Pre Works and Post Works bank Leakage and Seepage ($L^{PRE\ WORKS}$, $L^{POST\ WORKS}$, $S^{PRE\ WORKS}$, $S^{POST\ WORKS}$)

Where pondage testing data is available, pre and post works leakage and seepage are determined through evaluation of site testing results. We have reviewed the pondage testing methodology and results in previous audits and commented that we believe that the pre and post works seepage and leakage estimates, determined through site testing, are sound. Where post pondage data is estimated from pre works data and assumed remediation effectiveness (based on the measured remediation effectiveness in other pools), follow-up validation of the estimates with measured post pondage test data, needs to be made in the future.

Customer Deliveries in the Current Year (D_{YearX})

Customer deliveries in each irrigation district are determined from IPM reports. The volumes used are sourced from the same reports used for GMW's annual reporting.

6.7.5 Results

Water savings due to channel remediation are calculated on a channel by channel basis as each channel has a different leakage and seepage rate. The meter error correction is applied to whole irrigation areas.

Table 6-17 Phase 3 and Phase 4 Water Savings due to Channel Remediation

	SH	CG1-4	CG 5-9	MV	RO	PB	TO	Total
Phase 3 savings (ML)								
Stage 1	-	-	4,853	3,277	1,514	**-**	2,153	11,797
Stage 2	356	822	40	1,125	-	-	248	2,591
TOTAL	**356**	**822**	**4,893**	**4,402**	**1,514**	**-**	**2,401**	**14,388**
Phase 4 savings (ML)								
Stage 1	-	-	5,160	3,712	1,777	**-**	3,031	13,680
Stage 2	365	817	40	1,046	-	-	228	2,496
TOTAL	**365**	**817**	**5,200**	**4,758**	**1,777**	**-**	**3,259**	**16,176**

Note – Totals may not sum due to rounding

7 Recommendations on Technical Manual and Water Savings Approach

The Audit Protocol requires that comment be made following audit work regarding:

- Potential improvements to estimate the water savings in the areas of:
  - data collection
  - data analysis
  - assumptions
  - methods.
- Recommended changes to the Technical Manual for the Quantification of Water Savings.

We have observed improvements in the methods employed by GMW (and previously NVIRP) over the six years for which Cardno has completed audits of water savings estimates. In particular, GMW has made significant improvements in its records for construction works, particularly for the rationalisation of assets. However, we noted that the quality of the sample of construction records reviewed in 2014/15 were of a lesser quality than those reviewed in 2013/14. We therefore make the following recommendations in relation to quality assurance of construction records:

- If decommissioning of channels or service points has occurred through a channel block then an ITP or other quality assurance document should still be generated that covers all assets downstream of the block with asset data and photos included, as well as a plan showing the location of the decommissioned assets in relation to the block.
- GMW should reiterate to all internal staff and external contractors responsible for recording construction activities the importance of the quality of documentation.

For 2014/15, GMW has acted on our previous recommendation regarding outfall data and has implemented a tool that sources data from SCADA which is used as the primary point of truth, subject to review by operations. This is an improvement on previous practices.

This audit has not identified any need to change the Technical Manual. However, there may be merit in formalising in the manual the amended methodology applied by GMW in calculating water savings in certain areas. For example, subtracting from savings the losses incurred by new meters being introduced into the system. We are also aware that GMW has identified potential changes to the Technical Manual for consideration by the technical committees.

8 Progress against previous audit recommendations

The Audit Protocol requires the current year audit to report on the progress made by the relevant organisations in achieving the recommendations from previous audits. For the 2013/14 audit, we retained the consolidated recommendations from previous years to streamline the tracking of implementation of the recommendations.

In 2013/14 we identified outstanding recommendations in the main area of outfalls. .

The revised schedule detailing the actions and progress to date is shown in Table 8-1.

Table 8-1 Schedule of progress against previous audit actions

Ref	Year	Area	Comment	2014/15 Audit comment
13/14-1	2013/14	Outfalls	Operators should note reasons why their readings differ from SCADA measurements	The outfall data recording tool includes a change tracking tool. Operators review the SCADA outfall and advise of any changes. Reasons for changes must be noted and are date stamped. We consider that this recommendation is closed but note that ongoing diligence over the review of outfall data is required.
13/14-2	2013/14	Outfalls	For outfalls not connected to SCADA GMW's operators should report on the logsheets how frequently the sites are visited and on what basis their measurements are made	This recommendation is no longer relevant due to the introduction of the outfall data tool
13/14-3	2013/14	Outfalls	Operator logsheets should be reviewed to ensure that they are consistent with GMW's corporate asset identification.	This recommendation is no longer relevant due to the introduction of the outfall data tool. GMW has undertaken reconciliation of outfall identification as part of introducing the tool
12/13-1	2012/13	Outfalls	As noted in previous years we recommend that the SCADA be used as the primary point of reference for recording, storing and reporting outfall measurement data given that most major outfalls now have online measurement. Operators should continue to record where adjustments to flows need to be made, e.g. if a sensor is out of the flow. The SCADA may be programmed to identify (automatically or by manual prompting) rainfall flood water discharge events and thereby report an outfall figure that is net of flood volumes	GMW has introduced a tool that uses SCADA data as the primary source of outfall data. This tool we continue to be developed in coming years. We consider this recommendation closed.
12/13-2	2012/13	Outfalls	We recommend that GMW undertakes reconciliation of its outfall information. The exercise should compare the outfall IPM number, structure number, SCADA reference, location in GIS and actual location recorded on site. The works should be prioritised so that those outfalls most critical to the water savings calculations be investigated first. This recommendation follows on from our 2009/10 recommendation that the outfall names used by GMW should be reconciled with the outfall names used in the SCADA. Maintenance will be required as new outfalls are built and old ones are removed.	Complete

Ref	Year	Area	Comment	2014/15 Audit comment
12/13-3	2012/13	Outfalls	We believe that GMW must improve how it records and uses outfall data for the purpose of water savings audits. Our recommendations for this area are summarised in our response to Item 4 from 2009/10 in Appendix A. We are of the opinion that GMW Operations must take the lead in these initiatives and that these should be largely implemented before the commencement of the 2012/13 irrigation season given that two years have passed since the first recommendations were made in this area.	See 12/13-1. This recommendation is closed.

Audit of Irrigation Modernisation Water Recovery 2014/15 Irrigation season

APPENDIX A

Document Register

Cardno
Shaping the Future

Calculations

- TATDOC-#4092771-v1-AUTOMATION_SAVINGS_FOLLOWING_AUDIT_FINDS_26_NOV_INCL_RO435_AND_POD_SUM_CORECTS.XLS
- updated with RO405A v2 AUTOMATION_OUTFALL_WATER_SAVINGS_2014_15.xls
- v1 - Audit 2015 - old FPA Durability - v4.3.2 Channel Remediation Database - with Macros.xlsm
- TATDOC-#4073550-v1-METER_WORKS_AND_SAVINGS_STAGE_1_&2.XLSX
- TATDOC-#4075584-v1-SPREAD_-_2015_CHANNEL_REMEDIATION_AUDIT_CALCULATIONS.XLSM
- TATDOC-#4075584-v3-SPREAD_-_2015_CHANNEL_REMEDIATION_AUDIT_CALCULATIONS.XLSM
- TATDOC-#4076601-v1-VER_2_DECOMMISSIONING_WATER_SAVINGS_CALCS_SPREADSHEET_2014_15.XLSX
- TATDOC-#4077595-v1-UPDATED_METER_SAVINGS_STAGE_1&2__AUDIT_2014_15.XLSX
- TATDOC-#4077628-v1-UPDATED_CG1-4_SHEPP_METER_SAVINGS_AUDIT_2014_15.XLSX

Other

- Other\Lake_Elizabeth.pdf
- Other\Lake_Leaghur.pdf
- Other\Lake_Meran.pdf
- Other\Lake_Murphy.pdf
- Other\Lake_Yando.pdf
- Other\Little_Lake_Boort.pdf
- Other\Loddon_River.pdf
- Other\McDonalds_Swamp.pdf
- Other\NCCMA-43978_-_Pig_Swamp_Environmental_Watering_Plan_FINAL_.pdf
- Other\Round_Lake.pdf
- Other\IR191191 A0-L CG Regulator Rollout & Outfalls.pdf
- Other\IR191191 A0-L LV Regulator Rollout & Outfalls.pdf
- Other\IR191191 A0-L MV Regulator Rollout & Outfalls.pdf
- Other\IR191191 A0-L RO Regulator Rollout & Outfalls.pdf
- Other\IR191191 A0-L SH Regulator Rollout & Outfalls.pdf
- Other\IR191191 A0-L TO Regulator Rollout & Outfalls.pdf
- Other\Johnson_Swamp.pdf

Workpack documents

- TO3009_WP_PHOTO_LEFT.JPG
- TO3009_WP_PHOTO_RIGHT.jpg
- TO3009_WP_PHOTO_SP.jpg
- TO3009_WP_PHOTO_US.JPG
- TO3074_Commissionning.pdf

- TO3074_Workpack.pdf
- TO3074_WP_PHOTO_DS.jpeg
- TO3074_WP_PHOTO_LEFT.jpeg
- TO3074_WP_PHOTO_RIGHT.jpeg
- TO3074_WP_PHOTO_SP.JPG
- TO3074_WP_PHOTO_US.jpeg
- V__B6F8 - SP616-617.JPG
- Workpack RO15A-20.pdf
- WP_20140807_067 - MV530-532 HDPE.jpg
- WP_20140811_033 - MV530-532 Clay.jpg
- WP_20141119_013 - SP1118-1121.JPG
- WP_20141119_015 - SP1118-1121.JPG
- WP_20150304_022 - SP616-617.JPG
- TODS2198A WORK PACK 0521 TORRUMBARRY STAGE 1.PDF
- 1388_ST044204_Block.pdf
- 290620151684.jpg
- 290620151685.jpg
- 310720151755.jpg
- 310720151757.jpg
- 310720151760 scour + 2 meters.jpg
- 310720151762.jpg
- CH000288.docx
- CH000288.JPG
- CH000913.JPG
- CH003853.JPG
- Completed workpack MV6011.pdf
- FW CG1-4 13064 Decommissioning.msg
- IMG_1072.jpg
- IMG_1073.jpg
- IMG_1074.jpg
- IMG_1075.jpg
- IMG_1076.jpg
- IMG_1077.jpg
- IMG_1078.jpg
- IMG_1079.jpg
- IMG_1080.jpg
- IMG_1081.jpg
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- IMG_1084.jpg
- IMG_1085.jpg
- IMG_1086.JPG
- IMGP1857.jpg
- IMGP1858.jpg
- IMGP1859.jpg
- IMGP1860.jpg
- MV530-532 Workpack.pdf
- MV577_CivilConstruction.pdf
- MV1230 WORK PACK 1017 MURRAY VALLEY.PDF
- MV5031 WORK PACK 2317 MURRAY VALLEY.PDF
- MV5398_Commissionning.pdf
- MV5398_Workpack.pdf
- MV5398_WP_COMM_PHOTO1f4ca336-4d9f-4520-b1db-eae2a1b044f3.jpg
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- MV5398_WP_COMM_PHOTO6c8569dc-96e5-4d42-9036-4a1239287481.jpg
- MV5398_WP_COMM_PHOTO8b8b5224-5975-4729-a743-9cf4877e52b6.jpg
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- MV5398_WP_CON_PHOTO0349d11a-1c94-4efd-8021-027f3eeba834.jpg
- MV5398_WP_EPWPC_KRISLEE.pdf
- MV5398_WP_ITP_KRISLEE.pdf
- MV5398_WP_ITP_PEDESTAL.pdf
- MV5398_WP_ITP_TYCO.pdf
- MV5398_WP_PHOTO_DS.jpg
- MV5398_WP_PHOTO_LEFT.jpg
- MV5398_WP_PHOTO_RIGHT.jpg
- MV5398_WP_PHOTO_SP.JPG

- MV5398_WP_PHOTO_US.JPG
- MV5398_WP_RATIO_EPWPC.pdf
- MV5398_WP_RATIO_ITP.pdf
- MV5398_WP_RATIO_SDS.pdf
- MV5398_WP_SDS_KRISLEE.pdf
- MV5398_WP_SDS_ROBCOLLIE.pdf
- MV6011.pdf
- MV6047 WORK PACK 1085 MURRAY VALLEY STAGE 2.PDF
- MV6165 WORK PACK 0216 STAGE 1 MURRAY VALLEY (2).PDF
- MV6165_Workpack.pdf
- MV6207 WORK PACK 2231 MURRAY VALLEY STAGE 2.PDF
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